DRAFT REMEDIAL ACTION PLAN AND DESIGN REPORT

IR SITE 7 (WEST BASIN) DREDGING PROJECT
PORT OF LONG BEACH, CALIFORNIA

Prepared for

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1 INTRODUCTION

This report describes remedial design elements and anticipated construction actions for the planned dredging and disposal of chemically impacted sediments from Installation Restoration (IR) Site 7, a portion of the Long Beach Naval Complex (LBNC) at the Port of Long Beach (Port), California. Remedial action is required to comply with an August 2007 Record of Decision (ROD; USEPA 2007) for the site.

Specific elements of this report include a description of the existing conditions within the Long Beach Harbor's West Basin (West Basin), a review of the dredge and disposal plan proposed to comply with the terms of the final ROD, a review of the anticipated construction schedule and project sequencing, a summary of the expected short-term impacts along with potential Best Management Practices (BMPs) that will be used to further minimize potential impacts, and contingency measures that may be needed if construction activites do not accomplish the necessary removal of impacted sediments.

The Port has separately prepared a California Environmental Quality Act (CEQA) Mitigated Negative Declaration (MND) document detailing the predicted environmental impacts anticipated for the selected remedy. That same information has been summarized in this document and was used to develop the recommended construction activity BMPs.

1.1 Project Description and History

IR Site 7 comprises approximately 700 acres of submerged land in the Port, which was formerly used by the U.S. Navy for training troops and maneuvering, anchoring, berthing, and maintaining vessels. It is adjacent to three former dry docks used by the U.S. Navy. Figure 1-1 provides the general location of the project site and Figure 1-2 provides a more detailed depiction of the specific areas of interest.

In 1935, the U.S. Navy negotiated a 30-year lease with the City of Long Beach (City) for developing the property into a naval facility. The U.S. Navy additionally purchased a strip of coastline along the southern portion of Terminal Island from the cities of Long Beach and Los Angeles in 1938. Beginning in 1938, the U.S. Navy operated the LBNC for naval and other marine activities, such as providing maintenance facilities for the berthing operations of tugboats, scows, and similar vessels. The LBNC provided logistical support for assigned

ships and performed work in connection with construction, conversion, overhaul, repair, alteration, dry-docking, and fitting out of ships.

During LBNC operation, various fuels, oils, and other organic and metal wastes were discharged into IR Site 7 and LBNC in general. From the early 1940s to the mid-1970s, drainage from various industrial areas, and from cleaning and processing tanks, was discharged into Long Beach Harbor's West Basin, which was within the boundaries of the LBNC. It is believed that wastes were discharged through the storm drain system and from the flushing of dry docks. As a result, surface waters within the area received inputs of heavy metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Over time, these contaminants accumulated in sediments in parts of the West Basin to levels predicted to cause ecological risks to the resident benthic communities.

After more than 50 years of service, the Naval Station Long Beach (NAVSTA) was closed on September 30, 1994, under the Base Realignment and Closure Act (BRAC) II. During this same year, the U.S. Navy initiated a comprehensive field sampling effort to support a Remedial Investigation (RI) of the West Basin's sediments (Bechtel 1997) following Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance. Included in the RI were detailed ecological and human health risk assessments from potential exposures to site sediments. On September 30, 1997, Long Beach Naval Station (LBNS) was closed under BRAC IV. During this period, site ownership of the submerged land (except the 100-foot annulus) within the Port's West Basin was formally reverted back to the Port.

The results of the RI were published in 1997 and concluded no potential human health risks were posed by site sediments, but the results did conclude that ecological risks to benthic organisms residing in the IR Site 7 sediments could occur. As a result, a subsequent Feasibility Study (FS) was conducted to identify areas of potential ecological concern and possible remedial alternatives for managing these risks. The final FS was published in September of 2003 and identified several areas for sediment remediation and selected dredging with on-site disposal as the preferred alternative. The final FS was later amended to accept off-site disposal as an equally effective alternative.

Pursuant to the terms of the Lease in Furtherance of Conveyance (LIFOC) between the City and U.S. Navy, the Port will implement the required response and corrective actions at IR Site 7. The Port subsequently entered into a Consent Agreement with the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), to establish the process and timetable for the Port's implementation of the remedy selected during the FS. This work is required to be conducted in a manner consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] part 300 et seq.), as amended; California Health and Safety Code (Sections 6.5 and 6.8), as amended; and other applicable federal and state laws and regulations.

In September of 2007, a ROD was prepared and executed by the U.S. Navy in order to accept the proposed remedies from the RI/FS. This remedial action plan and design report documents the Port's proposed actions for complying with the ROD as well as the Consent Agreement and LIFOC.

1.2 Cleanup Areas and Anticipated Remedial Actions

The FS identified, screened, and evaluated a range of remedial alternatives to reduce the potential for adverse biological effects estimated for benthic communities living in the chemically impacted sediments of IR Site 7.

In the FS, IR Site 7 was divided into seven Areas of Ecological Concern (AOECs) to account for variable conditions across the site and potentially different remedial alternatives available to address site contaminants within each area:

- AOEC-A is in the northeastern corner of the West Basin, alongside Pier T. It comprises approximately 15 acres in aerial extent and was found to contain elevated concentrations of chemical compounds in surface sediments. No sediment toxicity or benthic community effects were reported.
  - Note that AOEC-A originally extended along the entire northern portion of the West Basin during the RI phase, but was dredged by the Port to deepen the area for shipping berths; the contaminated sediments from this area were removed and managed in accordance with state and federal permits and requirements.

- AOEC-B is defined as the area between Pier 9 and Pier 11. It comprises approximately 80 acres in aerial extent and was found to contain elevated chemical concentrations in surface sediments. No sediment toxicity or benthic community effects were reported.
- AOEC-C is defined as the area between Pier 11 and Pier 15. It comprises approximately 62 acres in aerial extent and was found to contain elevated chemical concentrations. Sediment toxicity and adverse benthic community effects were reported for surface sediment.
- AOEC-D is defined as the area offshore of the tip of the U.S. Navy Mole and the entrance to the West Basin. It comprises approximately 13 acres in aerial extent and was found to contain one chemical compound slightly above the target screening level, low toxicity, and no benthic observed effects.
- AOEC-E is defined as the area beneath Pier 12 (i.e., Fuel Pier). It comprises approximately 5 acres in aerial extent and was found to contain elevated chemical concentrations and minor sediment toxicity, but no reports of adverse benthic community effects.
- AOEC-F is defined as the area beneath Pier 15. It comprises approximately 4 acres in aerial extent and was found to contain elevated chemical concentrations, but no sediment toxicity or adverse benthic community effects.
- AOEC-G is defined as the area beneath Pier 16. It comprises approximately 5 acres in aerial extent and was found to contain elevated chemical concentration and minor sediment toxicity, but no adverse benthic community effects.

The sediments within each AOEC area were individually evaluated against a range of remedial action alternatives to determine the best mitigation measure for reducing potentially adverse biological effects. Alternatives considered include:

- *No Remedial Action*. This alternative involves leaving the chemically impacted sediments in place. In doing so, the initiation and/or continuation of natural recovery processes would be ongoing. Any potential adverse effects due to factors, such as resuspension of chemically impacted sediments, which could occur with other remedies, would be avoided.
- *Limited Action – Periodic Sediment Quality Monitoring*. Similar to the no remedial action option, this alternative would leave the chemically impacted sediments in

place, but a monitoring program would be established. The monitoring program would consist of sediment sampling and laboratory analysis to determine whether the natural recovery processes are effective in improving site conditions.

- *Limited Action – Institutional Controls*. Similar to the no remedial action option, this alternative would leave the chemically impacted sediments in place, but institutional controls (e.g., deed restrictions) would be implemented. Deed restrictions would include limiting the future use of IR Site 7 to Port-related activities, as to maintain access control and oversight. Limiting future access ensures that no disturbance of the subsurface sediments would occur without prior authorization and evaluation.
- *In Situ Capping of AOEC Areas with "Clean" Imported Sediments*. This alterative would leave chemically impacted sediments in place and would cap them with an isolating medium, such as imported "clean" dredged material. A monitoring program would also be implemented to ensure the cap is placed as intended, is effective in isolating the sediments from the environment, and is maintaining its design thickness.
- *Removal and On-site (Within IR Site 7) Containment of AOEC Sediments – Discharge of Dredged Material Along Inboard Face of U.S. Navy Mole*. This alternative would remove the chemically impacted sediments and place them within a diked containment area constructed on top of chemically impacted sediments within IR Site 7. The containment area would be capped with a 2-foot-thick layer of "clean" sediment and a 1-foot cover of asphalt pavement.
- *Removal and Off-site (Outside IR Site 7) Containment of AOEC Sediments – Discharge of Dredged Material Along Outboard Face of U.S. Navy Mole*. This alternative would remove the chemically impacted sediments and place them within a diked containment area constructed on top of chemically impacted sediments outside the IR Site 7 boundary. The containment area would be capped with a 2-foot-thick layer of "clean" sediment and a 1-foot cover of asphalt pavement.
- *Removal and Discharge of AOEC Sediments at Off-site (Outside IR Site 7) Projects*. This alternative would remove chemically impacted sediments and discharge them outside of the IR Site 7 boundary, such as at a Port development project like the Pier G Slip Fill.

A comparative analysis of the advantages and disadvantages of each remedial action alternative, by AOEC, resulted in a determination of the preferred remedial action alternative (Proposed Plan), as detailed in Bechtel (1997). Each of these remedial alternatives was further evaluated against the Threshold Criteria and the Primary Balancing Criteria as defined in the NCP. Threshold Criteria apply to the overall protection of human health and the environment and compliance with federal and state applicable or relevant and appropriate requirements. Primary Balancing Criteria weigh the positives and negatives of each alternative in terms of long-term effectiveness and permanence, reduction of toxicity, mobility or volume, short-term effectiveness, implementability, and cost.

The Proposed Plan, selected through the FS process, provides the greatest level of protection to IR Site 7 benthic communities, achieves the remedial action objectives, provides the greatest level of long-term effectiveness and permanence, and is easily implementable. The remedies of the Proposed Plan include:

- AOEC-A and AOEC-C: Removal of the AOEC sediments and disposal at off-site (outside IR Site 7) projects, thereby creating a clean substrate supporting the presence of an ecologically productive and diverse benthic community
- AOEC-B: No remedial action necessary to protect the environment as chemical concentrations have not resulted in sediment toxicity or adverse effects on the benthic community
- AOEC-E, AOEC-F, and AOEC-G (Pier AOECs): Limited action necessary for institutional controls to be implemented for the purpose of preventing unauthorized or uncontrolled disturbance and/or exposure of beneath-pier chemically impacted sediments

Since AOEC-B, AOEC-E, AOEC-F and AOEC-G were accepted as no action or limited action areas and do not require a formal remedy, these AOECs are not discussed further in this report. The remainder of this report will focus on remedial action efforts for AOEC-A and AOEC-C. For purposes of evaluation, AOEC-C has been subdivided into two areas—AOEC-C East (area to the east of Pier 12) and AOEC-C West (area to the west of Pier 12), which was based on sediment contamination potential. Figure 1-2 presents the layout of the project site and the location of each AOEC.

1.3 General Description of Remedial Action

The Remedial Action Objective (RAO) for AOEC-A and AOEC-C is to protect the ecologically productive and diverse benthic community in the sediments of the IR Site 7 AOECs, consistent with the existing land use (Port-related and industrial).

The selected remedial alternative involves eliminating the pathway for potential risk from chemicals of ecological concern (COECs) to the resident benthic community by dredging impacted sediments and disposing of them at an off-site location (i.e., Pier G Slip Fill site) designed to house such material. Sediments are considered to be "impacted" if they contain chemical concentrations for one or more COEC in excess of the Sediment Management Objectives (SMOs) developed for the project and defined in the ROD (Table 1-1).

In order to fulfill the requirements of the LIFOC and SMOs as outlined in the U.S. Navy's ROD for the property, the Port intends to remove up to approximately 800,000 cubic yards (cy) of chemically-impacted sediments from IR Site 7. The dredged material will be placed in the previously authorized Pier G Slip Fill site located near the West Basin for final confined disposal. The practice of disposing impacted sediments inside engineered port fills is extremely common globally, nationally, and regionally. The construction and placement methods have been developed and refined over the past 30 years and significant long-term monitoring data exists to show that port fills are very effective in isolating contaminated sediments. Disposal activities inside port fills are managed under the Clean Water Act and, as with the construction process, water quality monitoring techniques are equally advanced. Documentation to demonstrate the environmental protectiveness of this planned management technique is provided in Section 5.4 of this report.

Specifically, in order to fulfill the proposed project's purpose, the Port must undertake the following actions related to the chemically-impacted sediments in the West Basin:

- Remove four sunken barges from AOEC-C East and West
- Remove the abandoned sonar calibration pier from the U.S. Navy Mole on the southern portion of IR Site 7 in AOEC-C West
- Dredge a sufficient volume of material from AOEC-A and AOEC-C to achieve the target cleanup goals (to be verified by confirmation sampling)
- Transport the dredged material to the separately-permitted Pier G Slip Fill site for final confined disposal

Dredging remedies would achieve the RAO upon confirmation that the targeted sediments have been removed as planned and would preclude the need for further remedial action.

1.4 Applicable or Relevant and Appropriate Requirements

Applicable or Relevant and Appropriate Requirements (ARARs) are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law.

For AOEC-A and AOEC-C, the FS concluded that (at a minimum) the following ARARs should be implemented:

1. *Chemical Specific.* Chemical specific ARARs are health or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable ecological risk screening values for cleanup. During the FS, chemical concentrations for which there would be no cause of concern for ecological risk were determined using a sediment triad approach. The resulting specific concentration thresholds for COECs are listed in Table 1-1. These values were used to define the site SMOs and therefore were the bases for determining the required areas and depths of sediment removal at AOEC-A and AOEC-C.
2. *Location Specific.* In addition to requirements related to the protection of identified bird and mammal species, associated prey and habitat, and water quality, the location-specific ARARs applicable to this alternative include technical requirements of the Rivers and Harbors Act for construction of dikes and areas near navigation lanes. The site-specific ecological risk assessment results indicate that the protected

species identifed for the IR Site 7 AOECs are not considered to be among potential receptors. The potential risk posed by the impacted AOEC sediments for marine mammals is estimated as low and could not be directly related to site conditions. Remedial action will further minimize the potential risk posed by sediment COECs and will be conducted in a manner protective of wildlife species. After removal of the chemically impacted sediments, the remaining AOEC-A and AOEC-C sediments would not be expected to pose a potential risk to the marine environment.

3. *Action Specific.* Sediment removal with the use of dredging equipment is a common occurrence in harbor areas, and a remedial action is not likely to interrupt regular Port traffic or habitats for migratory birds. Relocation of AOEC-A and AOEC-C sediments is not expected to introduce materials that would adversely impact water quality and be inconsistent with beneficial uses of Los Angeles and Long Beach Harbors. The impact of dredging on water quality is expected to be limited to resuspension of AOEC-A and AOEC-C sediments in the water column in the immediate work area. This will be monitored and mitigated, if necessary, using the following approach:
    - The water column would be monitored in accordance with the substantive provisions of Section 6 of the Los Angeles Regional Water Quality Control Board (LARWQCB) Basin Plan as related to discharge of dredged sediments.
    - The monitoring results would be compared to the LARWQCB Basin Plan's Water Quality Objectives and to federal water quality standards.
    - Silt curtains surrounding the dredge areas would minimize the extent of the water affected by increased turbidity and sediment resuspension (Bechtel 2003).

For a complete description of ARARs that pertain to this project, including applicable federal and state codes and acts, please refer to Appendix A of the *Final Feasibility Study Report* (Bechtel 2003) or Section 13 of the ROD (USEPA 2007).

2 EXISTING CONDITIONS

2.1 Physical and Chemical Conditions

Physical properties of surface and subsurface sediments throughout IR Site 7 were evaluated through laboratory grain size analyses, total organic carbon (TOC), and observations made during sampling activities. IR Site 7 sediments were observed to be primarily fine grained (i.e., sediment particles smaller than 62.5 micrometers), averaging 65 percent fines overall. Surface sediment samples collected near the IR Sites 7 entrance contained a high percentage of coarser, sand-sized particles. Sediments located beneath piers, along the northern seawall, and along the U.S. Navy Mole contained a greater percentage of fine-grained particles, more so than the central areas of IR Site 7. TOC was found in a distribution similar to that of the sediment fines, with greater concentrations along the northern seawall, the U.S. Navy Mole, and beneath the piers (Bechtel 2003).

Chemical properties of surface and subsurface sediments were evaluated through laboratory analyses. Previous studies conducted within IR Site 7, by MEC Analytical Inc. in 1999 and Bechtel International, Inc., in 2003, characterized surface sediments along the docks and piers as being contaminated with PAHs, the pesticide dichlorodiphenyltrichloroethane (DDT), PCBs, and heavy metals. However, central areas of the West Basin were less contaminated then the nearshore areas. The principle contaminants of concern in the central areas are PAHs.

Sampling conducted during the FS in 1998 (Bechtel 2003) demonstrated that specifically in AOEC-A, mercury was significantly elevated above SMOs to a depth of approximately 5 feet; however, no significant biological effects were detected in toxicity tests. In AOEC-C East and West, mercury, lead, PAHs, and total PCBs were elevated in surface sediments to approximately 3 feet. Additional, toxicity to echinoderms as well as benthic community effects were observed in sediments for AOEC-C East and West.

Additional sediment sampling was conducted in AOEC-A, AOEC-C East, and AOEC-C West by Weston Solutions, Inc. (Weston), in June of 2007 in order to confirm the results of the FS and further delineate the vertical and horizontal sediment contamination within the dredging parameters of IR Site 7 (Tables 2-1 through 2-13) sampling locations are shown in Figure 2-1. In AOEC-A, 1-foot interval sampling per core location results indicated copper,

lead, mercury, and zinc were detected at concentrations greater than the SMOs only in the top 3 feet of sediment with the exception of two sampling locations where mercury and zinc exceeded SMOs as deep as 4 feet. As an area wide composite, arsenic, copper, mercury, nickel, and zinc were detected at concentrations below SMOs in AOEC-A. In AOEC C-East, no metals were detected at concentration in exceedance of their respective SMOs, for both 1-foot interval samplings and area wide composite samplings. In AOEC-C West, 1-foot interval sampling per core location results indicated mercury and zinc were detected at concentrations greater than the SMOs only in the top 4 feet of sediment. In an area wide composite for AOEC-C West, copper, nickel, and zinc were detected at concentrations below SMOs.

During the environmental review process for the IR Site 7 project, DTSC raised a concern regarding potentially elevated Soluble Threshold Limit Concentrations (STLC) estimated for the West Basin dredged material based on total concentrations. To address these concerns, and to prove that none of the material proposed for dredging would be considered "hazardous material" under California Code of Regulation (CCR) Title 22 regulations, the Port selected six samples from its last round of dredged material characterization (Weston 2007) that contained the highest total metals (i.e., copper, lead, and mercury) concentrations and sent them to an analytical laboratory for rush turn-around-time STLC testing. The total metals results for these six samples were comparable with the highest values observed during the entire FS and remedial design process.[1] The results of those tests, presented in Table 2-14, confirmed the Port's prediction that little, if any, additional leaching would occur from the marine sediments.

Measured STLCs were all well below the CCR Title 22 STLC thresholds, and more than 70 percent of the analyses contained nondetectable concentrations in the leachate. As a result, this data confirms that the material is not a "hazardous waste" according to the CCR Title 22 regulations and would not pose a risk to groundwater resources, even if an underlying groundwater source did exist at Pier G Slip Fill site. These results are not surprising since the affected sediments have been submerged in the marine environment for about 50 years, and thus, any readily leachable metals or organic compounds would have already

1. A total of approximately 500 samples have been tested to date from over 110 distinct sample stations located within the proposed dredge prism. The samples selected for STLC testing represent the upper end of the range of concentrations observed during any of the previous site investigations.

partitioned into the water column and been carried away from the site by the prevailing currents. This theory is supported by the basic concepts of equilibrium partitioning in sediments, which states that in order for contaminants to cross the interface between dredged material solids and water there must be a difference in chemical potentials. When chemical potentials are equal, the net transfer of contaminants across the solid-water interface is zero, and the mass of contaminant in each phase is constant but not necessarily equal. This stage is considered to be the equilibrium condition, and the ratio of contaminant mass in the solid phase to contaminant mass in the aqueous phase does not change. Over time, as the gradient between the sediment and water phases are minimized, the rate of partitioning is reduced.

2.2 Surrounding Land Use

General land use at and in the vicinity of the former LBNC, IR Site 7, and the future Pier G Slip Fill site is primarily Port-related and industrial. Facilities immediately surrounding IR Site 7 include tank farms; automobile-, cement-, and cargo-handling terminals; and storage terminals. The areas east and west of IR Site 7 are used for commercial shipping, liquid bulk handling, and heavy and industrial activities. The area north of the former LBNC is used for oil production activities. Terminal Island, where the former LBNC once operated, comprises the western portion of the Port and the eastern portion of the Port of Los Angeles. These ports participate in heavy shipping traffic, container storage, cargo handling, dredging activities, and loading/offloading operations. The future use of IR Site 7 is identified as Port-related and industrial (Bechtel 1997).

The area slated for disposal of IR Site 7 contaminated sediments, the Pier G Slip Fill, is a 2,500-foot-long by 500-foot-wide slip that extends north from the Southeast Basin and essentially bisects Pier G. This area is used for container cargo offloading and storage. Dredged material will be placed in a matter that will not change the existing land use. The dredged material will be placed behind a 200-foot-thick berm, topped with 40 feet of clean, sandy material, and paved with asphalt.

2.3 Hydraulic Conditions

Southern California coastal tides are semidiurnal, with two low and two high tides of unequal height every 25 hours. Rising tides, which vary with the phase of the moon, enter

Long Beach Harbor and flow up the various channels and basins while falling tides flow in reverse. Tidal currents generally create water circulation patterns, which within IR Site 7 occur in a clockwise manner. Mean tide in Long Beach Harbor has a maximum range of 5.5 feet. The maximum velocity at the entrance to Los Angeles and Long Beach Harbors has been estimated at 0.54 feet per second for ebb tide and 0.46 feet per second for flood tide. Velocity magnitudes throughout Los Angeles and Long Beach Harbors generally are small, usually less than 1 foot per second. The temperature within the IR Site 7 water column varies spatially by season; it is cooler in the winter and warmer in the spring and summer. The water depth of IR Site 7 is generally uniform with an average water depth of approximately 40 feet mean lower low water (MLLW). As a result of dredging by the Port, there is a deeper (55 feet MLLW) area along the northern portions of IR Site 7 and a shallower (40 feet MLLW) area in the western portion of the site (Bechtel 1997).

2.4 Geotechnical and Structural Conditions

Appendix A1 of the *Final Feasibility Study Report* (Bechtel 2003) presents a compilation of physical and chemical data for site sediments as well as soils underlying the surrounding land mass. Based on this information, sediments in the IR Site 7 dredging area consist primarily of interbedded silty sands and sandy silts. The sediment grain sizes ranged considerably, from 90 percent fines to coarse-grained sediment (78 percent sand). The coarsest sediment size was found near the entrance to the West Basin.

The current mudline is approximately 10 to 20 feet deeper than estimated historic mudline surfaces in 1909 and 1937 (Bechtel 2003). There are no known or documented submerged geological features at the current mudline grade, such as rock outcrops. Some instances of submerged debris (including sunken scows) are known to exist at the site and will be removed in their entirety to complete dredging.

The shoreline of IR Site 7 is lined with riprap-armored slopes and pile-supported piers (Bechtel 1997), and the areas planned for dredging are adjoined by existing structures, including the U.S. Navy Mole, Pier E, and the pile-supported Piers 10, 11, and 12.

2.5 Potential for Site Recontamination

After dredging is accomplished, the potential for sediment recontamination is typically dictated by the degree to which source control measures are implemented at the site as well as the proximity of external sediment sources (such as river mouths or outfalls carrying runoff from adjacent parcels). Since the U.S. Navy has vacated the site, previous operational practices have been discontinued and, therefore, will not be a cause of future recontamination. The Port's marine terminal operations are not expected to contribute to sediment recontamination. Meanwhile, the nearest off-site source of contaminated sediment is the Dominguez Channel, which drains a portion of the greater south Los Angeles area. Portions of the Dominguez Channel flow through the Back Channel and Cerritos Channel before entering the Long Beach Middle Harbor (just east of the proposed dredging areas), which could represent a potential source of future water-born containments. The U.S. Environmental Protection Agency (USEPA) and LARWQCB are actively working to remediate and restore the Dominguez Channel; therefore, the potential for becoming a future source of containments to IR Site 7 is likely very small. No other known inputs to the area are documented. Any sources of chemical contamination caused by on-site sediments will be removed in the process of conducting this dredging project.

3 DREDGE AND DISPOSAL PLAN

The Port intends to dredge up to approximately 800,000 cy of chemically impacted sediments from AOEC-A, AOEC-C East, and AOEC-C West, as shown on Figure 1-2. Further detail on the dredging plan is provided in the Construction Plans for the project, which were developed by KPFF Consulting Engineers (KPFF) and are included as Appendix A of this report. A typical plan view for AOEC-C West and a cross section of the dredging plan for AOEC-A, prepared by KPFF, are shown on Figure 3-1 and Figure 3-2. Because the engineering design documents were not finalized as contract documents at the time of this document's production, and because a contractor has not yet be retained to complete the work, all design information and specific equipment references presented in this document should be considered "reasonable and conservative estimates" for purposes of evaluating ROD compliance suitability and potential adverse impacts.

Table 3-1 contains the approximate volume and depth of sediment removal, including overdepth allowance for each AOEC as determined by recent sediment sampling by Weston in June of 2007 (Section 2.1). These volumes should be considered worst-case estimates and may be subject to revision as the dredging design is finalized.

Material will be dredged and transported to the Pier G Slip Fill site where it will be placed behind a constructed berm and covered with up to 40 feet of clean fill from other sources and paved with asphalt. The Pier G Slip Fill site, which is being designed by Moffatt and Nichol, has been engineered to safely contain chemically impacted materials using a containment berm that is a monolithic dike design along with a sand filter layer behind the rock. Figure 3-3 shows a cross section of the planned fill layers within Pier G Slip Fill site, which indicates how the material will be isolated with the fill. All West Basin dredged material will be placed within the most secure portion—the very bottom and back of the fill. A sand layer that ranges from 70 to over 200 feet think will separate the West Basin sediments from the inside edge of the rock dike. The thickness of the rock dike will range from about 60-feet thick at the top of the fill to nearly 200-feet thick along the bottom edge. For the model results presented in this document, the most conservative assumptions were applied to the input parameters by assuming a 70-foot-thick sand layer.

In order to ensure that removal of the sediments achieves SMOs, as described in Section 1 of this report, the Port will implement a post-dredging confirmation sampling program during construction. For more information on this program, please see the discussion in Section 6.

3.1 Anticipated Equipment and Assumptions

Besides having to use an electric dredge, there will be no other restrictions on the type of equipment the contractor may use to perform dredging and disposal work as long as all cleanup objectives can be achieved and the selected equipment keeps turbidity generation within acceptable limits according to the expected LARWQCB monitoring requirements.

For the purposes of modeling possible water quality impacts from sediment dredging and disposal, it has been assumed that dredging will be performed using one or more scow-mounted derrick equipped with an appropriately-sized clamshell bucket or buckets. The clamshell bucket approach is common for this type of work and is a good indicator of possible water quality impacts during the dredging process. After removal, dredged material will be transported to the Pier G Slip Fill site for disposal. This may be accomplished using a bottom-dump barge, as has been assumed for modeling purposes presented in this report; although, other types of barges or scows could be used by the contractor for this purpose. The dredged material will be placed behind the constructed submerged berm within the slip fill area, likely by direct offloading or dumping from a barge positioned within the slip fill, until the height of sediment fill within the slip gets high enough to preclude entry of a barge into the slip. After this point, the sediment will have to be rehandled over the berm into the slip fill. Re-handling of the material over the berm may be done by the use of a clamshell bucket or digging crane, a hydraulic offloader, or a material conveyor. Regardless of the selected approach, caution will be exercised to ensure that water quality conditions are not compromised.

3.1.1 Production

Dredging production rates (i.e., the volume of dredged material removed per hour) will vary based on the contractor's selection of equipment, site characteristics, and transient effects such as nearby vessel traffic and weather conditions. Production rates may be higher in some areas of the site and lower in others, depending on sediment type, water depths, and presence of debris.

The Port has estimated that dredging could be completed in 62 workdays, based on approximately 800,000 cy of dredged material. If only one dredging barge and a 12-cy clamshell bucket were used, then this production schedule could theoretically be obtainable if dredging were conducted 24 hours a day, as per the following calculation:

- The Clamshell bucket load can be assumed to contain 70 to 80 percent sediment and 20 to 30 percent water by volume. This means that each load in a 12-cy bucket will contain approximately 10 cy of sediment.
- The percentage of dredge "uptime" can be assumed to be approximately 70 percent. Uptime is the proportion of time that the dredge is actually working, excluding routine maintenance, unexpected maintenance, dredge positioning, encountering unexpected debris, and time needed to periodically switch out the scows used to transport dredged material. This would imply that out of a 24-hour dredging day, approximately 17 hours would be spent conducting actual dredging.
- The cycle time (i.e., the time used to close the bucket with dredged material, pull it out of the water, place the dredged material into a split-hull dump scow, and return the bucket to the water for the next dredge cut) is 45 to 60 seconds per cycle. This means that for 1 working day, or 17 hours (61,000 seconds) of dredging time, approximately 1,000 to 1,300 cycles would occur.
- Each clamshell bucket will contain 10 cy of in situ sediment, with 1,000 to 1,300 cycles this equals approximately 13,000 cy of dredging per day.
  - Maintaining this rate as an average production rate would enable 800,000 cy of dredging to be completed in approximately 62 days.

Dredging work at the Port usually operates on a two–shifts-per-day basis. If this schedule were used, the overall duration of the work would increase proportionately. Furthermore, it is possible that the theoretical production rate described above will be slowed due to factors relating to the project's required environmental controls (such as turbidity control requirements, and environmental and water quality monitoring) and confirmational sampling and the resulting potential need to re-dredge some areas. Other factors that could slow actual production rates include debris, weather, and other external influences.

The total project schedule for dredging will depend on the additional time required for mobilization and demobilization (including installation and removal of the turbidity barrier system, if required) and the number of dredges used, among other factors.

3.1.2 Dredging Limits

The dredging limits for IR Site 7 are defined by the target dredging surface elevations and horizontal limits of removal. All dredging limits are shown on plan views and cross-sectional views in the Construction Plans being developed by KPFF (Appendix A). Vertical dredging extents were defined by the U.S. Navy and verified by the pre-design sampling undertaken by Weston in 2007. Sample results were compared to the specified SMOs in order to determine a required dredging depth needed to reach expected clean sediments. In AOEC-A and AOEC-C West, Weston (2007) concluded that the depth to clean sediment would be reached by removing the top 4 feet of sediment. In AOEC-C East, Weston (2007) concluded that the depth to clean sediment would be reached by removing the top 2 feet of sediment. These estimates confirmed the information in the U.S. Navy's Proposed Plan. An additional 2 feet of dredging depth will be allowed below the design dredging elevations as a tolerance for dredging accuracy. Dredged side slopes have been designed to tie into existing side slopes, with variable offset distances selected to avoid undermining or reducing the stability of adjacent wharf structures and piers.

3.1.3 Placement of Sediment Within the Pier G Slip Fill

Chemically-impacted dredged material from AOEC-A, AOEC-C East, and AOEC-C West will be disposed of within the Pier G Slip Fill site. A cross section of the Pier G Slip Fill site is shown on Figure 3-3. It is expected that barges or scows will be filled during the dredging process and used to transport the dredged material to the Pier G Slip Fill site, using a tugboat for power and maneuvering. Once behind the submerged berm inside the slip fill, as confirmed by real-time kinematics positioning and/or global positioning system (GPS), the dredged material will be deposited within the slip.

When the Pier G Slip Fill reaches an elevation of approximately -15 feet MLLW, it will be infeasible for a bottom-dump barge to enter into the slip fill area because of its draft requirements. From this point forward, re-handling of the dredged material will be

necessary due to the limited dumping capabilities of the barge and raised dike. It is assumed that the dredged material will be rehandled from the bottom-dump barge, or similarly sized haul barge, over the dike and into the slip fill by the use of a clamshell bucket, a hydraulic offloader, a material conveyor, or similar methodology. The selection of re-handling equipment for this later stage of filling will be left to the contractor, subject to the engineer's approval. Regardless of the method selected, water quality conditions may not be compromised during the offloading process.

Material dredged from area AOEC-A will be placed in the Pier G Slip Fill first, before materials from AOEC-C East and AOEC-C West are placed. This placement is due to the chemical concentrations in AOEC-A being higher than chemical concentrations in AOEC-C East and AOEC-West; thus, first placing the dredged material from AOEC-A will ensure that its sediments are buried deepest and thus most isolated within the slip fill.

4 CONSTRUCTION SCHEDULE AND SEQUENCING

This section describes the planned construction sequencing for dredging AOEC-A, AOEC-C East, and AOEC-C West within IR Site 7. Dredging activities are anticipated to commence in the summer of 2009 in AOEC-A (first due to the presence of higher level of contaminated sediments) and dredging in AOEC-C East and West will follow. The following sequence of activities is listed in order of operation:

- Remove and dismantle four sunken barges from AOEC-C East and West
- Remove the abandoned sonar calibration pier from the U.S. Navy Mole on the southern portion of IR Site 7 in AOEC-C West
- Construct containment berm at Pier G Slip Fill site
- Mobilize construction equipment
- Dredge contaminated sediments from AOEC-A and place dredged material within the Pier G Slip Fill site
- Dredge contaminated sediments from AOEC-C West and place dredged material within the Pier G Slip Fill site
- Dredge contaminated sediments from AOEC-C East and place dredged material within the Pier G Slip Fill site
- Raise containment berm, as necessary, as height of placed sediment within the Pier G Slip Fill increases
- Place clean fill and soil surcharge and perform final grading operations
- Demobilize construction equipment

After dredging in each AOEC has been deemed complete by the contractor, the Port will review a post-dredging bathymetric survey to verify that the required dredging depths and extents have been achieved and will collect and analyze sediment samples to confirm all contaminated sediments above the SMOs have been removed. During this post-dredging testing phase, the contractor may elect to mobilize their equipment and begin dredging in another AOEC; however, the contractor may be required, at the Port's discretion, to remobilize their equipment back to the previous AOEC and remove any contaminated sediments above the SMOs that may still remain.

At the completion of dredging in the AOECs, placement of clean material and soil surcharge and final grading operations will be completed at Pier G Slip Fill containment berm.

Eventually, once the material in the fill has settled, some of the excess surcharge material will be removed, and the site will be paved and used for terminal operations, including the addition of storm water collection systems to prevent runoff and infiltration into the fill.

5 POTENTIAL CONSTRUCTION IMPACTS AND BEST MANAGEMENT PRACTICES

Dredging and in-water sediment disposal typically create turbidity in the water column, an effect that is short-term in duration but will need to be minimized by the contractor through the use of operational BMPs and controls. Water quality conditions will be monitored throughout construction, and the contractor will be required to meet all applicable water quality standards that will be specified as part of a 401 Water Quality Certification for the project or substantive equivalent.

Resuspension of sediment during mechanical dredging operations can result from the following bucket-related actions:

- Effect of bow wave, lowering the clamshell bucket
- Impact of the bucket with the bed
- Closure and removal of bucket from the bed
- Spillage and sediment sloughing during retrieval up through the water column
- Spillage and gravitational leakage from the bucket during hoisting and swinging from water to the split-hull dump scow

In addition to sediment loss from the bucket during mechanical dredging, sediment loss from the split-hull dump scow may also occur if the scow load reaches and exceeds its capacity. To minimize this potential, overflow and spillage of sediments from split-hull dump scows will be limited by the project specifications.

5.1 Effects of Resuspended Sediments Due to Dredging Impacts

In 2003, members of the Los Angeles Contaminated Sediments Task Force (CSTF) conducted a detailed review of the potential adverse impacts to biological organisms as a result of dredging induced turbidity. The complete results of the study are presented in *Literature Review of Effects of Resuspended Sediments Due to Dredging Operations* (Anchor 2003), and a summary of the results are presented below.

The results of the CSTF literature study (Anchor 2003) indicated that by comparing the dredging-induced suspended sediment concentrations observed in the field along with the associated physical effects of such concentrations as reported in relevant project literature,

very few dredging projects have ever been shown to produce suspended solids concentrations in the range documented to cause significant adverse effects to sensitive aquatic biological organisms (Anchor 2003). The threshold at which total suspended solids (TSS) are predicted to produce acute lethal effects is 760 milligrams per liter (mg/L). Sublethal effects are not expected to occur at concentrations below 100 mg/L. To put these numbers into perspective, a review of previous monitoring data for mechanical dredging projects within the Los Angeles region (Anchor 2003) shows that about 90 percent of all the monitoring data collected from water column sampling down current of recent dredging operations revealed TSS concentration below 100 mg/L. It is important to note that nearly all of these examples were projects conducted without the use of silt curtains to minimize off-site transport. Thus, even in the 10 percent of the projects where TSS concentrations exceeded sublethal thresholds, the use of silt curtains could prevent exposure beyond the immediate dredge area.

Potential impacts from dredging of contaminated sediments are more difficult to assess (Anchor 2003). Most of the information concerning the effects of contaminated sediments on marine organisms deals with the impacts of settled sediments. Few studies have dealt with resuspended contaminated sediments. Organisms exposed to resuspended contaminated sediments can develop physiological problems due to direct exposure to dissolved contaminants or bioaccumulation of metals and organic chemicals. However, much of the data suggests that significant adverse impacts do not occur at resuspension levels and durations typically associated with dredging projects. In general, previous studies indicate that potential effects from dredging are transient and not significant. Again, the conservative use of silt curtains for all contaminated sediment dredging, such as the case with the current project, will further minimize the potential for adverse impacts.

5.2 Potential Short-term Water Quality Impacts

The potential for water quality impacts from contaminated sediment dredging and disposal has been estimated using measured sediment characteristics as well as documented placement techniques. Laboratory elutriate testing was used to evaluate the potential for suspended sediments to contribute dissolved contaminants to the surrounding water column. In addition, the computer model DREDGE (developed by the U.S. Army Corps of Engineers [USACE]) was used to predict short-term water quality impacts at the point of

dredging, and the computer model Short-term Fate of Dredged Material Disposal in Open Water Models (STFATE; also developed by USACE) was used to predict water quality impacts at the Pier G Slip Fill site during sediment disposal, which was accomplished using split-hull dump scows. The methods and results of each of these predictive modeling efforts are described below.

5.2.1 Water Quality Impacts at Point of Dredging

To evaluate the potential for short-term water quality impacts during dredging, analytical tests on site sediments, as well as computer-based model predictions, were considered. Analytical measurements included the results of elutriate tests for comparison to water quality criteria as well as computer models to simulate resuspension. These results were then compared to published data on possible TSS-related effects.

Results of the Standard Elutriate Test (SET) were evaluated to assess potential impacts from dissolved constituent release into the water column. Site-specific SET results were readily available for this site (Weston 2007) and were usable for drawing conceptual-level conclusions regarding potential environmental impacts from the dredging process. The SET was conducted using composite samples from each of the IR Site 7 AOECs. Table 5-1 presents the results of elutriate testing, which indicated dissolved concentrations below relevant water quality criteria (i.e., California Ocean Plan).

These results suggest that it would be highly unlikely for short-term chemical releases from sediment at the point of dredging to exceed water quality criteria. Furthermore, the use of BMPs (e.g., silt curtains) will mitigate any potential chemical releases or water quality impacts.

5.2.2 DREDGE Model Input

The computer model DREDGE, developed by the USACE as part of its Automated Dredging and Disposal Alternatives Modeling System (ADDAMS) suite of modeling software, was used to predict the suspended sediment plume resulting from resuspension of dredged sediments during dredging, if conducted mechanically using a

clamshell bucket. Although the choice of dredging equipment, means, and methods will be left to the contractor, the mechanical clamshell bucket approach is a common one and is useful as an overall indicator of possible water quality impacts during the dredging process.

As was stated previously, the mechanisms by which dredging could cause resuspension of sediment particles include bucket impact, closure, withdrawal, and lifting of sediment to a scow. DREDGE uses an expected resuspension rate in conjunction with field parameters (e.g., water current, sediment settling velocities, etc.) to predict the total suspended sediment concentration released into the water column at the point of dredging and at points cross stream and downstream. These predicted resuspension concentrations were then compared to the CSTF literature study results (Anchor 2003; Figure 5-1) in order to assess the potential for adverse risks.

DREDGE models the transport of suspended sediment from dredging operations into two distinct areas, "near-field" and "far-field." The area in the immediate vicinity of the dredging operation (typically 30 to 60 feet down current from the dredge site) is the zone of the highest TSS. This area is termed the "near-field" and is dominated by mixing and currents induced by the dredging process. In the "far-field," suspended sediment transport is controlled by advection, turbulent diffusion, and sedimentation. The DREDGE program utilizes a two-dimensional, vertically averaged transport model published by the USACE to analyze sediment transport in the "far-field" (Hayes and Je 2000).

Table 5-2 presents key input parameters used in the DREDGE model for the prediction of TSS concentrations at selected distances from the point of dredge with an open clamshell bucket. Modeling was completed for a variety of conditions and distances from the dredging operation. A key point of interest for this analysis was a distance of 300 feet from the point of dredging—a distance which has been defined as a water quality monitoring point of compliance (per Waste Discharge Requirements [WDRs] put forth by the LARWQCB) for similar projects in the recent past.

This modeling was also used to evaluate various typical physical conditions and equipment use for the project. The model was run for both 8-cy (6.1 cubic meters) and 12-cy (9.2 cubic meters) bucket sizes and for various representative depths within the AOECs. While the actual bucket size and type will be left to the contractor, these bucket sizes and their associated cycle times (60 seconds in both cases) were selected for modeling purposes based on project-specific conditions and needs and on typical equipment and operating procedures used for similar projects performed in the Southern California region. These bucket size and type also represent reasonable worst-case scenarios for predicting associated impacts. Additionally, the cycle times selected are considered conservative in terms of resuspension, as longer cycles in excess of 2 minutes are not uncommon during remedial dredging. In general, longer cycle times tend to decrease the resuspension of sediments, if other parameters relating to operations are held constant.

Diffusion coefficients and sediment characteristics were selected based on previous DREDGE analysis performed for the Los Angeles River Estuary Pilot Study (CSTF 2002). Existing water depth at the site ranges from approximately 35 to 50 feet, while post-dredge depths will range from approximately 44 to 55 feet for AOEC-A, 48 feet for AOEC-C East, and 45 to 49 feet for AOEC-C West. The existing water depths and post-dredge water depths for each AOEC were used in the model to represent worst-case and final scenarios that can be expected during construction. In most cases, TSS concentrations generally increase with decreasing water depth.

5.2.3 DREDGE Model Results

Using the assumptions discussed above, the DREDGE model predicts the TSS concentrations associated with the dredging as a function of distance from the dredge. Results are presented graphically in Figures 5-1 through 5-6.

In AOEC-A and AOEC-C West, TSS concentrations were predicted to be approximately 20 to 34 mg/L at a distance of 30 feet from the point of dredging; assuming a 12-cy clamshell bucket is used. At this distance, the predicted TSS concentration is lessened slightly to approximately 13 to 22 mg/L, if an 8-cy bucket is assumed. In AOEC-C East, TSS concentrations 30 feet from the point of dredging are predicted to be slightly higher

than they were in AOEC-A and AOEC-C West, about 36 mg/L assuming a 12-cy bucket is used and 24 mg/L if an 8-cy bucket is used.

TSS concentrations were also predicted at a greater distance from the point of dredging—in particular, the 300-foot distance that has typically been defined as a water quality monitoring point of compliance for similar projects in the past. In AOEC-A, at 300 feet from the point of dredge (Figures 5-1 and 5-2), TSS concentrations are predicted to drop significantly to 4 to 7 mg/L depending on the size of the clamshell bucket used. In AOEC-C East, at 300 feet from the point of dredge (Figures 5-3 and 5-4), TSS concentrations are predicted to be no higher than 5 mg/L. In AOEC-C West, at 300 feet from the point of dredge (Figures 5-5 and 5-6), TSS concentrations are expected to be about 4 to 8 mg/L depending on the size of the clamshell bucket used.

As distances increase away from the point of dredging, TSS concentrations in AOEC-A and AOEC-C West tend to decrease gradually. TSS concentration in AOEC-C East decreases at a much greater rate due to the fact that the average grain size in this area is larger; thus, the material settles out faster.

When compared against known thresholds for acute lethal and sublethal TSS impacts (Anchor 2003), the relatively low predicted TSS concentrations during dredging operations are expected to have negligible impacts to the aquatic environment.

It is important to note that the predicted TSS concentrations resulting from dredging activities would be in addition to any ambient suspended solids that may already be present in the water column. The CSTF literature study (Anchor 2003) notes that 50 percent of the background monitoring data collected in the region showed ambient TSS concentrations of 31 mg/L, which is significantly higher than the predicted TSS concentrations for the current project. Even combining the predicted TSS concentrations resulting from dredging activities to the ambient levels, the resulting values are still well below the threshold used to determine the potential for adverse effects.

5.2.4 Prediction of Water Quality Impacts at Point of Disposal

The contractor will be required to devise their own process for transporting sediment and placing it within the Pier G Slip Fill site. The majority of the sediments dredged for this project can be hauled directly into the slip fill area where they can be deposited. Various types of haul barges could be used for this purpose, including bottom-dump barges or flat barges with perimeter walls for sediment containment. Later in the sediment disposal process, the containment berm will reach a height that will preclude entry by barge, at which point the contractor will need to devise an alternative means for depositing sediment within the slip fill. The dredged material can be rehandled from the holding scow over the dike and into the slip fill by the use of a clamshell bucket, a hydraulic offloader, a material conveyor, or similar methodology. The final selection of re-handling equipment will be left to the contractor and subject to the engineer's approval.

For the purposes of this evaluation, the potential for water quality impacts during disposal in the Pier G Slip Fill was assessed using both the results of the SET (for dissolved chemicals) and a computer model (STFATE, Version 5.01; Johnson et al. 1994) to model disposal and sediment resuspension for a representative disposal mechanism (i.e., the use of a bottom-dump barge). The STFATE computer model simulates resuspension and "stripping" of particulates during their descent after dumping and predicts the concentration of TSS remaining in suspension (in units of mg/L) at a particular time. Successive time steps can be used to predict the fate of the remaining suspended material in waters of Pier G Slip Fill site. The results of the STFATE modeling were compared to the results of the CSTF literature study (Anchor 2003) to evaluate the potential impacts to the aquatic environment.

The SET results are reflective of water quality impacts from dissolved chemicals over relatively short time intervals, specifically 1 hour after disposal. As was presented earlier and as depicted in Table 5-1, the elutriate test results indicate that the concentration of dissolved chemicals were all well below applicable water quality criteria; therefore, exceedances of water quality criteria are considered to be highly unlikely in the short term at the point of disposal.

5.2.5 Prediction of Spread of Placed Sediment

STFATE also allows prediction of the distribution of sediment mass on the seafloor after dumping from a barge. The sediment mass is subdivided into three primary components with different properties and settling velocities, clumps (settle to the bottom essentially instantly), sand (settles at a slower rate), and fines (are suspended in the water column as turbidity). Over time, each component builds up on the bottom surface in response to settling velocity, fall height, and ambient current velocity of surface waters, such that a mound of settled sediment is predicted. This mound of settled sediments can be compared to the geometry of the Pier G Slip Fill site and used as a guide for limiting the split-hull dump scow's positioning during dumping to ensure that sediment is not lost outside of the identified disposal area.

5.2.6 STFATE Model Input

Input parameters for the STFATE model included the following:

- Geometry of the sediment disposal area, including horizontal dimensions and water depth (defined according to a grid of points spanning the area of interest)
- Conditions of the ambient water column (i.e., density, salinity, and current velocity)
- Disposal operation data, including parameters that reflect typical dimensions, draft, and disposal rate from a disposal scow
- Dredged material physical properties (i.e., grain size, clumping fraction, etc.)

Again, the actual disposal means, methods, and equipment will be selected by the contractor. The input parameters used for this modeling effort are intended to represent reasonable and representative equipment types and anticipated site-specific conditions at the time of disposal as well as the physical characteristics of dredged material as determined from sampling data expected to be representative of the material being disposed of at Pier G Slip Fill site. Key input parameters used in modeling are summarized in Table 5-3. AOEC-C East has not been modeled since the elevation of the slip fill will already be at approximately -15 feet MLLW prior to its placement, at which point the material will need to be rehandled over the berm for placement into the fill site.

5.2.7 STFATE Modeling Results

This section presents a summary of the interpreted results from STFATE. These results should be considered conservative estimates, as STFATE can not precisely predict actual conditions during construction.

5.2.7.1 Predictions of Deposited Sediment Thickness

Each sediment load that is placed within the slip fill was estimated to be 1,200 cy in volume. For dredged material from AOEC-A and AOEC-C West, STFATE predicted that each 1,200 cy dump event would create a mound of deposited material ranging in thickness from 1.8 to 1.9 feet and extending about 150 to 200 feet from the center of the dumping, as shown on Figures 5-7 and 5-8. This setback distance is essentially equivalent to the amount of setback from the berm face for placed sediments within the slip fill, as shown on the typical berm cross section (Figure 3-3). The mound would be comprised of a combination of clumps, sands, and fines. This prediction can be used as a general guideline, recognizing its inherent imprecision, and can be adjusted in the field depending on observations during construction.

5.2.7.2 Predictions of Total Suspended Solids Concentrations

The TSS concentrations resulting from sediment release during a split-hull dump scow disposal was predicted for each of the two areas and for time periods of up to 20 minutes after dumping. During construction, AOEC-A will be the first area to be dredged and placed in the Pier G Slip Fill; it was analyzed assuming a disposal site water depth of 48 feet. TSS concentrations at three water depths, 7 feet (near the surface), 24 feet (mid-depth), and 48 feet (seafloor) below the water surface were analyzed to evaluate TSS plume dispersion with depth.

AOEC-C West was modeled assuming a 30-foot water depth and TSS concentrations were predicted at the surface (1 foot below water depth), at mid-depth (15 feet below water depth), and at seafloor(30 feet below water depth).

The following sections discuss the predicted water column TSS concentrations and lateral extent of sediments spreading from AOEC-A and AOEC-West.

5.2.7.2.1 AOEC-A

In general, the STFATE model suggests that the plume of suspended sediments, which forms after the sediment is released, is wider and more extensive at depth than it is at the surface. The predicted turbidity plume at the deepest depth extends about 150 feet from the dumping point as viewed at the surface 20 minutes (1,200 seconds) after the initial dump, as shown on Figure 5-10.

At a depth of 7 feet below the water surface, a small and diffuse TSS plume is predicted to extend over an area measuring approximately 150 feet by 150 feet. The TSS concentration at the center of the turbidity plume is expected to be only 0.34 mg/L, which is essentially negligible. It should be noted that the STFATE model predicted minimal TSS concentrations (below .001 mg/L) within the upper 6 feet of the water column during all of the disposal scenarios.

At a depth of 24 feet below the water surface, the TSS plume is predicted to extend over an area measuring roughly 250 feet by 250 feet, where a worst-case scenario predicted TSS concentration of about 35 mg/L at the center of the plume.

At a depth of 48 feet below the water surface, the TSS plume is predicted to extend over an area measuring 300 feet by 300 feet. A maximum TSS concentration of 171 mg/L is predicted to occur in the center of the plume.
At distances over 200 feet from the dump location, minimal amounts of suspended sediment are predicted.

5.2.7.2.2 AOEC-C West

In general, the STFATE model predicts a relatively wide plume will develop both at shallow depths (1 foot), mid-depth (15 feet), and at the bottom depth (30 feet below the water surface) for AOEC-C West sediments. Maximum TSS concentrations of 0.5, 1.8, and 138 mg/L are predicted at the center of the plume for shallow depths, mid-depths, and greater depths, respectively (Figure 5-10).

5.2.7.2.3 Conclusions

Under conditions modeled for the AOEC-A and AOEC-C West, significant TSS concentrations are not expected after 20 minutes (for a single dump event) at distances of approximately 300 feet from the disposal point (the anticipated point of compliance for water quality monitoring, based on recently issued WDRs for similar projects in the region). Furthermore, when compared against known and documented thresholds for acute and sublethal impacts from TSS (Anchor 2003), the predicted TSS concentrations for IR Site 7 are predicted to have negligible impacts to the aquatic environment. Thus, sediment disposal at locations less than 300 feet from the Pier G Slip Fill containment berm appears to be possible without significant impacts to water quality. It appears that the amount of setback from the berm face required by the containment berm design (Figure 3-3) will be sufficient to allow the contractor to conduct sediment placement within the slip fill. The contractor will need to be attentive to the sequence and spacing of their dump events, particularly at locations closer to the berm to ensure materials settle within the fill site. If dump events occur in succession or prior to sediments fully settling, higher TSS concentrations than those presented would be expected.

5.2.8 Re-handling Over Containment Berm

The modeling results presented above are specific to the process of direct dumping from a split-hull dump scow or bottom-dump barge located inside the slip fill area. It is anticipated that when sediments placed in the Pier G Slip Fill reach an elevation of approximately -15 feet MLLW, entry into the slip by barges (particularly for bottom-dump barges, which draw a relatively deeper draft when loaded) will be precluded. At which point, it would be necessary for the dredged material to be rehandled over the berm.

As shown on the Pier G Slip Fill cross section and dimensions presented on Figure 3-3, this point may be reached after dredged material from AOEC-A and AOEC-C West are placed. It appears likely that the dredged material from AOEC-C East will need to be placed in the slip fill area by re-handling it over the containment berm and into the slip fill rather than by directly dumping it from a barge.

The contractor will be required to devise their own process for moving material into the slip fill for approval by the engineer. As stated previously, re-handling of dredged material may involve the use of a clamshell bucket or digging crane, a hydraulic offloader, a material conveyor, or other means. Each of these equipment types and methods will have a range of possible placement rates and placement locations within the slip (as measured in terms of distance from the berm). The contractor will need to develop their sediment re-handling and offloading equipment, means, and methods in such a way as to ensure their continued compliance with water quality criteria outside of the disposal area (e.g., hay bales, silt fences, etc.). For instance, when the top of the berm reaches an elevation of -5 feet MLLW, the berm will not reach the water surface and suspended solids can still be carried outside of the slip fill area, particularly during an outgoing tide. Later, when the berm has been raised further (to an elevation of +8 feet MLLW after its fourth lift has been added), it will act as a barrier to water within the slip fill; although, even under this scenario, continued filling of the slip with sediment will require an exit point for water from inside the fill area.

5.2.9 Dredge Residual Management

Residual contamination is typically encountered in surface sediments following the completion of an initial remedial dredging pass. The presence of residual contaminants is inevitable to some degree when dredging contaminated sediments, due to the inability of mechanical or hydraulic dredging equipment to completely and perfectly remove all sediment within a submerged dredge prism. Resuspension of sediment during bucket impact and retrieval, or disturbance during hydraulic excavation, results in fine-grained sediment becoming suspended and transported away from the immediate location of the dredge. Larger grain sizes, such as sand, settle out of the water column fairly rapidly while finer-grained sediment, such as silts and clays, can remain in suspension for longer periods of time (traveling farther distances before settling out).

5.2.10 Post-dredge Residual Expectations

A variety of recently completed remedial dredging projects has demonstrated that dredge residuals are commonly spread both within dredged areas and, in some cases, off site. Site conditions, dredging equipment, and BMPs can all effect residual

concentrations. A survey of recent projects demonstrates that residuals can be expected in all dredging projects to differing degrees and can result in post-remediation contaminant exposure within and immediately beyond the dredge prism if adequate control measures are not taken (Desrosiers et al. 2005; Stern and Patmont 2006). Residuals can potentially result in a thin layer of recently deposited sediment in which post remediation surface concentrations may be similar to pre-remediation levels. Using a mass balance-based measure of residuals from a series of well-documented dredging projects, realistic expectations of residuals can be used to plan for and manage dredge residuals. The *Evaluation of Post-dredge Monitoring Results to Assess Net Risk Reduction of Different Sediment Cleanup Options* (Stern and Patmont 2006) summarizes detailed residuals measurements from the following project sites:

- Fox River, Wisconsin (pilot projects)
- Lavaca Bay, Texas (pilot project)
- New Bedford Harbor, Massachusetts (pilot project)
- Reynolds Aluminum, New York
- Hylebos Waterway (mouth & middle), Washington
- Middle Waterway, Washington
- Duwamish/Diagonal, Washington

Evaluating the monitoring data for these remedial dredging projects showed that after dredging to the design depth, the amount of sediment that remained on site as a residual layer ranged from approximately 2 to 9 percent of the mass of sediment, or contaminant, dredged. The median amount of dredge residuals remaining in these environmental dredging projects was approximately 5 percent of the mass of sediment/contaminant dredged. Similar dredge residual amounts have been reported for mechanical and hydraulic dredging operations, both with or without the use of BMPs (e.g., silt curtains).

5.2.11 West Basin Residual Analysis Results

For the purposes of this Remedial Action Plan and Design Report, a range of 2 to 6 percent (for sites with little debris or rock/hardpan surface) of the mass of sediments loosened by the dredge in the AOECs was assumed to settle back within or immediately adjacent to the newly cut surface of the dredge prism. In addition, the concentration of

residuals was assumed to be equal to the average concentration of the sediment dredged from the immediate area. Based on these assumptions and using the preliminary dredge plan design and sampling data described previously, the approximate ranges of post-dredge residual thickness in AOEC-A, AOEC-C East, and AOEC-C West were estimated.

These calculations reveal that without dredge residual management, assuming an average 2 to 6 percent mass loss during dredging, the estimated post-dredge residual thickness will likely be approximately 2 to 6 inches in AOEC-A, 1 to 4 inches in AOEC-C East, and 2 to 6 inches in AOEC-C West (as summarized in Table 5-4).

The concentration of chemicals within the residual sediment layer can be reasonably predicted through a statistical, proportionate averaging of the chemical mass indicated by the various samples obtained from the dredged area. Using the sediment chemistry data provided by Weston (2007) during the most recent sediment sampling program for IR Site 7, the 95 percent Upper Confidence Limits (UCLs) were calculated for each individual AOEC. Although average values would be acceptable in this analysis, the 95 percent UCL values provide a more conservative end value. The resulting 95 percent UCL values were compared with the site-specific SMOs presented in Section 1. These values assume full removal of the specified dredge prism, plus the full amount of allowable overdredging of underlying materials.

As shown in Table 5-5, the 95 percent UCLs for various constituents in each AOEC are below the approved SMOs. The results indicate that even though a residual layer will remain after dredging is complete, the layer is not expected to contain chemical concentrations in excess of SMOs for the project. Furthermore, conformational sampling will be conducted to ensure SMOs have been met.

5.3 Contractor Controls and Best Management Practices

To ensure water quality standards are maintained throughout construction, permits and final construction documents will require the contractor to implement a quality control plan and follow BMPs. The CSTF developed a list of available dredging BMPs that may be used as a starting point for consideration. Refer to Appendix B for a description of the

technologies available and a toolbox for selecting appropriate BMPs. The contractor's performance in this regard will be documented by a LARWQCB required water quality monitoring program, which will be implemented by the Port's representative.

5.3.1 Operational Controls

At a minimum, the following BMPs will be incorporated into the project specifications to be implemented by the contractor during the duration of the construction period:

- Overtopping of the split-hull dump scow will not be allowed, as to avoid leakage of sediment directly into surface water.
- The bucket will be fully closed during lift up.
- Excessive overdredging will be discouraged through the payment process.
  - Contractor will only be paid for finite digging.
- All equipment will be required to be in good working order and shall be maintained.
- A spill containment plan will be prepared and all necessary cleanup materials shall be readily available if the need arises.
- Silt curtains will be used during dredging operations within the AOECs.

5.3.2 Specialized Equipment

In order to help control loss of suspended solids beyond the immediate work areas, floating silt curtains will be required during dredging operations. As part of the project specifications, it will be a requirement for the contractor to maintain silt curtains around all dredging work as to reduce the potential for water quality impacts and the escape of suspended solids beyond the project dredging boundaries.

If a water quality exceedance occurs, the contractor may elect to use a cable-arm clamshell bucket (frequently referred to as an environmental bucket) for dredging. This bucket design typically reduces loss of sediment and turbid water during closing and withdrawal of the bucket from the water. A cable-arm bucket, however, may not be sufficiently heavy enough to excavate denser sediments or large debris. The use of this type of bucket will be left to the contractor's choice and discretion.

To ensure water quality criteria requirements are maintained, the specialized equipment, plus the BMPs mentioned in Section 5.2.1, will need to be supplemented by appropriate sequencing and productions rates by the contractor.

5.3.3 Water Quality Monitoring

Water quality monitoring will be conducted at a predetermined frequency by the contractor and will be performed in accordance with the regulatory permits obtained for this project. Specifically, water quality monitoring will be required through the 401 Water Quality Certification process with the LARWQCB. When the contractor is not in compliance with the water quality criteria, they will be required to correct the condition. The contractor may choose to slow down, stop, or modify their operations until the adverse water quality conditions are returned to normal.

The frequency of water quality monitoring will initially be high (e.g., once per day) but may be lessened as dredging proceeds and data is collected to document the results, provided that no water quality exceedances are noted.

Appendix C presents more details on the elements of the expected water quality monitoring requirements for the site. See Section 6 for further discussion of contingency actions that may be undertaken in the event of water quality exceedances.

5.3.4 Post-dredge Monitoring

A post-dredge bathymetric survey will be preformed to verify that the contractor has reached the target dredging depths and extents, as predicted to accomplish full removal of chemically impacted sediment to comply with the ROD.

Confirmation sampling will be performed after dredging is completed in each area to verify successful removal of chemically impacted sediments. The sampling program will be designed to evaluate whether the remaining sediments meet SMO requirements or if additional dredging is necessary for compliance with the ROD.
Confirmatory sampling depths need to be adequate to estimate potential exposure to ecological receptors, encompassing the expected biologically active zone of the sediment (USACE 2008). At IR Site 7, the biologically active zone is anticipated to extend to a

depth of approximately 20 centimeters (approximately 8 inches) below the surface (Weston 2007). Therefore, confirmatory samples will be taken from the upper 20 centimeters of sediment.

It will also be valuable to obtain samples from below the residual layer that is likely to be present after dredging. Therefore, the samples will be extended an additional 20 centimeters below the initial depth of 20 centimeters, such that the total sampled depth will be 40 centimeters (or approximately 16 inches). The lower sample depth interval will archived for possible laboratory testing, if any upper residual-layer samples indicate possible issues with chemical concentrations.

See Section 6 and Appendix D for further discussion of the development of the Confirmatory Sampling Plan for this site.

5.3.5 Management of Dredging Residuals

BMP controls have been developed as part of the contract specifications to minimize, to the extent practical, the extent and magnitude of residual sediment deposition. These controls will include the use of a precise horizontal and vertical positioning system and real-time monitoring of the dredge head and bed elevation. The contractor will also be required to control vessel draft and movement as to limit the disturbance of bottom conditions and contaminated sediments via propeller wash scour from their vessels.

5.4 Long-term Effectiveness of Disposal Location

In an effort to estimate chemical concentrations in porewater expressed through the Pier G Slip Fill containment berm under steady-state (long-term equilibrium) conditions, chemical partitioning and migration were modeled in response to porewater flow and tidal exchange processes through the berm. The model operates on the basic assumption that porewater and/or tidal flux has a net outward flow direction through the contained sediments, where the contaminants partition from the solid phase into the groundwater, and on through the containment berm, which is constructed of rock and clean sand fill. As the dissolved contaminants move through the containment berm, they are predicted to undergo biodegradation while at the same time partitioning onto the granular berm material. The model predicts steady-state concentrations of sediment or porewater expressed at the

surface of the inside edge of the berm (i.e., point where the sand layer touches the inside of the rock dike) by applying developed formulas to represent these various processes. The chemical isolation performance of the berm can then be evaluated by comparing the predicted steady-state surficial concentrations to selected toxicity guidelines or criteria. Thus, the model output is extremely conservative in its design, because it does not account for any additional degradation that could occur within the rock portion of the dike, which in some areas will be nearly 200-feet thick or twice the thickness of the sand layer.

The chemical concentrations for sediments underlying the cap were calculated using sampling results from Weston (2007). The chemicals of potential concern (COPCs) were determined after evaluating the data to be metals (i.e., arsenic, chromium, copper, lead, mercury, selenium, silver, and zinc). Organic chemicals that were tested (PAHs, PCBs, and DDT) were not detected in any samples and, therefore, do not appear to be significant in terms of overall sediment containment evaluation.

Using the model developed by Reible et al. (2004), the chemical concentrations expressed through the berm were calculated as a balance between the flux into the berm (from the confined sediments behind it), the flux leaving the berm and thus biologically available (characterized by a mass transfer coefficient, k_{bio}), and the benthic boundary layer in the overlying water column (characterized by a mass transfer coefficient, k_{bl}). Considering that porewater seepage and transport of contaminants may potentially occur independently of these processes, the predicted porewater concentration in the bioturbation layer (C_{bio}) is related to the flux out of the chemical isolation layer by the following equation:

$$C_{bio} = Flux\left[\frac{1}{k_{bio}\,R_f + U} + \frac{1}{k_{bl} + U}\right]$$

where: R_f = retardation factor for the movement of chemicals through the cap
U = Darcy velocity of the groundwater (feet per second).

5.4.1 Model Inputs and Assumptions

To calculate the overall flux noted above, the Reible et al. (2004) model requires the input values defined in Table 5-6 and Table 5-7. Conservative values were selected in all cases. Specific assumptions are described below.

The 95 percent UCLs of all available data for each COPC were calculated. These values were then converted into porewater concentrations assuming equilibrium partitioning conditions. The resulting partitioned porewater concentrations were input into the model as initial porewater concentrations (C_0) within the contained sediment.

5.4.1.1 Infinite Source Assumption/Zero Degradation

The underlying sediment was conservatively assumed to maintain the maximum estimated porewater concentration at all times, without any biodegradation or depletion during its movement through the cap. Thus, the anaerobic degradation rate was assumed to be zero (Table 5-7).

5.4.1.2 Seepage Velocities

The seepage velocities are a key variable in cap modeling, as it directly influences the timespan over which chemical concentrations are expressed through the cap. For the planned Pier G Slip Fill containment berm, it has been assumed that a maximum differential hydrostatic head of 10 feet will occur during extreme low tide events, representing a typical vertical elevation difference between extreme high tide events and low tide events. This hydrostatic head difference reflects an extreme low-tide condition in which groundwater within the slip fill remains at a high-tide elevation and under such conditions would act as the driving force for porewater movement through the berm. Assuming porewater travels through the thinnest possible amount of berm material (estimated as 100-feet [per the typical berm cross section, as shown on Figure 3-3]), this amounts to an equivalent hydraulic gradient of 0.1. Assuming a maximum (most conservative) hydraulic conductivity (K) of 1.0×10^{-5} centimeters per second, and a maximum (most conservative) porosity of 0.5, the resulting prediction of seepage velocity (per Darcy's Law) is 63.1 centimeters per year. This value was used in the modeling.

5.4.1.3 Biodegradation Rates

Biodegradation rates were obtained from the Hazardous Substances Database available from the Toxicology Database Network (USNLM 2008). To be conservative, the slowest biodegradation rate provided from this source was used as input to the model.

5.4.1.4 Partitioning Coefficients

Porewater concentrations have not been directly measured at this site; therefore, partition coefficients (K_d) were used to calculate porewater concentrations in the confined sediment from the bulk chemistry data. These K_d values were obtained from the USEPA's *Soil Screening Guidance: Technical Background Document* (1996) and *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture* (Baes 1984). The calculated porewater concentration in the confined sediment was used as the initial concentration entering the cap (C_0, in mg/L; as presented in Table 5-7).

5.4.2 Model Results

Model results are summarized in Table 5-8. The time to reach steady-state chemical concentrations was predicted for each COPC, and the predicted steady-state concentrations expressed through the cap were compared to sediment and water quality guidelines with the resulting comparisons to quality guidelines expressed as a hazard quotient (HQ). HQ values less than 1 indicate that the guideline is not predicted to be exceeded under steady-state conditions in the surface of the berm. Values greater than 1 indicate potential toxicity to benthic organisms in or around the berm surface.

The results from Table 5-8 suggest that predicted HQs remain lower than 1, indicating that there are no anticipated exceedances of the stated criteria, for the foreseeable future (time periods of several thousand years). In most cases, in fact, the long-term steady-state equilibrium condition for expressed porewater remains lower than the chronic water quality criteria.

The only indicated exception to this, a moderate exceedance for mercury in porewater (HQ of 1.20), is not predicted to occur for over 25,000 years, which is well beyond the range of any conceivable monitoring or measurable effects. These predictions are based on modeling assumptions that are inherently conservative. For example, the 95 percent UCL concentration of mercury was used as an input parameter, rather than its average concentrations. Revising this assumption alone would lead to the resulting long-term steady-state HQ for mercury being significantly lower than 1. Also, as a reminder, degradation occurring within the rock portion of the dike is not accounted for in the model, which, if included, would certainly suggest even longer times to reach steady state if measured on the outside edge of the rock versus the inside edge of the rock.

In summary, the implications of these results are that even when worst-case, conservative assumptions are used to define inputs to the model, the Pier G Slip Fill containment berm is still predicted to be effective in isolating all contaminants in the long term.

6 CONTINGENCY MEASURES

6.1 Confirmation of Sufficient Sediment Removal

Confirmation sampling will be performed after dredging is completed in each AOEC in order to verify successful removal of chemically impacted sediments. The sampling program will be designed to evaluate whether the remaining sediments meet SMO requirements or if additional dredging is necessary for compliance with the ROD. This confirmatory sampling program will be designed to have sufficient coverage and density of sampling points to ensure statistically meaningful results for COECs. Appendix D documents the development of a Confirmatory Sampling Plan for IR Site 7.

The results of the post-dredging confirmational sampling will be evaluated on an area-wide basis, and an area-weighted average determined, to identify if any significant contaminants in excess of SMO cleanup standards remain after dredging. If so, then an additional dredging pass may be required over the area or areas from which significant SMO exceedances were noted. The size of the redredging area will be determined based on a statistical evaluation of the results.

After the redredging is completed, the redredged area will be resampled. If sampling results still indicate SMO cleanup standards have not been met, then one or all of the following contingency measures may be undertaken depending on the sample results and the remaining capacity at the Pier G Slip Fill site at the time:

- Determine (by analyzing archived 20 to 40 centimeter sample depths) if the apparent contamination is related to dredging residuals only or if it extends into previously undredged materials
- Decide on possible additional sampling to narrow down areas in which the contaminants may be present
- Additional dredging pass may be conducted in an attempt to remove remaining contamination to achieve the SMOs
- Second dredging pass may then be followed by another round of confirmational sampling
- Place residuals sand cover over dredged areas to reduce the surficial concentrations and achieve SMOs (as provided by the ROD)

- This approach may be implemented if additional dredging is judged to be an inefficient means of addressing the issue.

6.2 Contingency Actions for Short-term Water Quality

Water quality will be monitored around the point of dredging and outside the Pier G Slip Fill containment berm. If water quality exceedances are noted during dredging or disposal operations, the contractor may choose any of the following contingency adjustments in order to ensure that water quality criteria are met:

- Adjust the sequence and/or speed of dredging and disposal operations
- Temporarily stop dredge or disposal operations until the water quality exceedence is no longer noted
- Reposition dredge or disposal operations in such a way as to ensure future exceedances do not occur
- Fix, maintain, and/or upgrade floating silt curtains
- Modify, either on a temporary or permanent basis, dredge equipment (such as the dredging bucket size or type)

7 CONCLUSIONS

This report describes environmental elements of the IR Site 7 sediment dredging project and documents how the proposed work will accomplish SMOs stipulated in the ROD.

In particular, this report documents the following environmental cleanup-related aspects of the proposed project:

- Planned extents and depths of dredging are consistent with the extents and depths of chemically contaminated sediments, as determined through previous site investigations.
- Regular surveying will be utilized during construction to ensure that dredging is accomplished to the required extents and depths.
- Confirmatory samples will be obtained after dredging is complete to determine if there are any significant remaining sediment that exceed cleanup goals in which case additional dredging (or other countermeasure) will be employed to mitigate the issue.
- Residual sediments are expected to be present on the seafloor after the completion of dredging but are predicted to contain chemical concentrations that are below cleanup goals for the site.
- Water quality impacts at the point of dredging and at the point of disposal were modeled and are predicted to be negligible at an expected compliance boundary of 300 feet away. Nevertheless, water quality will be closely monitored throughout construction.

Therefore, the proposed project is consistent with the cleanup goals of the ROD, and the Port (and its consultants) will manage the construction process to make sure that all project requirements are met.

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TABLES

Table 1-1
West Basin Sediment Management Objectives

Contaminant	Final SMOs
Copper	254 mg/kg
Lead	100 mg/kg
Mercury	0.9 mg/kg
Silver	3.5 mg/kg
Zinc	307 mg/kg
Total PAHs	5400 µg/kg
Total PCBs	570 µg/kg
Total DDTs	210 µg/kg

Notes:
DDT = dichlorodiphenyltrichloroethane

Table 2-1
Summary of Total Solids and Metals in AOEC-A 01 and AOEC-A 02 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-A 01											AOEC-A 02									
					A-01 0-1	A-01 1-2	A-01 2-3	A-01 3-4	A-01 4-5	A-01 5-6	A-01 6-7	A-01 7-8	A-01 8-9	A-01 9-10	A-01 10-11	A-02 0-1	A-02 1-2	A-02 2-3	A-02 3-4	A-02 4-5	A-02 5-6	A-02 6-7	A-02 7-8	A-02 8-9	A-02 9-10
General Chemistry																									
Solids, Total (%)					66.4	70.5	72.2	73.3	68.8	75.7	71.5	70	70.4	70.5	71.8	48.1	54.8	73	70	72.1	70.3	79.1	77.1	76.4	73.6
Metals (mg/kg)																									
Arsenic	**8.2**	**70**	**500**	-	**12.1**	5.46	4.36	4.06	**20.8**	7.8	4.87	**12.2**	**8.7**	**9.31**	**8.44**	**19.4**	**37.6**	**10.5**	**11.8**	7.16	**8.35**	4.32	2.77	6.29	1.69
Cadmium	**1.2**	**9.6**	**100**	-	0.654	<0.142	<0.139	<0.136	0.21	0.137	<0.140	0.152	<0.142	<0.142	<0.139	1.1	1.9	0.416	0.288	0.156	0.28	<0.126	<0.130	<0.131	<0.136
Chromium	**81**	**370**	**500**	-	42.8B	21.1B	15.0B	17.7B	32.7B	29.2B	32.3B	41.7B	39.6B	40.2B	40.7B	**87.8B**	**84.1B**	33.5B	34.2B	22.6B	38.9B	15.5B	11.0B	20.0B	23.3B
Copper	**34**	**270**	**2500**	**254**	**177**	25.4	8.56	11.6	45.7	32.8	36.8	42	38.7	40.2	43.3	**337**	**568**	**603**	**64.8**	**50.5**	**103**	27.1	7.53	23.6	29
Lead	**46.7**	**218**	**1000**	**100**	**151**	28.3	2.38	2.92	10	6.4	6.98	9.22	8.27	8.55	8.67	**116**	**133**	**83.6**	18	10.5	21	5.46	2.21	6.44	4.68
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.722**	0.0564	<0.0278	<0.0273	0.111	0.0812	<0.0280	0.0704	0.0686	0.0874	0.0698	**0.635**	**3.04**	**1.45**	**0.166**	0.109	0.13	0.0804	<0.0260	0.0859	0.0583
Nickel	**20.9**	**51.6**	**2000**	-	**23.5**	13.8	10.3	12.6	**26.5**	**23.7**	**26.5**	**30.9**	**28.1**	**29.5**	**29.3**	**42.8**	**43.9**	20.2	**25.8**	17	19.9	11.4	8.91	17.9	**22.2**
Selenium	-	-	**100**	-	0.872	<0.709	<0.693	0.77	1.05	1.02	1.06	1.7	1.33	1.45	1.35	<1.04	<0.912	<0.685	<0.714	<0.693	<0.711	<0.632	<0.649	<0.654	<0.679
Silver	**1**	**3.7**	**500**	**3.5**	0.414	<0.142	<0.139	<0.136	<0.145	<0.132	<0.140	0.152	<0.142	<0.142	<0.139	0.966	1.06	0.222	0.154	<0.139	<0.142	<0.126	<0.130	<0.131	<0.136
Zinc	**150**	**410**	**500**	**307**	**243**	68.9	36.4	47.5	87.2	88.4	92.5	106	96.2	100	99.4	**377**	**423**	145	126	72.9	145	46.7	28.9	54.7	72

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-2
Summary of Total Solids and Metals in AOEC-A 03 and AOEC-A 04 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-A 03										AOEC-A 04							
					A-03 0-1	A-03 1-2	A-03 2-3	A-03 3-4	A-03 4-5	A-03 5-6	A-03 6-7	A-03 7-8	A-03 8-9	A-03 9-10	A-02 0-1	A-04 1-2	A-04 2-3	A-04 3-4	A-04 4-5	A-04 5-6	A-04 6-7	A-04 7-8
General Chemistry																						
Solids, Total (%)					67.1	68.4	58.9	76	73.6	74.6	76.7	72.4	71.8	71.5	48	49.7	61.8	61.6	65.7	67.9	71.8	75.3
Metals (mg/kg)																						
Arsenic	**8.2**	**70**	**500**	-	**11.3**	**15.4**	**21.8**	3.74	2.75	2.33	1.96	1.58	1.45	1.54	**19.9**	**28.1**	**11.1**	**21.3**	**15.9**	**11.2**	**9.56**	**9.9**
Cadmium	**1.2**	**9.6**	**100**	-	**1.78**	**3.17**	**3.28**	0.192	<0.136	0.216	<0.130	<0.138	<0.139	<0.140	0.983	**1.95**	1.01	0.969	0.306	0.199	0.217	0.222
Chromium	**81**	**370**	**500**	-	**126B**	**102B**	**145B**	18.0B	20.0B	31.7B	23.7B	20.6B	17.8B	18.9B	**82.9B**	**101B**	55.9B	65.2B	41.8B	34.2B	30.8B	38.4B
Copper	**34**	**270**	**2500**	**254**	**365**	**440**	**377**	29	22.7	**39.6**	25.7	21.6	20.1	16.6	**234**	**430**	**309**	**228**	**54.2**	**36.4**	**44.5**	**50**
Lead	**46.7**	**218**	**1000**	**100**	**449**	**283**	**422**	32.8	8.06	11	6.63	4.3	3.94	3.43	**87**	**111**	**71**	**59.2**	16	10.2	11.4	12.1
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.199**	**0.325**	**0.763**	0.0312	<0.0272	0.0987	0.143	0.0577	<0.0279	<0.0280	**0.567**	**1.1**	**2.47**	**1.7**	0.16	0.1	0.108	0.0597
Nickel	**20.9**	**51.6**	**2000**	-	**26.8**	**30.7**	**43.5**	12.9	**23.7**	**31**	20.8	17.6	15.2	14.9	**45.9**	**50.2**	**33.1**	**40.9**	**32.5**	**25.9**	**23.1**	**31.9**
Selenium	-	-	**100**	-	1.58	<0.731	<0.849	<0.658	<0.679	<0.670	<0.652	<0.691	<0.696	<0.699	<1.04	3.24	2.28	2.44	<0.761	<0.736	<0.696	<0.664
Silver	**1**	**3.7**	**500**	**3.5**	0.43	**1.57**	0.894	<0.132	<0.136	<0.134	<0.130	<0.138	<0.139	<0.140	0.813	1.05	0.517	0.526	0.162	<0.147	<0.139	<0.133
Zinc	**150**	**410**	**5000**	**307**	**746**	**1020**	**1590**	90.3	73.6	80.7	64.1	55.9	57.6	56.8	**324**	**416**	**298**	**225**	111	90.9	84.3	104

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-3
Summary of Total Solids and Metals in AOEC-A 05 and AOEC-A 06 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

					AOEC-A 05											AOEC-A 06										
Analyte	ERL	ERM	TTLC	LBNS SMOs	A-05 0-1	A-05 1-2	A-05 2-3	A-05 3-4	A-05 4-5	A-05 5-6	A-05 6-7	A-05 7-8	A-05 8-9	A-05 9-10	A-05 10-11	A-06 0-1	A-06 1-2	A-06 2-3	A-06 3-4	A-06 4-5	A-06 5-6	A-06 6-7	A-06 7-8	A-06 8-9	A-06 9-10	A-06 10-11
General Chemistry																										
Solids, Total (%)					56.9	61.1	62.1	57.5	64.2	55.1	68	63.6	64.1	70.5	74.9	55.5	55.8	54.9	67.4	76.7	78.4	76.5	71.6	70.1	70.7	72
Metals (mg/kg)																										
Arsenic	**8.2**	**70**	**500**	-	**20.6**	**14.9**	**12.8**	**15.7**	**15.9**	**19.3**	**13.6**	**17.2**	**13.4**	**8.36**	**11.3**	**22.3**	**30.6**	**17.8**	**13.4**	5.66	**9.47**	6.99	8.03	**10.4**	**9.42**	**9.9**
Cadmium	**1.2**	**9.6**	**100**	-	0.967	0.931	**2.13**	**2.69**	0.598	0.526	0.326	0.487	0.317	0.181	0.213	**1.35**	**1.24**	**1.4**	0.385	<0.130	0.147	<0.131	<0.140	<0.143	<0.141	<0.139
Chromium	**81**	**370**	**500**	-	**95.1B**	69.4B	56.5B	49.3B	38.1B	45.7B	42.2B	44.2B	44.3B	28.8B	34.2B	75.2B	72.4B	60.4B	32.8B	15.4B	30.9B	28.8B	28.0B	28.8B	23.1B	33.6B
Copper	**34**	**270**	**2500**	**254**	**177**	**183**	**149**	**143**	**58.8**	**69.9**	**55.9**	**61.9**	**57**	31.7	**42.2**	**212**	**244**	**202**	**55.3**	13.2	**38.3**	30.7	**34.3**	32.2	25.2	**49.9**
Lead	**46.7**	**218**	**1000**	**100**	**158**	**52.5**	**47.1**	43.4	21.1	28.6	16.1	26.2	20	9.3	11.7	**93.8**	**110**	**62.5**	20.2	3.24	7.59	4.92	5.82	6.64	4.46	6.63
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.66**	**2**	**0.694**	**0.627**	**0.338**	**0.166**	**0.154**	0.137	0.0698	0.0374	0.0495	**0.605**	**0.901**	**1.2**	0.108	**0.156**	0.0443	<0.0262	0.0322	<0.0286	<0.0283	<0.0278
Nickel	**20.9**	**51.6**	**2000**	-	**71.4**	**79.1**	**53.8**	**56.4**	**32.9**	**35.7**	**34.5**	**35.7**	**35.6**	**22.5**	**27.7**	**42.2**	**45.9**	**45.9**	**27.5**	12.3	**27**	**26.4**	**25.5**	**25.9**	**21.4**	**30.3**
Selenium	-	-	**100**	-	<0.879	<0.818	1.42	3.22	<0.779	1.28	<0.735	<0.786	<0.780	<0.709	<0.668	0.951	1.04	1.96	<0.742	<0.652	<0.638	<0.654	<0.698	<0.713	<0.707	<0.694
Silver	**1**	**3.7**	**500**	**3.5**	0.519	0.378	0.462	0.752	0.255	0.312	0.171	0.253	0.193	<0.142	<0.134	0.807	0.756	0.747	0.212	<0.130	<0.128	<0.131	<0.140	<0.143	<0.141	<0.139
Zinc	**150**	**410**	**5000**	**307**	**348**	**198**	**185**	**504**	117	131	118	130	121	76.2	88.2	**303**	**314**	**230**	103	42.6	82.7	77	80	80.2	69.1	90.2

Notes:

All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-4
Summary of Total Solids and Metals in AOEC-A 07 and AOEC-C East 01 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-A 07									AOEC-C East 01							
					A-07 0-1	A-07 1-2	A-07 2-3	A-07 3-4	A-07 4-5	A-07 5-6	A-07 6-7	A-07 7-8	A-07 8-9	CE-01 0-1	CE-01 1-2	CE-01 2-3	CE-01 3-4	CE-01 4-5	CE-01 5-6	CE-01 6-7	CE-01 7-8
General Chemistry																					
Solids, Total (%)					54.6	57.3	58.3	69.5	75.6	76	76.4	76.3	76.1	54.9	65.9	68.7	63.7	77.4	74.7	74.7	71.1
Metals (mg/kg)																					
Arsenic	**8.2**	**70**	**500**	-	**15.7**	**25.8**	**20.1**	**12.7**	6.4	5.35	4.12	4.39	5.2	**19.4**	**10.1**	**9.43**	**12.7**	6.17	5.32	**12**	**13.7**
Cadmium	**1.2**	**9.6**	**100**	-	1.13	**2.93**	**1.91**	0.853	0.243	0.243	<0.131	<0.131	<0.131	0.819	0.312	0.438	0.605	<0.129	<0.134	0.164	0.297
Chromium	**81**	**370**	**500**	-	59.6B	**97.0B**	**86.0B**	52.5B	35.6B	24.8B	20.4B	20.1B	27.1B	71.8B	37.9B	37.5B	43.5B	25.3B	16.4B	20.4B	27.4B
Copper	**34**	**270**	**2500**	**254**	**196**	**303**	**323**	**161**	**57.2**	**40.1**	19.2	20.9	27.7	**154**	**56.2**	**50.7**	**65.5**	21	15.3	18.6	**38.9**
Lead	**46.7**	**218**	**1000**	**100**	**74.1**	**310**	**122**	**61.6**	27	18.9	4.25	5.22	6.81	**67.5**	19.5	10.9	14.7	6.09	4.58	4.86	8.88
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.376**	**1.14**	**2.47**	**0.353**	0.144	0.0883	<0.0262	<0.0263	0.0614	**0.569**	0.284	0.111	0.149	0.0656	0.0311	<0.0268	**0.196**
Nickel	**20.9**	**51.6**	**2000**	-	**36.4**	**51.6**	**45.4**	**35.1**	**31.7**	20.4	17.5	17.9	**24.1**	**41.3**	**26.1**	**29.7**	**35.1**	19	13.4	16.7	**23.8**
Selenium	-	-	**100**	-	0.978	1.07	1.37	1.01	<0.661	<0.658	<0.654	<0.655	<0.657	<0.911	<0.759	<0.728	<0.785	<0.646	<0.669	<0.669	<0.703
Silver	**1**	**3.7**	**500**	**3.5**	0.589	**1.43**	0.833	0.37	<0.132	<0.132	<0.131	<0.131	<0.131	0.665	0.208	<0.146	0.168	<0.129	<0.134	<0.134	<0.141
Zinc	**150**	**410**	**5000**	**307**	**303**	**991**	**538**	**240**	124	122	63.6	60.9	73.8	**256**	109	103	122	63.5	46.1	54.9	82.3

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-5
Summary of Total Solids and Metals in AOEC-C East 02 and AOEC-C East 03 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C East 02								AOEC-C East 03							
					CE-02 0-1	CE-02 1-2	CE-02 2-3	CE-02 3-4	CE-02 4-5	CE-02 5-6	CE-02 6-7	CE-02 7-8	CE-03 0-1	CE-03 1-2	CE-03 2-3	CE-03 3-4	CE-03 4-5	CE-03 5-6	CE-03 6-7	CE-03 7-8
General Chemistry																				
Solids, Total (%)					59.3	62.8	74.4	73.3	71.1	71.2	70.8	70.8	61.7	66.2	72	72.6	73.3	78.5	76.9	75.1
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**11.8**	**8.67**	5.34	5.9	4.83	3.61	**19.5**	3.05	**15.2**	**11.6**	4.23	2.96	2.45	3.02	5.4	**14.8**
Cadmium	**1.2**	**9.6**	**100**	-	0.455	0.268	<0.134	<0.136	<0.141	0.73	<0.141	<0.141	0.562	0.399	<0.139	<0.138	0.443	0.152	<0.130	<0.133
Chromium	**81**	**370**	**500**	-	48.4B	32.5B	32.0B	27.4B	20.6B	40.2B	28.8B	20.3B	59.2B	44.9B	17.2B	18.9B	16.5B	13.3B	13.0B	14.6B
Copper	**34**	**270**	**2500**	**254**	**106**	**35.2**	**36.1**	**35.4**	22.3	**55.8**	**36.9**	21.5	**101**	**67.7**	10.9	21.8	16.8	12	13.1	14.8
Lead	**46.7**	**218**	**1000**	**100**	**48.2**	10.8	6.69	7.71	3.89	10.6	6.41	4.2	46	29.4	3.41	4.95	3.24	2.48	2.45	2.7
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.403**	**0.188**	0.0559	0.0586	0.0402	0.123	0.0495	<0.0283	**0.384**	**0.157**	0.0325	0.0478	0.0374	<0.0255	0.0332	<0.0267
Nickel	**20.9**	**51.6**	**2000**	-	**28.2**	**24.2**	**28.7**	**23.7**	18.8	**33.2**	**25.1**	17.5	**36.4**	**28.9**	12.1	14.8	13.5	11.9	11.4	12.6
Selenium	-	-	**100**	-	1.94	<0.796	<0.672	<0.682	<0.703	<0.702	<0.706	<0.706	<0.810	<0.755	<0.694	<0.689	<0.682	<0.637	<0.650	<0.666
Silver	**1**	**3.7**	**500**	3.5	0.447	<0.159	<0.134	<0.136	<0.141	0.382	<0.141	<0.141	0.449	0.303	<0.139	<0.138	<0.136	<0.127	<0.130	<0.133
Zinc	**150**	**410**	**5000**	307	**183**	85.9	89.1	80.6	59.9	113	76.5	57.3	**209**	139	47.2	54.5	47	34.3	40	45.7

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-6
Summary of Total Solids and Metals in AOEC-C East 04 and AOEC-C East 05 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C East 04								AOEC-C East 05							
					CE-04 0-1	CE-04 1-2	CE-04 2-3	CE-04 3-4	CE-04 4-5	CE-04 5-6	CE-04 6-7	CE-04 7-8	CE-05 0-1	CE-05 1-2	CE-05 2-3	CE-05 3-4	CE-05 4-5	CE-05 5-6	CE-05 6-7	CE-05 7-8
General Chemistry																				
Solids, Total (%)					55.2	63.9	73.4	73.9	70.9	76.6	76	73.5	61.6	61.5	73.5	74.1	75.6	70.7	77.3	78.3
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**18.4**	**20.3**	7.49	7.89	4.66	2.84	2.47	8.1	**16.1**	**16.8**	5.67	2.49	3.29	2.38	1.8	1.64
Cadmium	**1.2**	**9.6**	**100**	-	0.737	0.936	0.308	0.196	<0.141	<0.131	<0.132	<0.136	0.505	0.441	0.141	<0.135	<0.132	<0.141	<0.129	<0.128
Chromium	**81**	**370**	**500**	-	72.2B	62.1B	30.5B	24.0B	23.7B	16.1B	13.4B	24.5B	60.3B	55.1B	18.7B	15.5B	14.0B	15.2B	14.3B	14.3B
Copper	**34**	**270**	**2500**	**254**	**153**	**130**	**37**	28.3	27.7	15.1	12.4	28.5	**111**	**68.3**	16.5	15.8	13.1	14.6	13.8	13.8
Lead	**46.7**	**218**	**1000**	**100**	**74.9**	**63**	18.2	8.54	6.43	3.09	2.77	4.35	**55.9**	22.9	6.77	4.08	2.6	3.45	2.91	2.75
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.62**	**0.808**	0.109	0.0723	**0.375**	**0.191**	<0.0264	<0.0273	**0.426**	**0.228**	0.0573	0.0406	<0.0265	0.0661	0.038	0.029
Nickel	**20.9**	**51.6**	**2000**	-	**40.6**	**39.5**	**22.8**	18.3	20.5	13.6	11	**22.1**	**35**	**40.4**	14.2	13.4	12	14	12.7	12.2
Selenium	-	-	**100**	-	1.09	1.17	<0.681	0.754	<0.705	<0.653	<0.658	<0.680	<0.812	1.4	<0.680	<0.675	<0.661	<0.707	<0.647	<0.639
Silver	**1**	**3.7**	**500**	**3.5**	0.665	0.676	0.181	<0.135	<0.141	<0.131	<0.132	<0.136	0.504	0.313	<0.136	<0.135	<0.132	<0.141	<0.129	<0.128
Zinc	**150**	**410**	**5000**	**307**	**250**	**223**	89.7	65.5	63.6	44.6	38.5	77.1	198	138	52.1	46.2	42.3	47.3	41.4	40.4

Notes:
- All values in dry weight except where noted
- bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
- bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
- bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
- bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
- < = below the method detection limit indicated
- B = analyte was present in associated method blank

Table 2-7
Summary of Total Solids and Metals in AOEC-C East 06 and AOEC-C East 07 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C East 06								AOEC-C East 07							
					CE-06 0-1	CE-06 1-2	CE-06 2-3	CE-06 3-4	CE-06 4-5	CE-06 5-6	CE-06 6-7	CE-06 7 8	CE-07 0-1	CE-07 1-2	CE-07 2-3	CE-07 3-4	CE-07 4-5	CE-07 5-6	CE-07 6-7	CE-07 7-8
General Chemistry																				
Solids, Total (%)					56.1	60.7	64.6	77	77.6	79.1	78	77.6	56.1	57.7	66.6	69.4	78.3	73.9	77.5	71.7
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**15.4**	**15**	**15.2**	2.61	2.48	1.59	1.22	1.17	**19.4**	**21.5**	**11.2**	**8.22**	1.69	2.44	1.04	4.45
Cadmium	**1.2**	**9.6**	**100**	-	0.52	0.661	0.425	<0.130	<0.129	<0.126	<0.128	<0.129	0.641	0.802	0.307	0.239	<0.128	<0.135	<0.129	0.234
Chromium	**81**	**370**	**500**	-	60.1B	51.9B	57.1B	17.9B	15.1B	12.7B	13.7B	12.5B	72.3B	67.8B	45.4B	33.6B	11.2B	13.2B	12.2B	40.2B
Copper	**34**	**270**	**2500**	**254**	**112**	**97.1**	**65.1**	17.9	13.4	13.1	13	11.4	**152**	**134**	**51.6**	**39.4**	9.91	11.5	12.3	**50.1**
Lead	**46.7**	**218**	**1000**	**100**	**51.6**	**50.6**	20.8	4.64	3.24	4.51	3.39	2.26	**68.7**	**70.6**	15.8	12.8	2.25	2.49	2.3	10.9
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.464**	**0.625**	**0.155**	0.126	0.0301	0.0502	0.0315	<0.0258	**0.506**	**0.793**	0.0795	0.0753	<0.0256	0.0278	0.0653	0.0876
Nickel	**20.9**	**51.6**	**2000**	-	**34.8**	**31.4**	**41.6**	13.8	11.9	11.6	11.7	15.9	**39.8**	**40.8**	**34.1**	**26.5**	9.32	11.3	10.8	**33.1**
Selenium	-	-	**100**	-	1.17	1.32	1.04	<0.649	<0.644	<0.632	<0.641	<0.644	1.39	1.2	0.786	<0.720	<0.639	<0.677	<0.645	0.832
Silver	**1**	**3.7**	**500**	**3.5**	0.509	0.481	0.258	<0.130	<0.129	<0.126	<0.128	<0.129	0.621	0.611	0.196	<0.144	<0.128	<0.135	<0.129	<0.139
Zinc	**150**	**410**	**5000**	**307**	**192**	**228**	144	49.6	42.3	39.4	40.6	46.3	**251**	**257**	120	95.8	33.1	38.5	38.1	112

Notes:

All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-8
Summary of Total Solids and Metals in AOEC-C East 08 and AOEC-C East 09 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C East 08								AOEC-C East 09							
					CE-08 0-1	CE-08 1-2	CE-08 2-3	CE-08 3-4	CE-08 4-5	CE-08 5-6	CE-08 6-7	CE-08 7-8	CE-09 0-1	CE-09 1-2	CE-09 2-3	CE-09 3-4	CE-09 4-5	CE-09 5-6	CE-09 6-7	CE-09 7-8
General Chemistry																				
Solids, Total (%)					57.7	64.9	77.1	76.5	72.6	68.6	74.8	74	53.1	58.2	60.9	76.1	75.6	75.3	76.5	76.5
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**19.3**	**12.4**	**8.69**	3.47	2.55	5.67	4.91	3.28	**20.2**	**19.4**	**17.5**	8.1	3.7	2.34	1.62	2.38
Cadmium	**1.2**	**9.6**	**100**	-	0.733	0.452	0.143	<0.131	<0.138	<0.146	<0.134	<0.135	0.867	0.575	0.516	0.164	<0.132	<0.133	<0.131	<0.131
Chromium	**81**	**370**	**500**	-	68.9B	42.0B	29.4B	19.7B	30.5B	28.6B	17.7B	17.3B	60.1B	49.3B	56.8B	25.2B	18.8B	20.5B	12.8B	21.6B
Copper	**34**	**270**	**2500**	**254**	**133**	**65.4**	29.3	19.5	**35.4**	33.2	18.5	17	**149**	**82.5**	**76.5**	26.3	23.2	20	13.5	23.4
Lead	**46.7**	**218**	**1000**	**100**	**65.6**	29.9	7.47	4.55	6.21	6.14	3.7	3.3	**84.8**	36.5	30	7.67	6.39	3.85	2.7	3.5
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.347**	**0.173**	0.0277	<0.0262	0.0336	<0.0292	<0.0268	<0.0271	**0.881**	**0.23**	**0.181**	0.0575	0.0539	<0.0266	<0.0262	0.043
Nickel	**20.9**	**51.6**	**2000**	-	**40.5**	**26.9**	**22.1**	16.1	**27.4**	**24.7**	15.2	14.7	**36.2**	**37.6**	**40.2**	20.2	15.6	17.3	11	17.3
Selenium	-	-	**100**	-	1.09	0.787	<0.649	<0.654	<0.689	<0.729	<0.668	<0.676	<0.942	<0.859	0.989	<0.657	<0.661	<0.664	<0.654	<0.654
Silver	**1**	**3.7**	**500**	**3.5**	0.594	0.299	<0.130	<0.131	<0.138	<0.146	<0.134	<0.135	0.627	0.35	0.317	<0.131	<0.132	<0.133	<0.131	<0.131
Zinc	**150**	**410**	**5000**	**307**	**251**	143	71.5	54.9	77	73.4	50.3	51.2	**251**	**164**	**157**	70	58.4	61.6	40.6	58

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-9
Summary of Total Solids and Metals in AOEC-C West 01 and AOEC-C West 02 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C West 01								AOEC-C West 02							
					CW-01 0-1	CW-01 1-2	CW-01 2-3	CW-01 3-4	CW-01 4-5	CW-01 5-6	CW-01 6-7	CW-01 7-8	CW-02 0-1	CW-02 1-2	CW-02 2-3	CW-02 3-4	CW-02 4-5	CW-02 5-6	CW-02 6-7	CW-02 7-8
General Chemistry																				
Solids, Total (%)					55.6	67.3	73.2	73.6	74.9	78	73.5	73.4	48.8	52.1	59	56.5	62.8	69.9	77.6	77
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**11.8**	7.05	3.13	**8.5**	3.83	7.9	5.43	6.35	**16.7**	**22.8**	**13.8**	**10.4**	7.02	1.38	2.4	1.41
Cadmium	**1.2**	**9.6**	**100**	-	0.439	0.234	<0.137	0.189	0.446	0.13	<0.136	<0.136	0.635	0.804	0.428	0.284	0.187	<0.143	<0.129	<0.130
Chromium	**81**	**370**	**500**	-	46.0B	25.1B	14.1B	24.8B	17.8B	15.8B	21.9B	18.0B	61.4B	61.6B	42.7B	33.8B	26.1B	7.79B	11.3B	22.4B
Copper	**34**	**270**	**2500**	**254**	**87.7**	**37.5**	9.01	32	29.5	20.7	27.3	23.8	**132**	**129**	**60.3**	**40.2**	32.6	8.91	11.3	23.7
Lead	**46.7**	**218**	**1000**	**100**	45.1	19.4	2.54	7.57	4.73	4.09	5.25	4.82	**64.5**	**74.6**	23.1	14.4	10.8	2.2	2.57	5.71
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.568**	0.139	<0.0274	0.0703	0.0421	**0.445**	0.045	0.0739	**0.856**	**1.04**	**0.396**	**0.184**	0.128	<0.0287	<0.0258	0.0321
Nickel	**20.9**	**51.6**	**2000**	-	**26.9**	16.1	10.7	**24.1**	16.5	15.3	20.9	17.9	**35.7**	**35.8**	**33**	**26.2**	20.8	7.89	10.3	19.3
Selenium	-	-	**100**	-	<0.899	<0.743	<0.683	<0.679	<0.668	<0.641	<0.680	<0.681	<1.02	<0.960	<0.847	<0.885	<0.796	<0.715	<0.644	<0.649
Silver	**1**	**3.7**	**500**	**3.5**	0.482	0.174	<0.137	<0.136	0.206	<0.128	<0.136	<0.136	0.59	0.67	0.25	<0.177	<0.159	<0.143	<0.129	<0.130
Zinc	**150**	**410**	**5000**	**307**	**175**	93.9	46.3	75.8	65.9	54.8	68.2	61.1	**220**	**247**	126	94.5	78.9	65.7	45.1	64.3

Notes:

All values in dry weight except where noted

bold = measured concentration exceeds the analyte's respective effects change low (ERL) value

bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.

bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value

bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value

< = below the method detection limit indicated

B = analyte was present in associated method blank

Table 2-10
Summary of Total Solids and Metals in AOEC-C West 03 and AOEC-C West 04 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C West 03								AOEC-C West 04							
					CW-03 0-1	CW-03 1-2	CW-03 2-3	CW-03 3-4	CW-03 4-5	CW-03 5-6	CW-03 6-7	CW-03 7-8	CW-04 0-1	CW-04 1-2	CW-04 2-3	CW-04 3-4	CW-04 4-5	CW-04 5-6	CW-04 6-7	CW-04 7-8
General Chemistry																				
Solids, Total (%)					50.6	56.3	55.3	71.3	71.9	79.6	78.7	77.3	49.1	64.2	69.4	75.9	74.3	80.6	77.4	67.9
Metals (mg/kg)																				
Arsenic	**8.2**	**70**	**500**	-	**12.2**	**14.4**	**16.9**	3.08	**10.5**	**8.74**	5.17	3.61	**14.6**	**11.3**	3.54	5.13	5.78	4.57	5.04	6.19
Cadmium	**1.2**	**9.6**	**100**	-	0.439	0.567	0.662	<0.140	0.168	<0.126	<0.127	0.131	0.518	0.362	<0.144	<0.132	<0.135	<0.124	<0.129	<0.147
Chromium	**81**	**370**	**500**	-	53.1B	52.5B	49.8B	14.0B	34.7B	31.7B	19.8B	18.2B	57.3B	38.7B	14.5B	22.5B	28.1B	20.2B	21.9B	26.0B
Copper	**34**	**270**	**2500**	**254**	**67.2**	**108**	**96**	10.9	**35.8**	32.5	27.2	20.1	**89.2**	**45.5**	9.61	25	**36.8**	31.9	28.4	32.5
Lead	**46.7**	**218**	**1000**	**100**	34	**54.4**	**49.9**	2.94	11.6	10.8	5.95	5.8	42.6	21.8	2.85	7.49	8.82	6.07	6.96	6.25
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.347**	**0.581**	**0.728**	<0.0281	0.0609	0.0533	0.0486	0.0531	**0.473**	**0.23**	0.0544	0.0645	0.078	0.0448	**0.188**	0.0657
Nickel	**20.9**	**51.6**	**2000**	-	**34.1**	**31.2**	**32.7**	11	**30.3**	**28.8**	18.1	16.6	**37.2**	**56.5**	10.7	19.3	**24.7**	17.4	19.3	**24.7**
Selenium	-	-	**100**	-	<0.988	<0.888	<0.904	<0.701	<0.695	<0.628	<0.635	<0.647	<1.02	<0.779	<0.720	<0.659	<0.673	<0.620	<0.646	<0.736
Silver	**1**	**3.7**	**500**	**3.5**	0.34	0.528	0.56	<0.140	<0.139	<0.126	<0.127	<0.129	0.419	0.22	<0.144	<0.132	<0.135	<0.124	<0.129	<0.147
Zinc	**150**	**410**	**5000**	**307**	146	**194**	**203**	43.7	103	81.2	63.7	58.2	**185**	109	48.3	82.4	76.9	60.7	68.2	78.9

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-11
Summary of Total Solids and Metals in AOEC-C West 05 and AOEC-C West 06 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C West 05							AOEC-C West 06								
					CW-05 0-1	CW-05 1-2	CW-05 2-3	CW-05 3-4	CW-05 4-5	CW-05 5-6	CW-05 6-7	CW-06 0-1	CW-06 1-2	CW-06 2-3	CW-06 3-4	CW-06 4-5	CW-06 5-6	CW-06 6-7	CW-06 7-8
General Chemistry																			
Solids, Total (%)					50	62.3	62.6	67.5	71.7	80	74.6	43.6	48.6	53.5	71.2	65.6	70.5	68.2	68.3
Metals (mg/kg)																			
Arsenic	**8.2**	**70**	**500**	-	**12.7**	**15.5**	5.54	3.62	5.99	3.84	4.16	**13.7**	**18.7**	**22.5**	**16.8**	**20.9**	2.87	4.75	5.74
Cadmium	**1.2**	**9.6**	**100**	-	0.456	0.557	0.17	<0.148	0.243	<0.125	0.473	0.512	0.895	**1.48**	**1.22**	0.165	<0.142	<0.147	<0.146
Chromium	**81**	**370**	**500**	-	54.3	54.3	23.0B	16.0B	27.0B	20.6B	17.1B	64.4	73.1	75	51.7	29.5	20.1	19.7	25.6
Copper	**34**	**270**	**2500**	**254**	**64.2**	**111**	24.6	10.1	25	25.2	24.5	**98.9**	**168**	**200**	**148**	32	20.8	23.4	**49.6**
Lead	**46.7**	**218**	**1000**	**100**	32.4	**58**	12.7	2.95	6.88	5.16	5.09	46.1	**79.7**	**98.6**	**70.2**	7.92	4.35	4.82	8.67
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.237**	**0.697**	0.0792	<0.0297	0.0524	0.0528	0.125	**0.44**	**0.485**	**1.46**	**0.943**	0.0746	0.0419	0.0353	0.0697
Nickel	**20.9**	**51.6**	**2000**	-	**48.8**	**30.2**	14.5	11.4	**23.1**	18	**43.9**	**39.7**	**40.3**	**38.8**	**27.4**	**24.9**	16.5	17.9	**22.5**
Selenium	-	-	**100**	-	<1.00	<0.803	<0.799	<0.741	<0.697	<0.625	<0.670	<1.15	<1.03	<0.935	<0.702	<0.762	<0.709	<0.733	<0.732
Silver	**1**	**3.7**	**500**	**3.5**	0.301	0.551	<0.160	<0.148	<0.139	<0.125	0.323	0.449	0.744	0.919	0.705	0.222	<0.142	<0.147	0.23
Zinc	**150**	**410**	**5000**	**307**	142	**204**	75.6	48.3	102	66.2	55.9	**195**	**271**	**326**	**242**	77.2	59.2	61.4	72.5

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-12
Summary of Total Solids and Metals in AOEC-C West 07 and AOEC-C West 08 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C West 07							AOEC-C West 08							
					CW-07 0-1	CW-07 1-2	CW-07 2-3	CW-07 3-4	CW-07 4-5	CW-07 5-6	CW-08 6-7	CW-08 0-1	CW-08 1-2	CW-08 2-3	CW-08 3-4	CW-08 4-5	CW-08 5-6	CW-08 6-7	CW-08 7-8
General Chemistry																			
Solids, Total (%)					53.1	60.4	63.8	71.5	70.9	68.9	79	71.6	64	67.1	73.3	76.3	76.7	74.1	77.8
Metals (mg/kg)																			
Arsenic	8.2	70	500	-	**12.2**	**12.7**	**13.8**	6	5.86	**10.7**	**10.6**	**18.2**	5.9	4.22	6.94	7	7.45	6.36	**8.55**
Cadmium	1.2	9.6	100	-	0.497	0.467	0.518	0.173	<0.141	0.19	0.165	0.335	0.176	<0.149	<0.136	<0.131	<0.130	<0.135	<0.129
Chromium	81	370	500	-	58.9	54.7	46.3	26.2	25.4	36.2	27.5	21.2	26.0B	19.6B	26.9B	28.4B	19.2B	16.8	20.9
Copper	34	270	2500	254	**74.4**	**71.8**	**84**	26.5	22.2	**35.8**	28.4	27	28.9	16.5	25.8	28.1	19.1	17.8	20.2
Lead	46.7	218	1000	100	34.5	36.1	42.3	10.9	6.12	8.89	7.43	7.86	12.6	6.33	5.09	5.74	4.39	3.62	4.81
Mercury	0.15	0.71	20	0.9	**0.259**	**0.503**	**0.495**	0.075	0.0443	**0.163**	0.0594	0.118	0.109	<0.0299	0.0526	0.0563	<0.0261	<0.0270	0.0569
Nickel	20.9	51.6	2000	-	**36.4**	**34.3**	**26.9**	17.2	19	**26.6**	20.8	18.4	**22.4**	14	**22.8**	**23.6**	16.1	16.1	16.5
Selenium	-	-	100	-	<0.942	<0.828	<0.784	<0.699	<0.705	<0.726	<0.633	<0.698	<0.781	<0.745	<0.682	<0.655	<0.652	<0.675	<0.643
Silver	1	3.7	500	3.5	0.351	0.358	0.421	<0.140	<0.141	<0.145	<0.127	<0.140	<0.156	<0.149	<0.136	<0.131	<0.130	<0.135	<0.129
Zinc	150	410	5000	307	**160**	147	**160**	73.4	69.1	89.7	72	64.7	80.9	60.7	76.6	89.4	56.6	60.1	57.6

Notes:

All values in dry weight except where noted

bold = measured concentration exceeds the analyte's respective effects change low (ERL) value

bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.

bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value

bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value

< = below the method detection limit indicated

B = analyte was present in associated method blank

Table 2-13
Summary of Total Solids and Metals in AOEC-C West 09 and AOEC-C West 10 and a Comparison to Published Effects Range Low and Effects Range Median Sediment Quality Values, Long Beach Naval Station Sediment Management Objectives, and Total Threshold Limit Concentration Regulatory Levels

Analyte	ERL	ERM	TTLC	LBNS SMOs	AOEC-C West 09							AOEC-C West 10							
					CW-09 0-1	CW-09 1-2	CW-09 2-3	CW-09 3-4	CW-09 4-5	CW-09 5-6	CW-09 6-7	CW-10 0-1	CW-10 1-2	CW-10 2-3	CW-10 3-4	CW-10 4-5	CW-10 5-6	CW-10 6-7	CW-10 7-8
General Chemistry																			
Solids, Total (%)					53	62.6	60.3	61.5	65.6	76.3	64	54	51.6	50.8	51.5	53.3	68.3	79.1	74.2
Metals (mg/kg)																			
Arsenic	**8.2**	**70**	**500**	-	**14.7**	**12.8**	8.11	4.44	3.68	3.62	4.46	**14**	**16.5**	**23.2**	**29.8**	**12**	7.78	**12.9**	6.08
Cadmium	**1.2**	**9.6**	**100**	-	0.535	0.457	0.258	<0.163	<0.152	<0.131	<0.156	0.477	0.655	1.13	**2.16**	0.992	0.158	0.199	<0.135
Chromium	**81**	**370**	**500**	-	64.0B	56.0B	31.4B	17.9B	16.4B	22.4B	25.3B	67.1B	75.6B	**89.6B**	**95.6B**	52.2B	27.9B	38.3B	31.4B
Copper	**34**	**270**	**2500**	**254**	**73**	**73.1**	**40.6**	12.5	12	22.9	29.9	**93.8**	**94.5**	**238**	**267**	**121**	**36**	**50.8**	**43.1**
Lead	**46.7**	**218**	**1000**	**100**	32.8	32.9	16.8	3.98	2.8	4.63	5.5	41.1	45	**99.5**	**148**	**91.7**	11.1	11.3	8.7
Mercury	**0.15**	**0.71**	**20**	**0.9**	**0.202**	**0.226**	**0.645**	<0.0326	0.0888	0.0285	0.0485	0.356	0.291	**1.22**	**1.6**	**0.423**	**0.352**	0.13	0.0885
Nickel	**20.9**	**51.6**	**2000**	-	**42.4**	**35.4**	19.8	13	13.2	19.9	**22.3**	**49.6**	**47.1**	**46.7**	**67.1**	**38.8**	**24.5**	**72.2**	**25.8**
Selenium	-	-	**100**	-	1.22	0.879	<0.829	<0.813	<0.762	<0.655	<0.781	<0.926	1.16	1.53	1.77	<0.938	<0.732	0.755	<0.674
Silver	**1**	**3.7**	**500**	**3.5**	0.317	0.315	0.169	<0.163	<0.152	<0.131	<0.156	0.392	0.445	0.972	1.19	0.682	<0.146	0.135	<0.135
Zinc	**150**	**410**	**5000**	**307**	**164**	**151**	103	53.9	58.9	70.8	76.6	**193**	**193**	**357**	**457**	**248**	83.5	97.6	97.1

Notes:
All values in dry weight except where noted
bold = measured concentration exceeds the analyte's respective effects change low (ERL) value
bold and yellow = measured concentration exceeds the analyte's respective effects range median (ERM) value.
bold and orange = measured concentration exceeds the analyte's respective Total Threshold Limit Concentration (TTLC) value
bold outline around cell = measured concentration exceeds the analyte's respective Long Beach Naval Station (LBNS) Sediment Management Objectives (SMOs) value
< = below the method detection limit indicated
B = analyte was present in associated method blank

Table 2-14
IR Site 7 – West Basin Soluble Threshold Limit Concentrations Chemistry Results

Core Number	Core Horizon (feet)	Analyte	Total Metals (mg/kg d/w)	STLC (mg/L)	STLC Limits (mg/L)	TTLC Limits (mg/L w/w)
A-02	2 to 3	Copper	603	**ND** (0.0500)	25	2500
		Lead	83.6	1.14	5	1000
		Mercury	1.45	**ND** (0.00500)	0.2	20
		Chromium	33.5 (b)	0.369	560	2500
A-03	1 to 2	Copper	440	**ND** (0.0500)	25	2500
		Lead	283	**ND** (0.100)	5	1000
		Mercury	0.325	**ND** (0.00500)	0.2	20
		Chromium	102 (b)	1.01	560	2500
A-03	0 to 1	Copper	365	**ND** (0.0500)	25	2500
		Lead	449	0.571	5	1000
		Mercury	0.199	**ND** (0.00500)	0.2	20
		Chromium	126 (b)	1.25	560	2500
A-07	1 to 2	Copper	303	**ND** (0.0500)	25	2500
		Lead	310	**ND** (0.100)	5	1000
		Mercury	1.14	**ND** (0.00500)	0.2	20
		Chromium	97 (b)	0.83	560	2500
A-02	1 to 2	Copper	568	0.133	25	2500
		Lead	133	1.49	5	1000
		Mercury	3.04	**ND** (0.00500)	0.2	20
		Chromium	84.1 (b)	0.778	560	2500
A-04	2 to 3	Copper	309	**ND** (0.0500)	25	2500
		Lead	71	0.27	5	1000
		Mercury	2.47	**ND** (0.00500)	0.2	20
		Chromium	55.9 (b)	0.263	560	2500

Notes:

Total metals tested according to EPA 6020; STLC according to USEPA 6010B/EPA 7470A
Total metals tested in 6/07; STLC tested in 8/08
(b) = analyte also detected in method blank
TTLC = Total Threshold Limit Concentration
mg/kg d/w = milligrams per kilograms dry weight
mg/L = milligrams per liter
mg/L w/w = milligrams per liter wet weight

Table 3-1
Estimated Dredge Sediment Volumes

Dredge Area	Acreage (acres)	Depth of Remedial Dredging (feet)	Allowed Contractor Overdepth (feet)	Approximate Dredge Volume (cy)
AOEC-A	16.33	4	2	181,000
AOEC-C West	33.20	4	2	371,000
AOEC-C East	33.38	2	2	248,000
			Total	**800,000**

Table 5-1
Summary of Physical and Chemical Analysis of IR Site 7 Project Sediment Elutriates and Site Water and a Comparison to California Ocean Plan Water Quality Objections

Analyte	Daily Maximum Criteria California Ocean Plan	IR Site 7 Water	AOEC-A Elutriate	AOEC-C East Elutriate	AOEC-C West Elutriate
Metals (mg/L)					
Arsenic	**0.032**	<0.0010	0.00944	0.00718	0.00579
Cadmium	**0.004**	<0.0010	<0.0010	<0.0010	<0.0010
Chromium	**0.008**	0.0072	0.00259	0.00383	0.00281
Copper	**0.012**	0.0024	0.00104	<0.0010	<0.0010
Lead	**0.008**	<0.0010	<0.0010	<0.0010	<0.0010
Mercury	**0.00016**	<0.0000177	<0.0000177	<0.0000177	<0.0000177
Nickel	**0.02**	0.0012	0.00123	<0.0010	<0.0010
Selenium	**0.06**	<0.0010	<0.0010	<0.0010	<0.0010
Silver	**0.0028**	<0.0010	<0.0010	<0.0010	<0.0010
Zinc	**0.08**	<0.0050	<0.0050	<0.0050	<0.0050
Pesticides (µg/L)					
2,4'-DDD	-	<0.050	<0.050	<0.050	<0.050
2,4'-DDE	-	<0.050	<0.050	<0.050	<0.050
2,4'-DDT	-	<0.050	<0.050	<0.050	<0.050
4,4'-DDD	-	<0.050	<0.050	<0.050	<0.050
4,4'-DDE	-	<0.050	<0.050	<0.050	<0.050
4,4'-DDT	-	<0.050	<0.050	<0.050	<0.050
PAHs (µg/L)					
1-Methylnaphthalene	-	<1.0	<1.0	<1.0	<1.0
2-Methylnaphthalene	-	<1.0	<1.0	<1.0	<1.0
Acenaphthene	-	<1.0	<1.0	<1.0	<1.0
Acenaphthylen	-	<1.0	<1.0	<1.0	<1.0
Anthracene	-	<1.0	<1.0	<1.0	<1.0

Table 5-1
Summary of Physical and Chemical Analysis of IR Site 7 Project Sediment Elutriates and Site Water and a Comparison to California Ocean Plan Water Quality Objections

Analyte	Daily Maximum Criteria California Ocean Plan	IR Site 7 Water	AOEC-A Elutriate	AOEC-C East Elutriate	AOEC-C West Elutriate
Benzo (a) Ant	-	<1.0	<1.0	<1.0	<1.0
Benzo (a) Pyr	-	<1.0	<1.0	<1.0	<1.0
Benzo (b) Flu	-	<1.0	<1.0	<1.0	<1.0
Benzo (g,h,i)	-	<1.0	<1.0	<1.0	<1.0
Benzo (k) Flu	-	<1.0	<1.0	<1.0	<1.0
Chrysene	-	<1.0	<1.0	<1.0	<1.0
Dibenz (a,h)	-	<1.0	<1.0	<1.0	<1.0
Fluoranthene	-	<1.0	<1.0	<1.0	<1.0
Fluorene	-	<1.0	<1.0	<1.0	<1.0
Indeno (1,2,3)	-	<1.0	<1.0	<1.0	<1.0
Naphthalene	-	<1.0	<1.0	<1.0	<1.0
Phenanthrene	-	<1.0	<1.0	<1.0	<1.0
Pyrene	-	<1.0	<1.0	<1.0	<1.0
Total PAHs	-	0.0	0.0	0.0	0.0
Aroclors (µg/L)					
Aroclor-1016	-	<0.50	<0.50	<0.50	<0.50
Aroclor-1221	-	<0.50	<0.50	<0.50	<0.50
Aroclor-1232	-	<0.50	<0.50	<0.50	<0.50
Aroclor-1248	-	<0.50	<0.50	<0.50	<0.50
Aroclor-1254	-	<0.50	<0.50	<0.50	<0.50
Aroclor-1260	-	<0.50	<0.50	<0.50	<0.50

Notes:
bold = the measured concentration exceeds the analyte's respective daily maximum criteria

Table 5-2
Input Parameters Used in DREDGE Modeling

Variable	Unit	Value Used											
		AOEC-A				AOEC-C East				AOEC-C West			
		A1	A2	A3	A4	CE1	CE2	CE3	CE4	CW1	CW2	CW3	CW4
Bucket Size	cy	12	12	8	8	12	12	8	8	12	12	8	8
Cycle Time	sec	60	60	60	60	60	60	60	60	60	60	60	60
Settling Velocity[1]	ft/sec	0.01	0.01	0.01	0.01	0.055	0.055	0.055	0.055	0.014	0.014	0.014	0.014
Dry Density	lb/ft3	75.97	75.97	75.97	75.97	75.97	75.97	75.97	75.97	75.97	75.97	75.97	75.97
Turbidity Generation Unit (TGU)[2]	lb/ft3	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1	5556.1
Fraction of Particles < 74 µm[3]		0.56	0.56	0.56	0.56	0.32	0.32	0.32	0.32	0.51	0.51	0.51	0.51
Fraction of Particles < Critical Settling Velocity		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dredge Depth	ft	50	55	50	55	45	48	45	48	35	49	35	49
Lateral Diffusion Coefficient	ft2/sec	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4	1076.4
Vertical Diffusion Coefficient	ft2/sec	.00538	.00538	.00538	.00538	.00538	.00538	.00538	.00538	.00538	.00538	.00538	.00538
Ambient Water Velocity[4]	ft/sec	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
Mean Particle Size[3]	µm	60	60	60	60	150	150	150	150	75	75	75	75
Specific Gravity		2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57

Notes:

1. Value is calculated by the DREDGE program based on Stokes' Law, using mean grain size from each sediment source
2. Based on literature values applicable to use of 8-cy bucket, as presented in Nakai (1978)
3. Determined using the results of sediment sampling and grain size testing (Weston 2007)
4. Assumed value for ambient current conditions due to intertidal exchange

Table 5-3
Key Input Parameters Used in STFATE Modeling

Parameter	Unit	AOEC-A	AOEC-C West
Site Description			
Number of Grid Points in Z-Dir		18	18
Number of Grid Points in X-Dir		30	30
Spacing Between Grid Points	ft	50	50
Density of Water (constant with depth)	g/cm^3	1.023	1.023
Water Depth in Disposal Area	ft	48	30
Material Description			
Volume of Each Layer of Placed Sediments	cy	181,000	248,000
Number of Solids Fractions in Material		3	3
Characteristics of Material that Falls in Clumps			
Specific Gravity		1.6	1.6
Fall Velocity	ft/sec	3	3
Void Ratio After Deposition		0.4	0.4
Volumetric Concentration of Total Solids	%	0.25	0.25
Characteristics of Material Sand Fraction			
Specific Gravity		2.7	2.7
Fall Velocity	ft/sec	0.1	0.1
Void Ratio After Deposition		0.6	0.6
Volumetric Concentration of Total Solids	%	0.11	0.125
Characteristics of Material Fines Fraction			
Specific Gravity		2.65	2.65
Fall Velocity	ft/sec	0.01	0.01
Void Ratio After Deposition		4.5	4.5
Volumetric Concentration of Total Solids	%	0.14	0.125
Length of Disposal Vessel (split-hull dump scow)	ft	200	200
Width of Disposal Vessel (split-hull dump scow)	ft	50	50
Pre-disposal Draft of Disposal Vessel	ft	16	16
Post-disposal Draft of Disposal Vessel	ft	8	8
Time Needed to Empty Disposal Vessel	sec	30	30

Table 5-4
Estimated Residual Layer Thickness

Dredge Area	Estimated Thickness of Residual Sediment Layer (inches)	
	Assuming 2 Percent of Sediment Mass Remains as Residual Layer	Assuming 6 Percent of Sediment Mass Remains as Residual Layer
AOEC-A	2	6
AOEC-C East	1	4
AOEC-C West	2	6

Table 5-5
Sediment Management Objective Limits and Calculated 95 Percent Upper Confidence Limits

Contaminant	Final SMO	95% UCL AOEC-A (HQ[1])	95% UCL AOEC-C East (HQ[1])	95% UCL AOEC-C West (HQ[1])
Copper	254 mg/kg	149 mg/kg (0.59)	55 mg/kg (0.22)	66 mg/kg (0.26)
Lead	100 mg/kg	73 mg/kg (0.73)	22 mg/kg (0.22)	29 mg/kg (0.29)
Mercury	0.9 mg/kg	0.59 mg/kg (0.66)	0.22 mg/kg (0.24)	0.3 mg/kg (0.33)
Silver	3.5 mg/kg	0.4 mg/kg (0.11)	0.3 mg/kg (0.08)	0.3 mg/kg (0.08)
Zinc	307 mg/kg	261 mg/kg (0.85)	133 mg/kg (0.43)	133 mg/kg (0.43)
Total PAH	5400 µg/kg	ND (528 µg/kg)[2]	ND (512 µg/kg)[2]	ND (512 µg/kg)[2]
Total PCBs	570 µg/kg	ND (128 µg/kg)[3]	ND (128 µg/kg)[3]	ND (128 µg/kg)[3]
Total DDT	210 µg/kg	ND (9.6 µg/kg)[4]	ND (9.6 µg/kg)[4]	ND (9.6 µg/kg)[4]

Notes:
1. HQ = hazard quotient, defined as the stated concentration divided by the applicable SMO
2. A total of 16 PAHs were analyzed. None, however, were detected. The detection limit for each analyte was 33 micrograms per kilogram (µg/kg) in AOEC-A and 32 µg/kg in AOEC-C East and West; therefore, the maximum potential total PAH value for each area is 528 µg/kg, 512 µg/kg, and 512 µg/kg, respectively.
3. A total of eight aroclors were analyzed. None, however, were detected. The detection limit for each was 16 µg/kg; therefore, the maximum potential total PCB value for each of the three areas is 128 µg/kg.
4. The detection limit for each of the DDT derivatives (4,4-DDT, 2,4-DDT, 4,4-DDE, 2,4-DDE, 4,4-DDD, and 2,4-DDD) was 1.6 µg/kg. The maximum potential total DDT result is, therefore, 9.6 µg/kg. No DDT derivatives were detected.
5. All chemistry results from Weston (2007).

Table 5-6
Summary of Physical Input Parameters for Chemical Isolation Modeling

Symbol	Value	Units	Comments
L_{eff}	70	ft	Effective width of containment berm, which acts as the chemical isolation layer; the minimum distance through which porewater must travel before entering the surrounding environment
ε_0	0.4	unitless	Porosity of cap sediments; 0.4 is a typical value for imported sand materials
ε_s	0.5	unitless	Porosity of underlying sediments
SG	2.5	g/cm^3	Specific gravity of cap sediment particles (typical value)
P_b	1.5	g/cm^3	Bulk sediment density of cap sediments calculated as P_b = (1- ε)*SG
foc	0.01	percent	Fraction of organic carbon in cap material
I	0.1	ft/ft	Estimated hydraulic gradient in surrounding sediment (for computing seepage velocity)[a]
K	1.00E-05	cm/sec	Estimated hydraulic conductivity in surrounding sediment (for computing seepage velocity)[a] ; to be conservative, the upper range was used

Notes:

a. Seepage velocity estimated by K*I/ε_s = 63.1 cm/yr.

Table 5-7
Summary of Chemical Input Parameters for Chemical Isolation Modeling

Chemical	$Log_{10}K_d$[a]	Molecular Diffusion Coefficient (cm^2/yr)[b]	95 Percent UCL of Detected Concentration of Confined Sediment (mg/kg)	Calculated Porewater Concentration in Confined Sediment = C_o (mg/L)[c]	Ratio of Porewater Concentration to Chronic Water Quality Criteria[d]	Minimum Reported Anaerobic Biodegradation Rate (year)[e]
Copper	1.54	435	92.1	2.63	2.0	0
Lead	2.95	212	42.9	0.048	5.9	0
Mercury	2.30	215	0.4	0.002	38.6	0
Silver	2.04	306	0.3	0.003	1.5	0
Zinc	2.72	427	173.5	0.33	4.0	0

Notes:

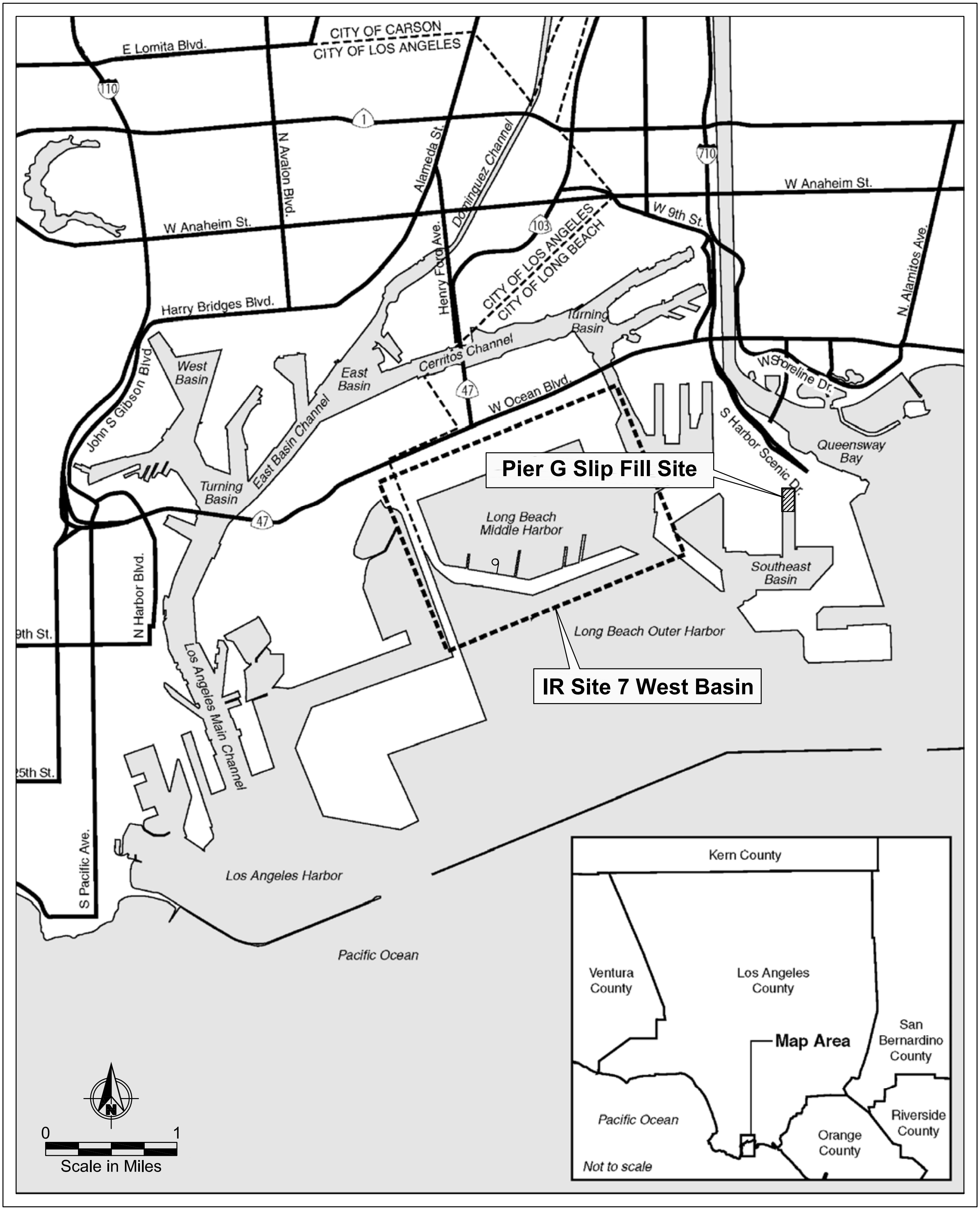
a. Kd values from *Soil Screening Guidance: Technical Background Document* (USEPA 1996) and *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture* (Baes 1984).
b. Molecular diffusion coefficients were developed from a best fit relationship based on diffusion rates in the Risk Assessment Information System database (RAIS 2006).
c. Calculated as the underlying bulk sediment concentration divided by K_d
d. See Table 5-1 for chronic water quality criteria
e. It was conservatively assumed that metals do not biodegrade.

Table 5-8
Summary of Chemical Isolation Layer Modeling Steady-state Results Under Nominal Seepage Velocity Scenario

Chemical	Time to reach Steady-state Conditions (years)	Porewater Concentration (C_{bio}) at Steady State (mg/L)	Chronic Water Quality Criteria (mg/L)	Porewater HQ	Sediment Concentration (C_{bio}) at Steady State (mg/kg)	Sediment Cleanup Standards for LBNS SMO (mg/kg)	Sediment HQ
Arsenic	3971	0.027	0.036	**0.75**	0.84	NA	**N/A**
Chromium	107984	0.001	0.05	**0.01**	0.44	NA	**N/A**
Copper	4479	0.190	1.3	**0.15**	6.65	254	**0.03**
Lead	114334	0.000	0.0081	**0.06**	0.43	100	**0.004**
Mercury	25434	0.0001	0.000051	**1.20**	0.01	0.9	**0.01**
Selenium	313	0.050	0.071	**0.71**	0.11	NA	**N/A**
Silver	14004	0.000	0.0019	**0.07**	0.01	3.5	**0.004**
Zinc	67344	0.005	0.081	**0.06**	2.62	307	**0.01**

Notes:
N/A = not applicable

FIGURES



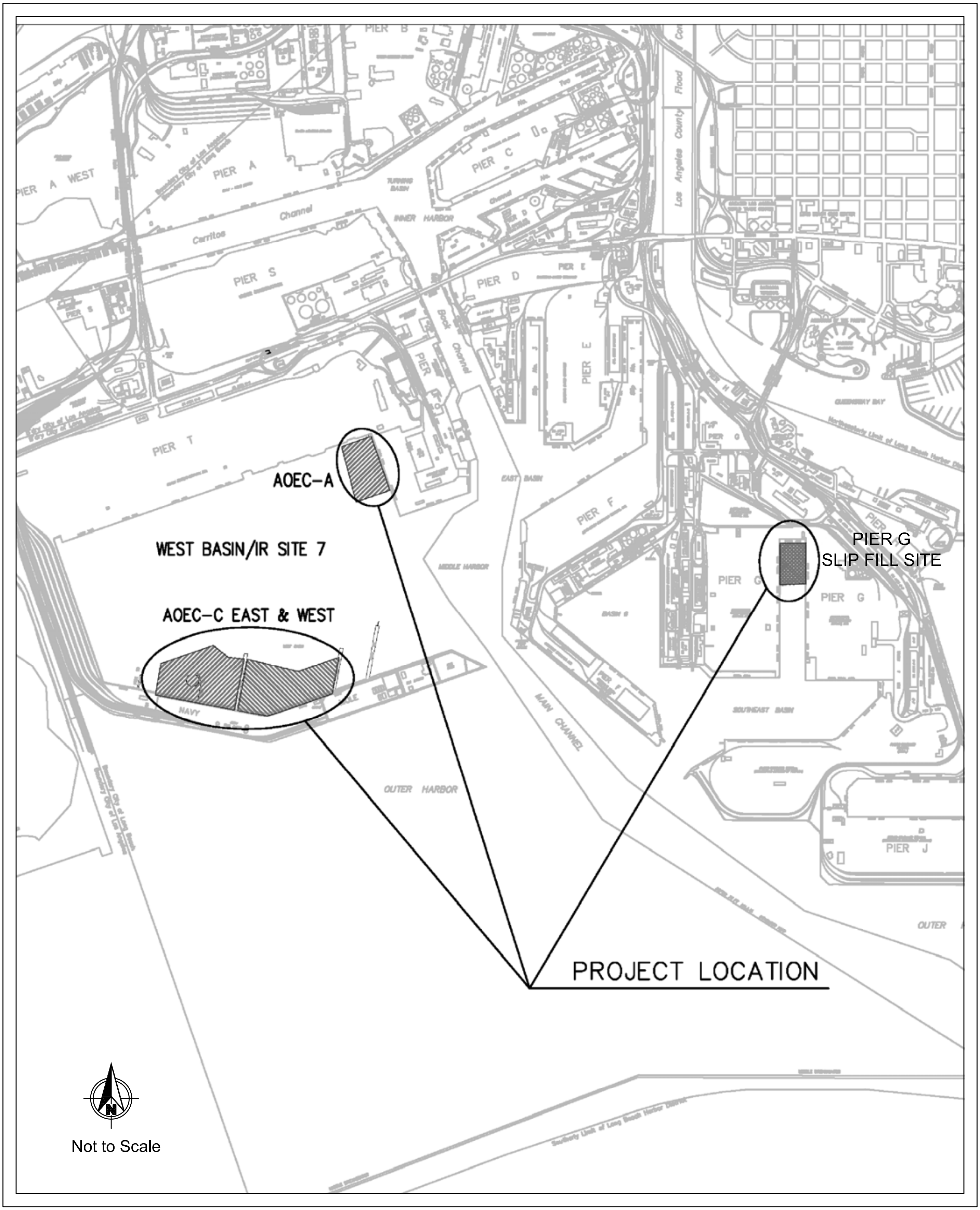
Sep 17, 2008 1:37pm heriksen K:\Jobs\060343-Port of Long Beach-West Basin\060343-01\06034301-003.dwg F1-1

Note: Drawing prepared from file provided by the Port of Long Beach.

Figure 1-1
Project Vicinity Map
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

ANCHOR ENVIRONMENTAL, L.L.C.

Sep 17, 2008 1:37pm heriksen K:\Jobs\060343-Port of Long Beach-West Basin\060343-01\06034301-003.dwg F1-2



Note: Drawing prepared from file provided by the Port of Long Beach.

Figure 1-2
Project Location and Overall Site Plan
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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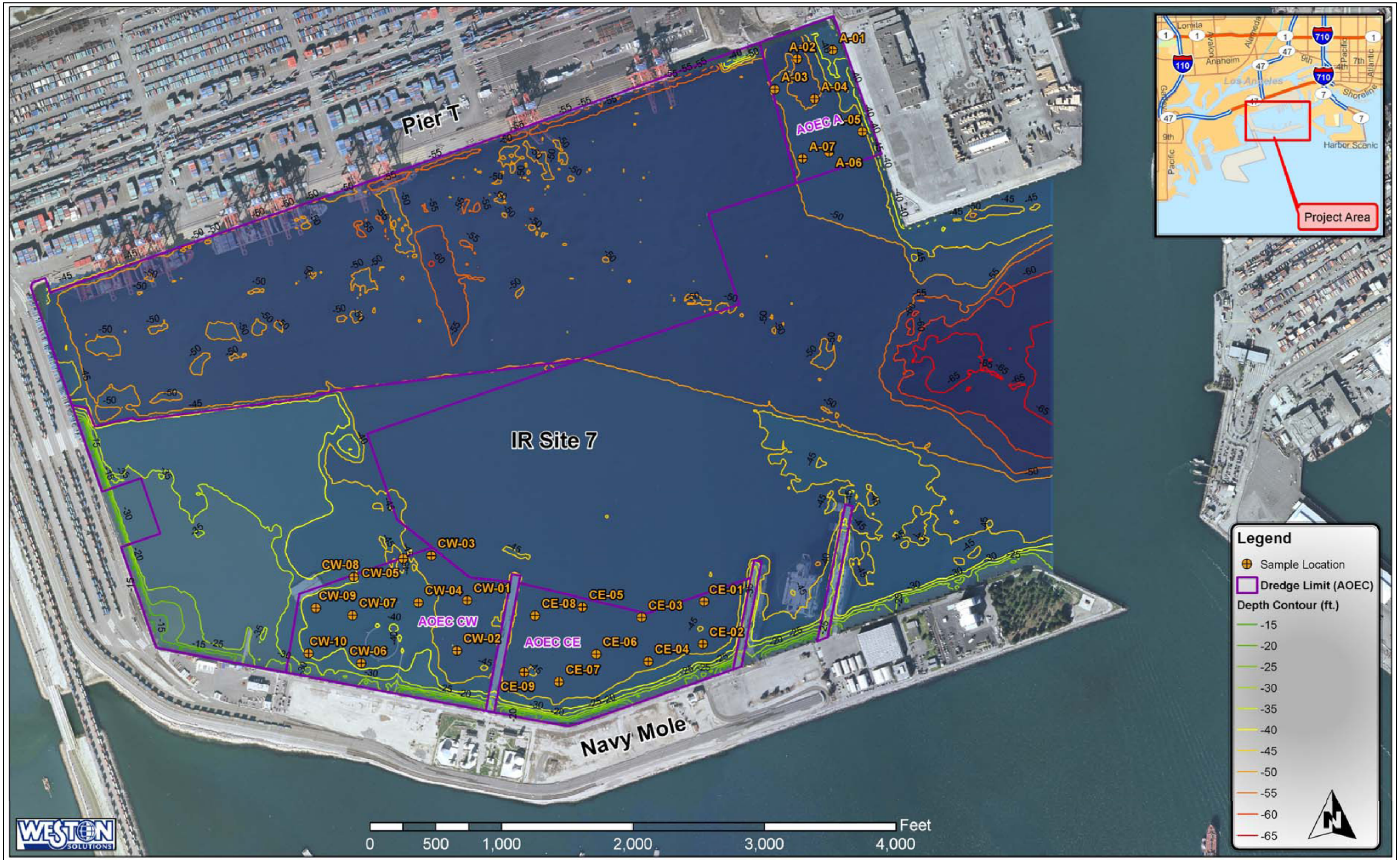

Source: Drawing prepared from electronic file by Weston Solutions, Inc.

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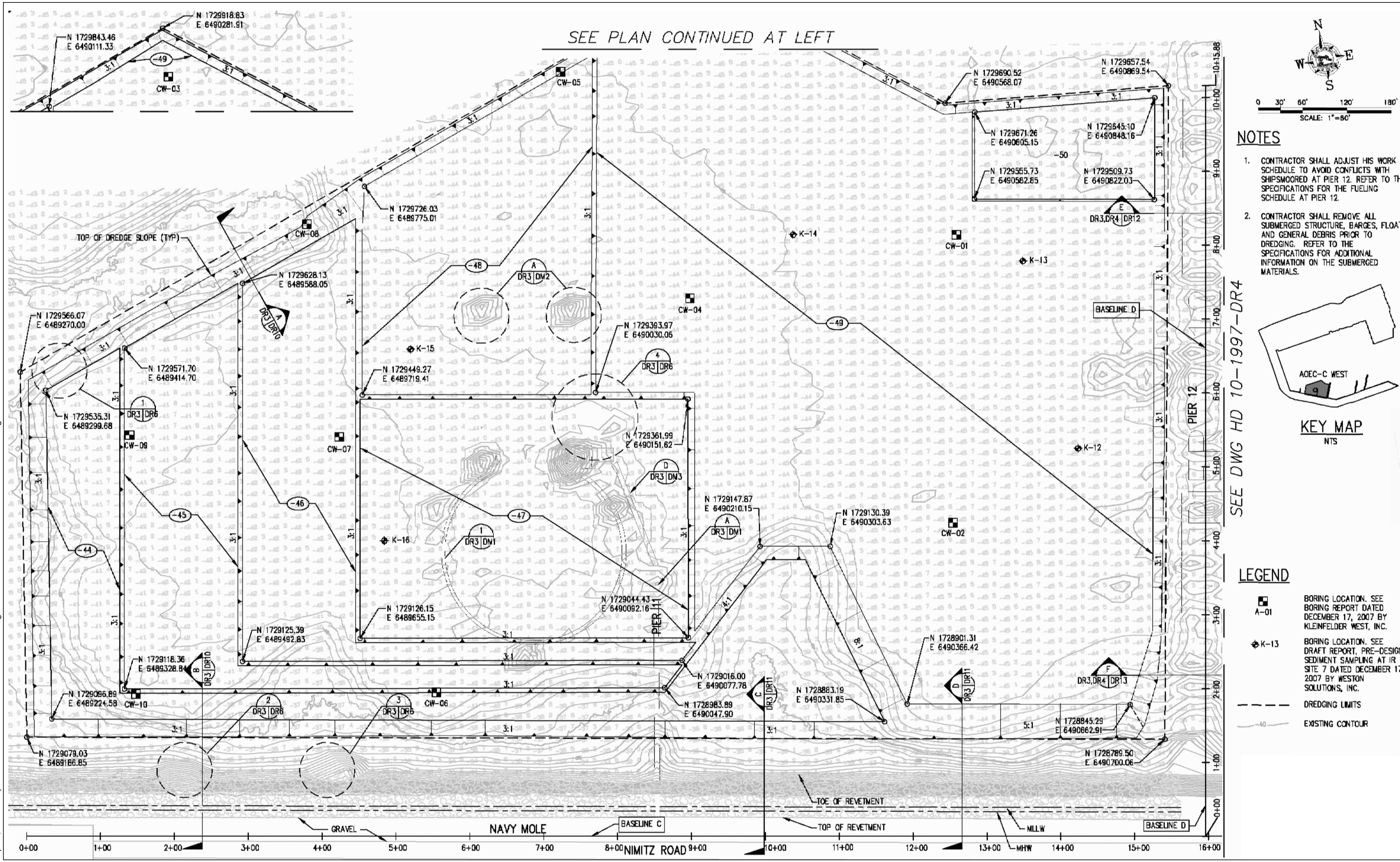
Figure 2-1
Weston 2007 Sediment Sampling Locations
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

Sep 17, 2008 1:49pm heriksen K:\Jobs\060343-Port of Long Beach-West Basin\060343-01\06034301-004.dwg F3-1



Note: Drawing prepared from electronic file by KPFF Consulting Engineers.

Figure 3-1
Plan - Typical Dredging Plan View for AOEC-C West
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

DRAFT

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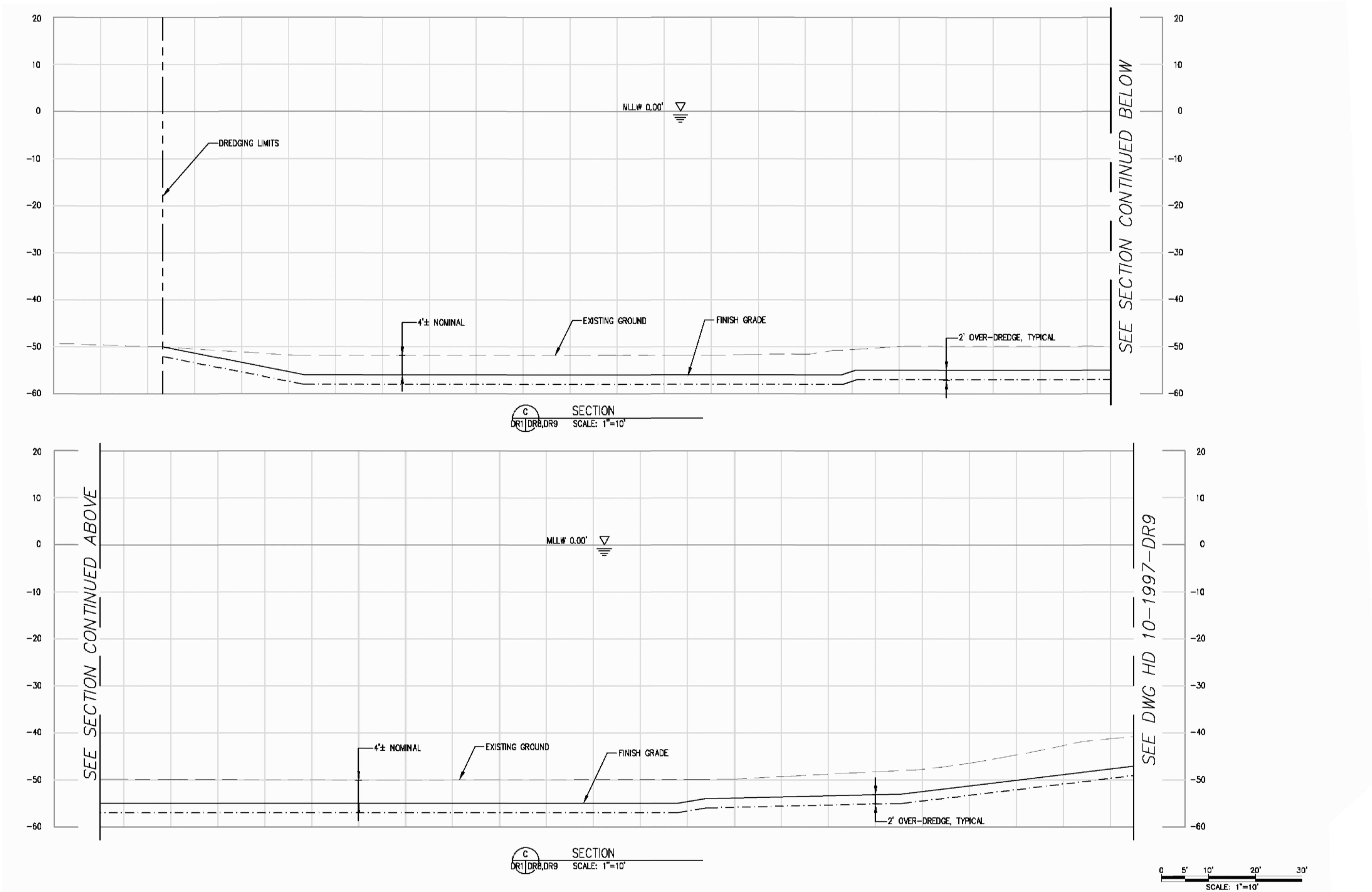

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Note: Drawing prepared from electronic file by KPFF Consulting Engineers.

Figure 3-2
Section - Typical Dredge Cross Section for AOEC-A
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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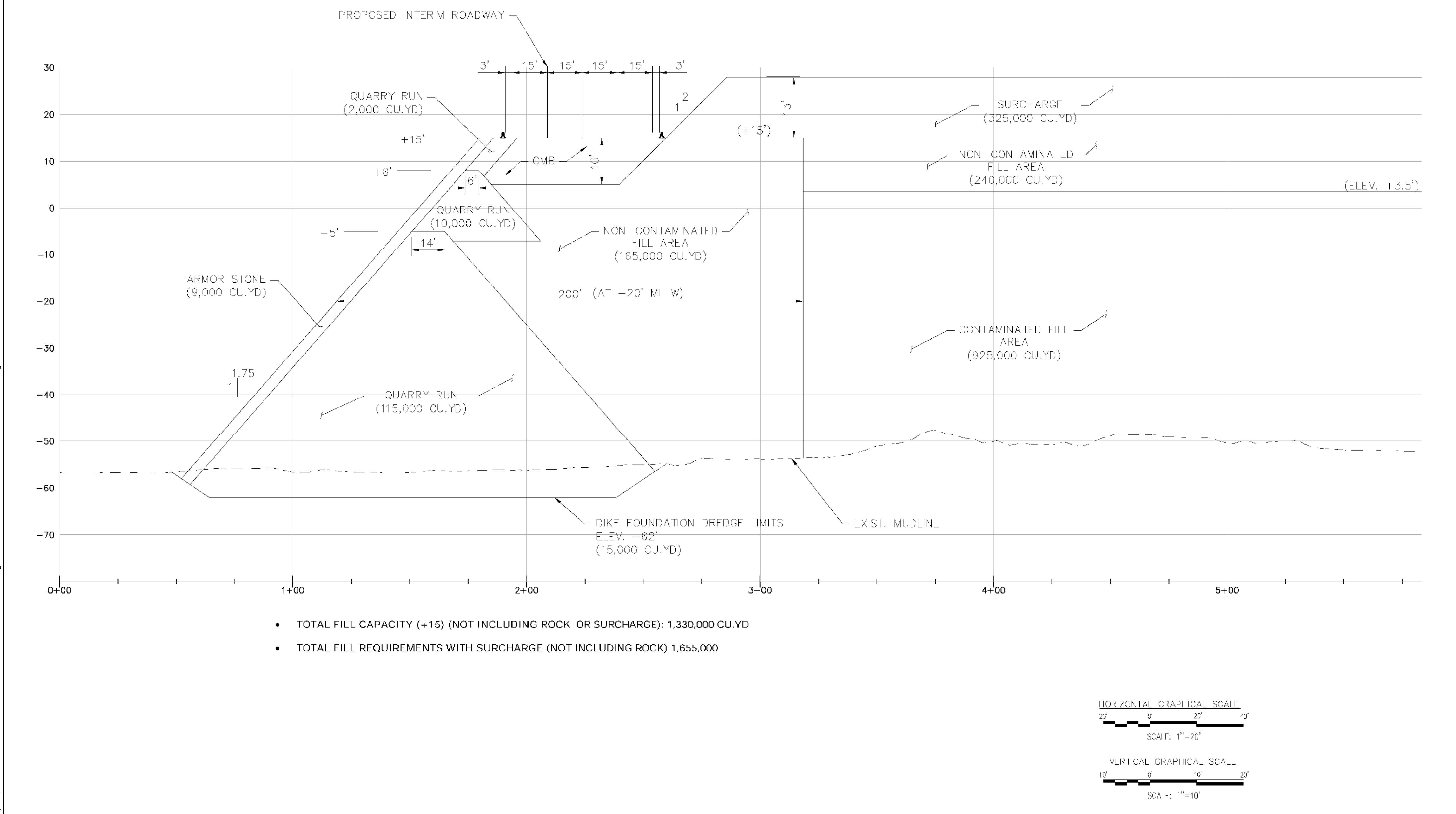
DRAFT



- TOTAL FILL CAPACITY (+15) (NOT INCLUDING ROCK OR SURCHARGE): 1,330,000 CU.YD
- TOTAL FILL REQUIREMENTS WITH SURCHARGE (NOT INCLUDING ROCK) 1,655,000

Source: Drawing prepared from electronic file by Moffatt & Nichol dated 8/2008.

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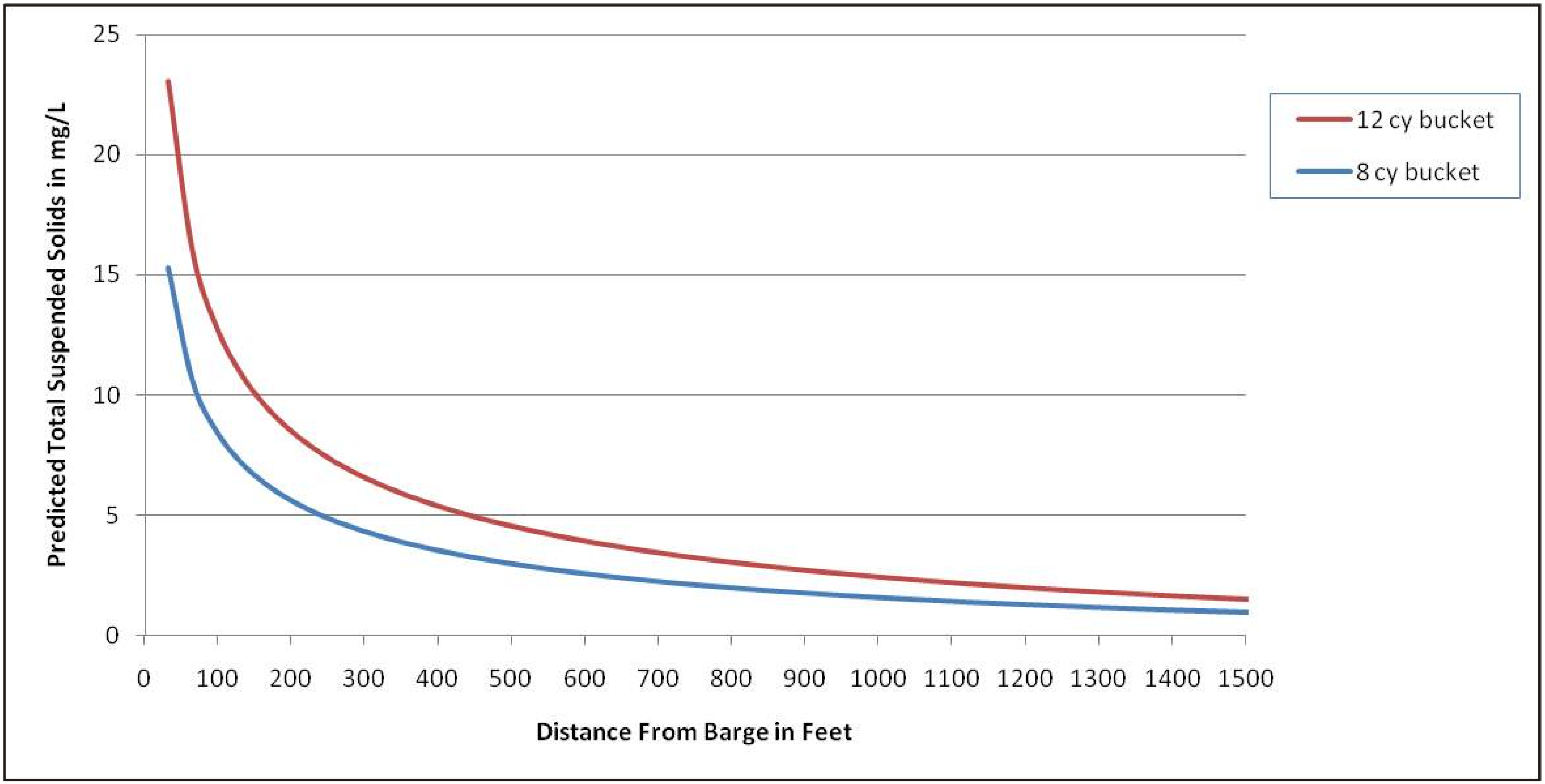
Figure 3-3
Section - North Slip Fill Closure Dike
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA



5/30/08 heriksen 06034301-AD.cdr

Figure 5-1
AOEC-A at 48 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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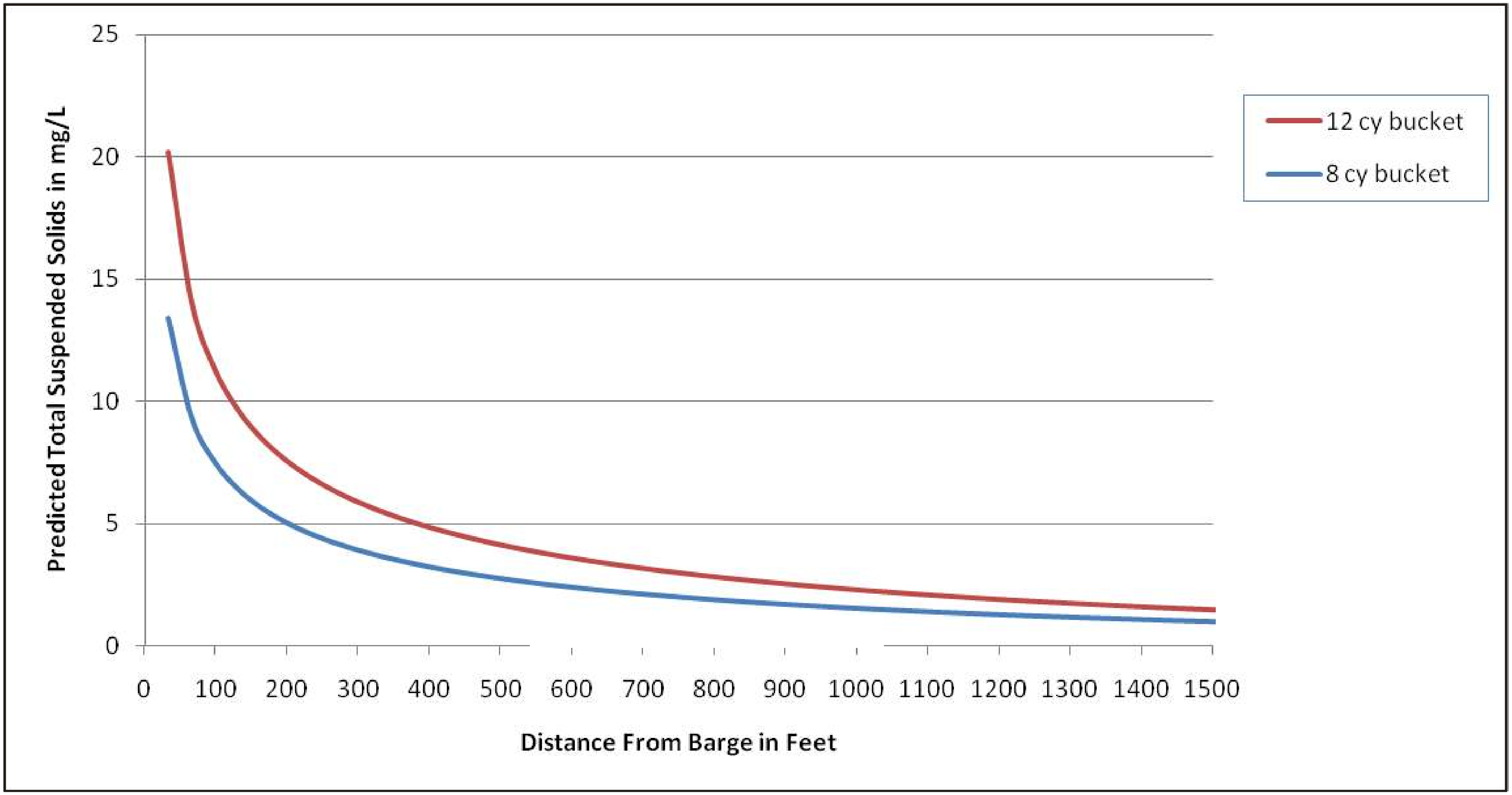

5/30/08 heriksen 06034301-AD.cdr

Figure 5-2
AOEC-A at 55 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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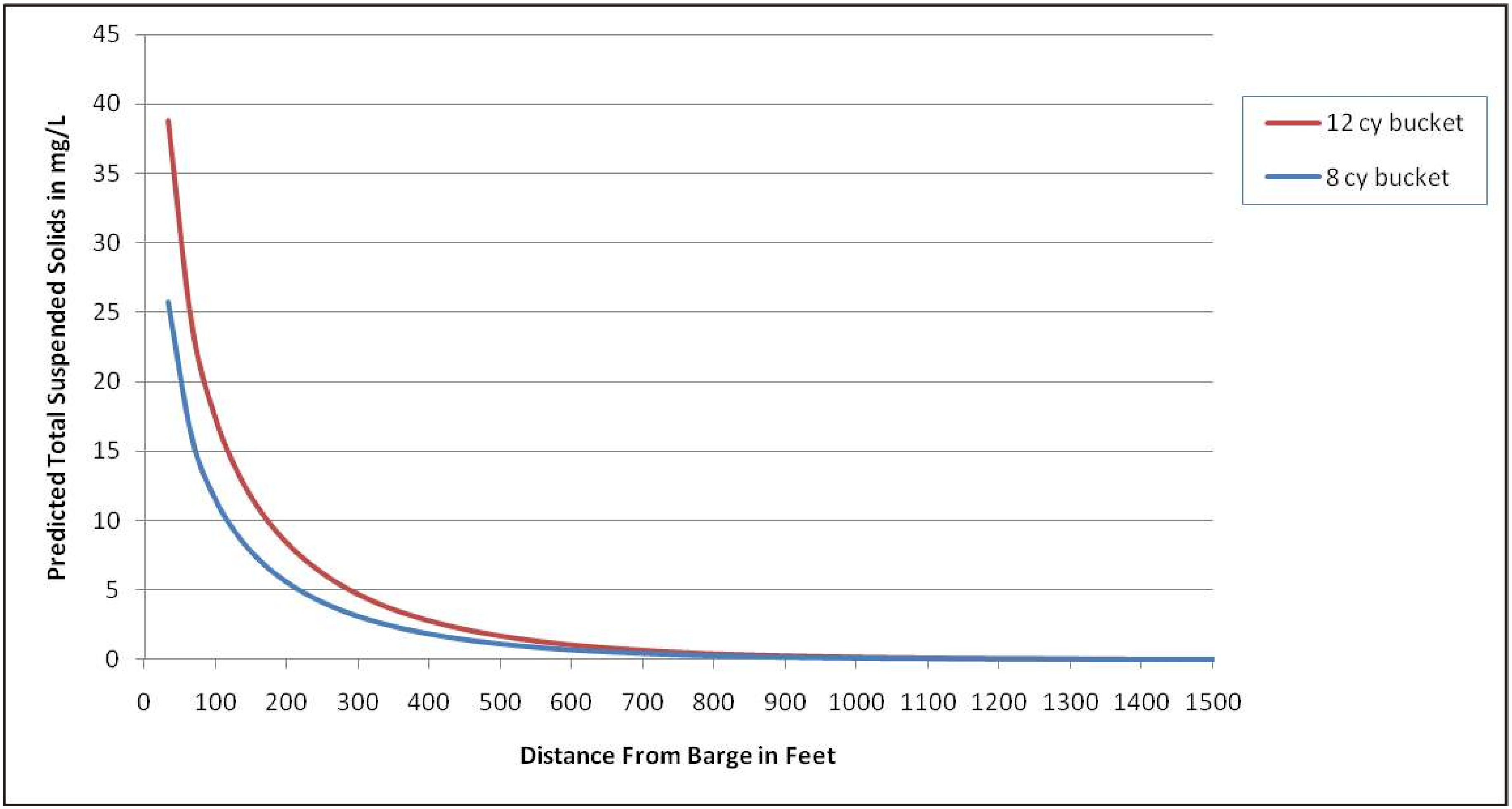

5/30/08 heriksen 06034301-AD.cdr

Figure 5-3
AOEC-C East at 45 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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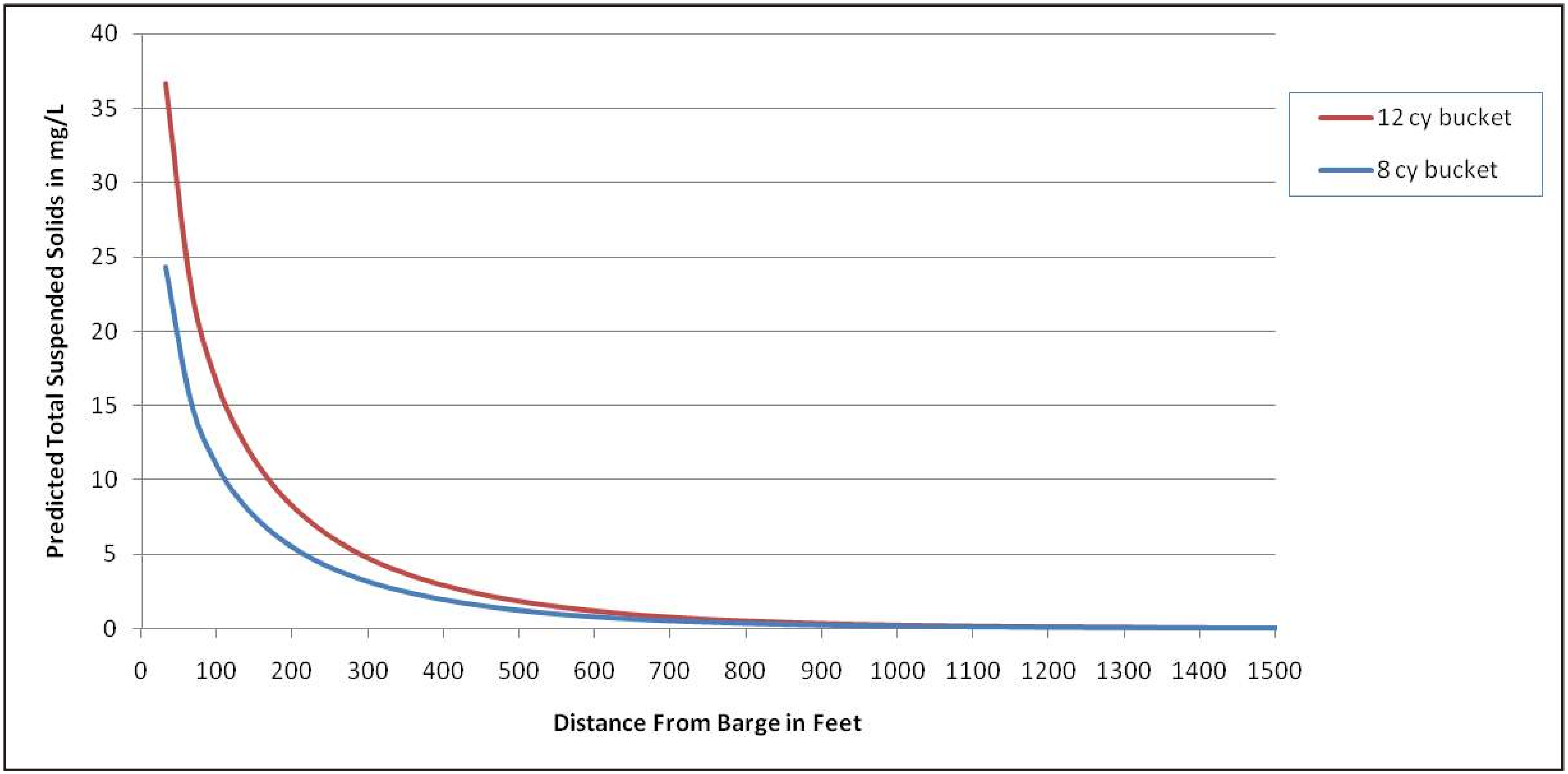
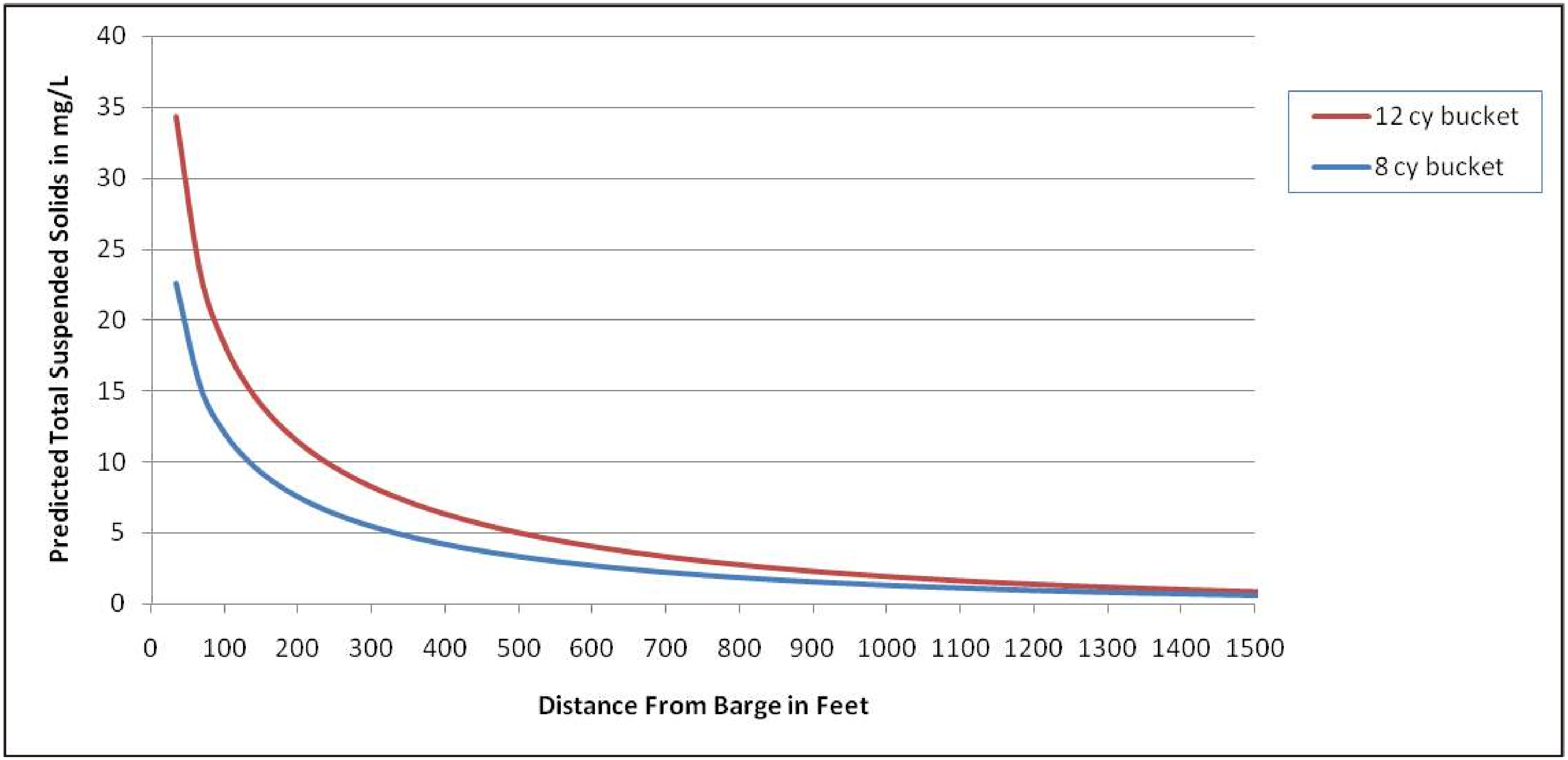


5/30/08 heriksen 06034301-AD.cdr

Figure 5-4
AOEC-C East at 48 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

ANCHOR ENVIRONMENTAL, L.L.C.



5/30/08 heriksen 06034301-AD.cdr

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Figure 5-5
AOEC-C West at 35 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

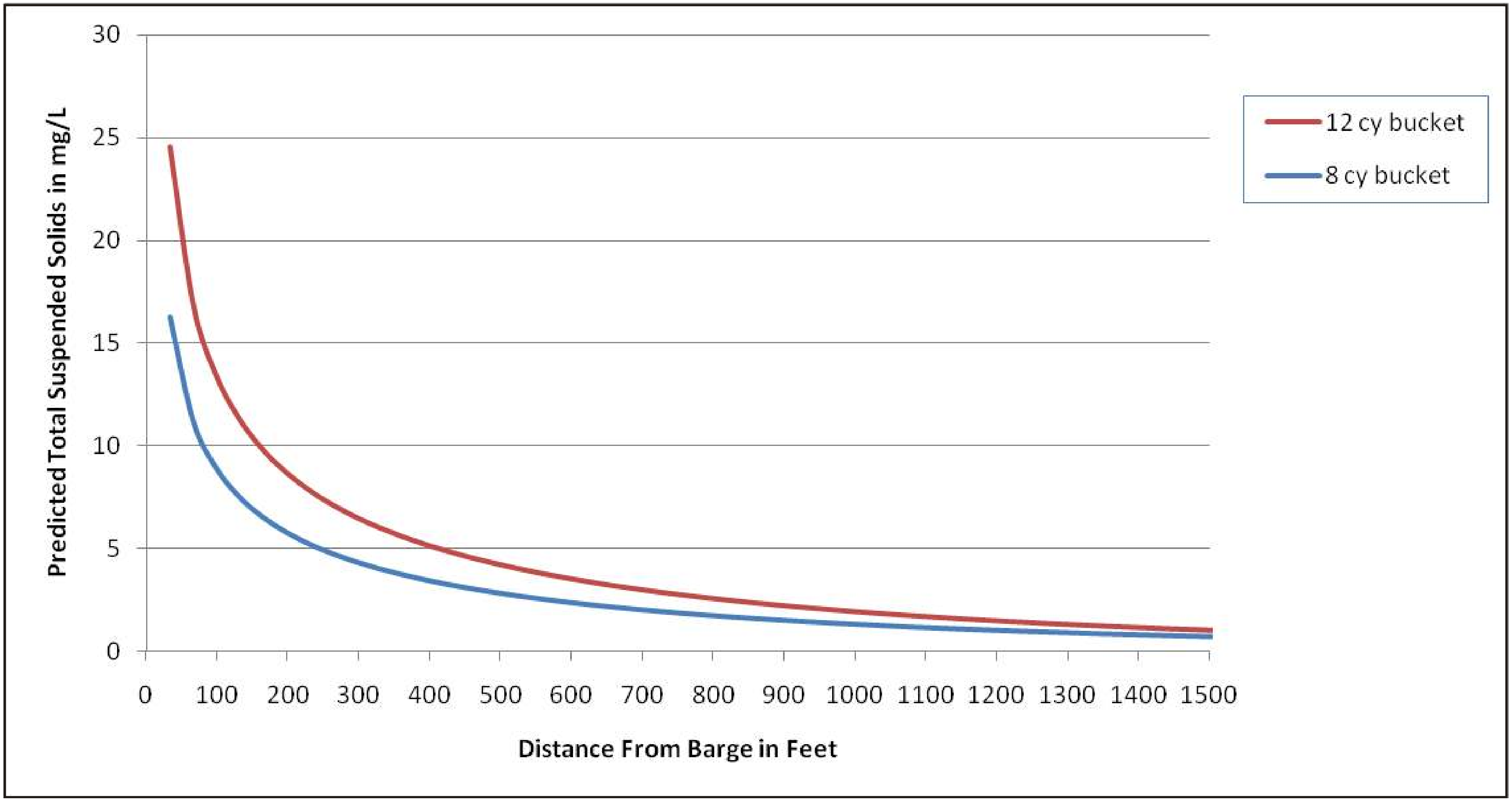
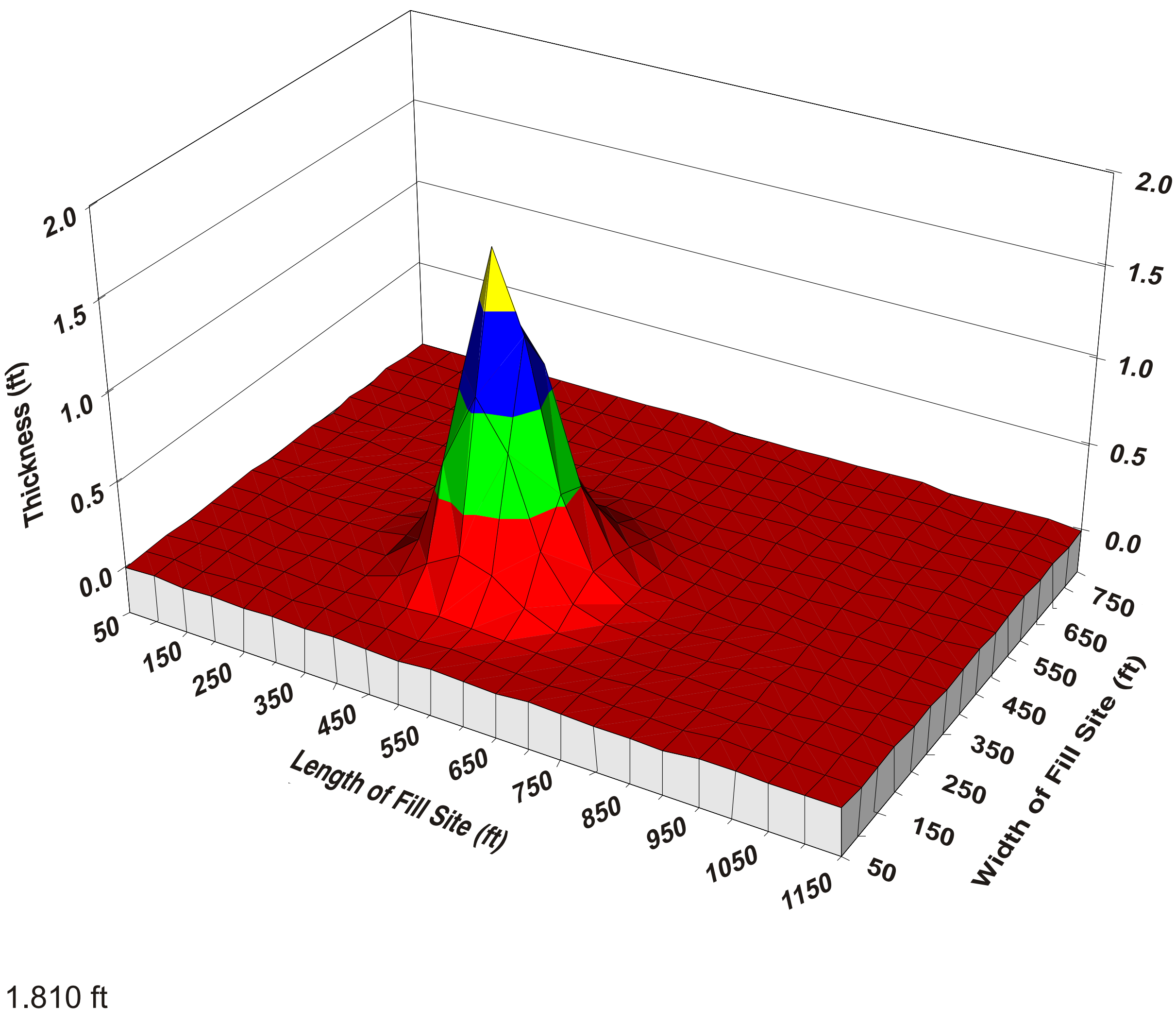


Figure 5-6
AOEC-C West at 49 Feet Depth
Total Suspended Solids as Predicted by DREDGE
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

ANCHOR ENVIRONMENTAL, L.L.C.



March 28, 2008 heriksen 06034301-AB.cdr

Figure 5-7
Total Deposited Material Thickness as a Function of Distance from Dump Location for AOEC-A
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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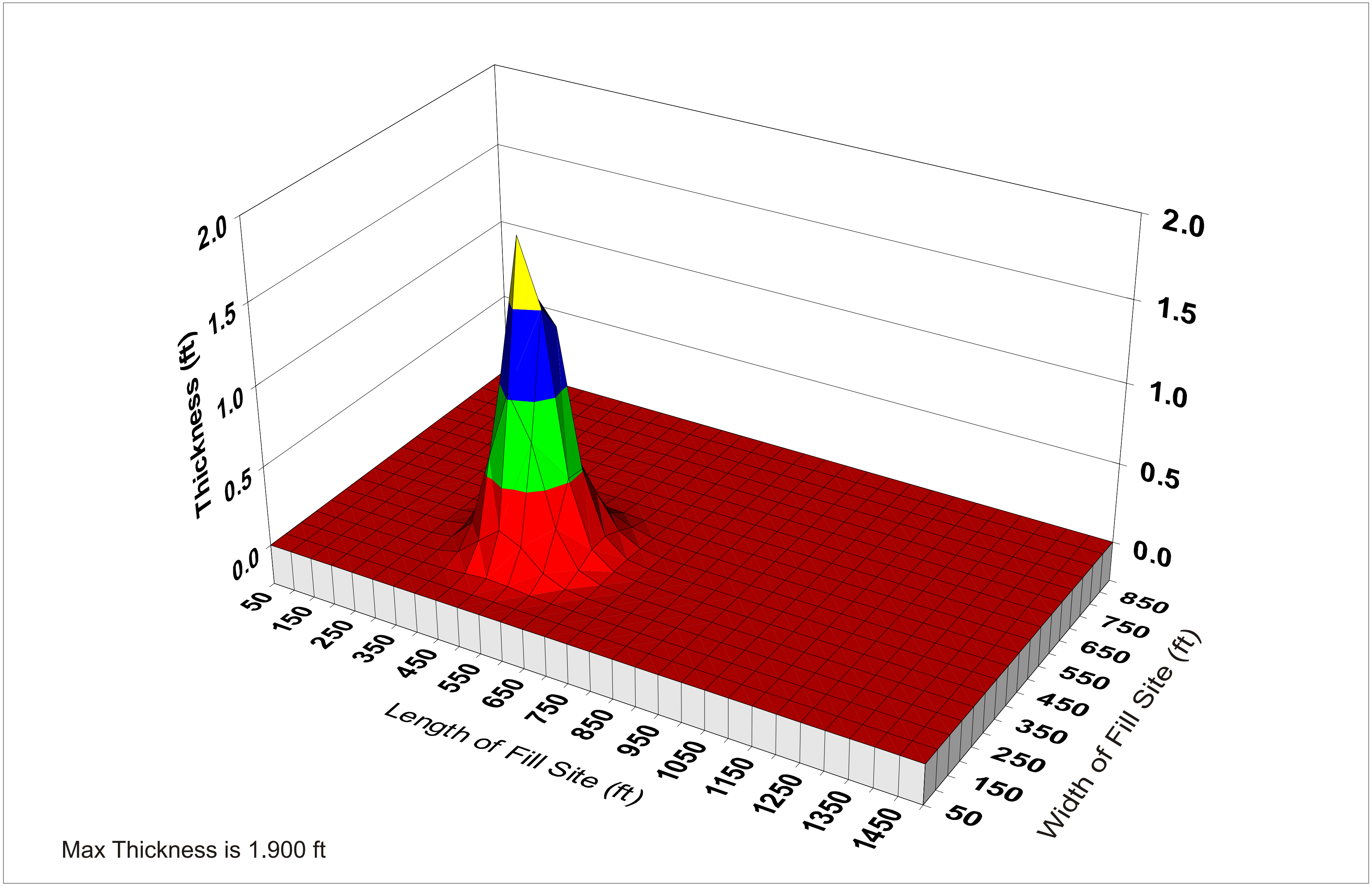

7/21/08 heriksen 06034301-AE.cdr

Figure 5-8
Total Deposited Material Thickness as a Function of Distance from Dump Location for AOEC-C West
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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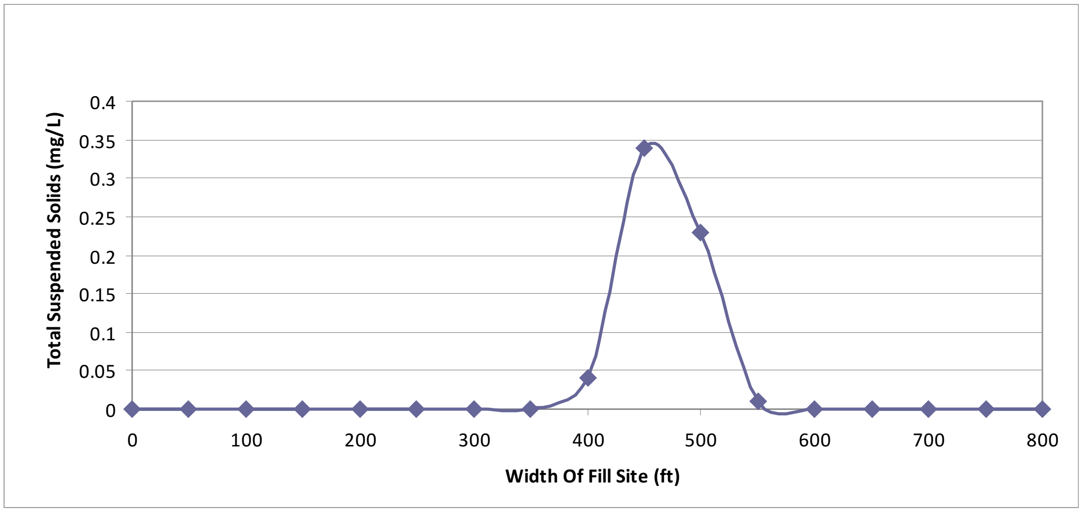
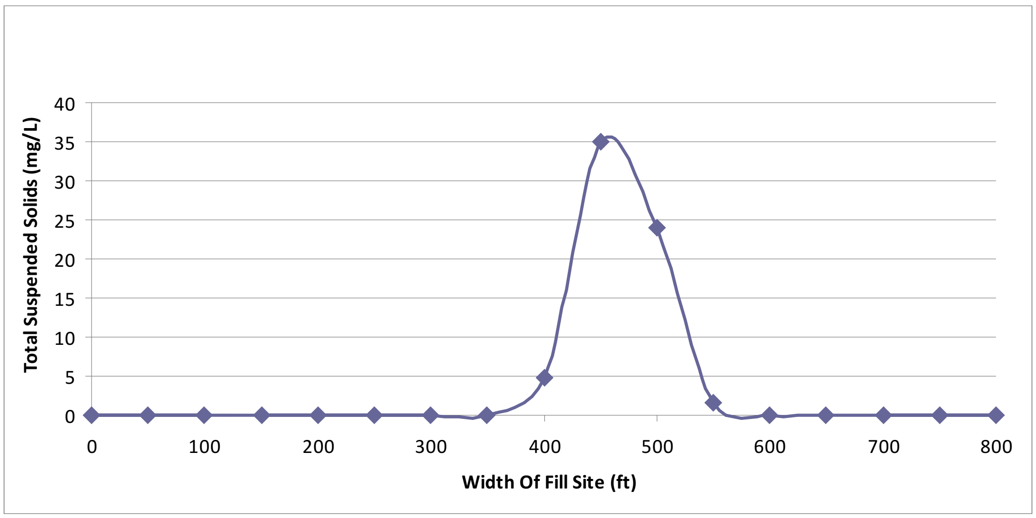
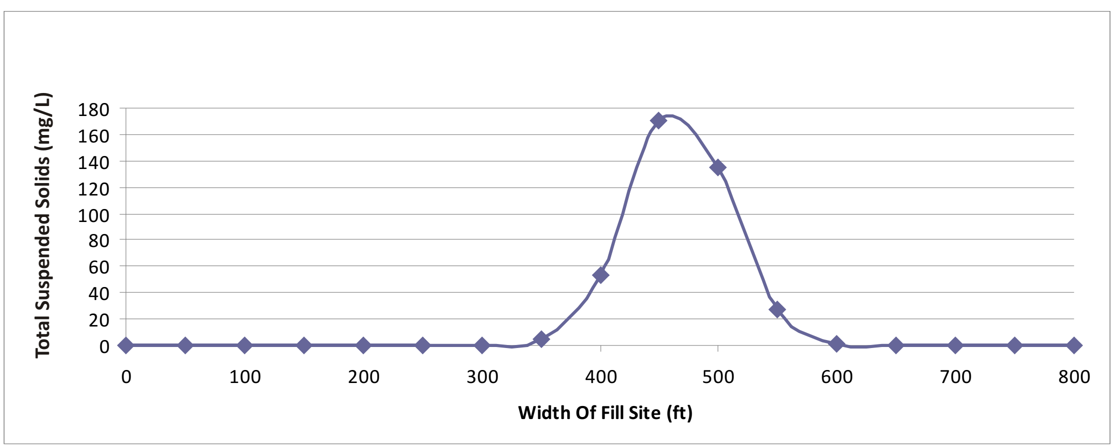


A. At 7 Feet Below Water Depth



B. At 24 Feet Below Water Depth



C. At 48 Feet Below Water Depth

7/21/08 heriksen 06034301-AF.cdr

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Figure 5-9
Concentration of Total Suspended Solids as a Function of Distance from Dump Location for AOEC-A
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
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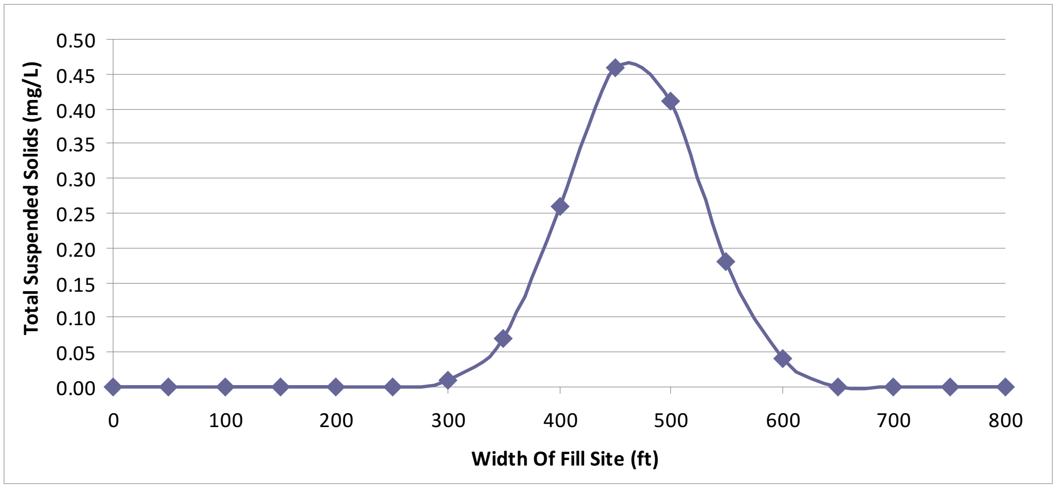
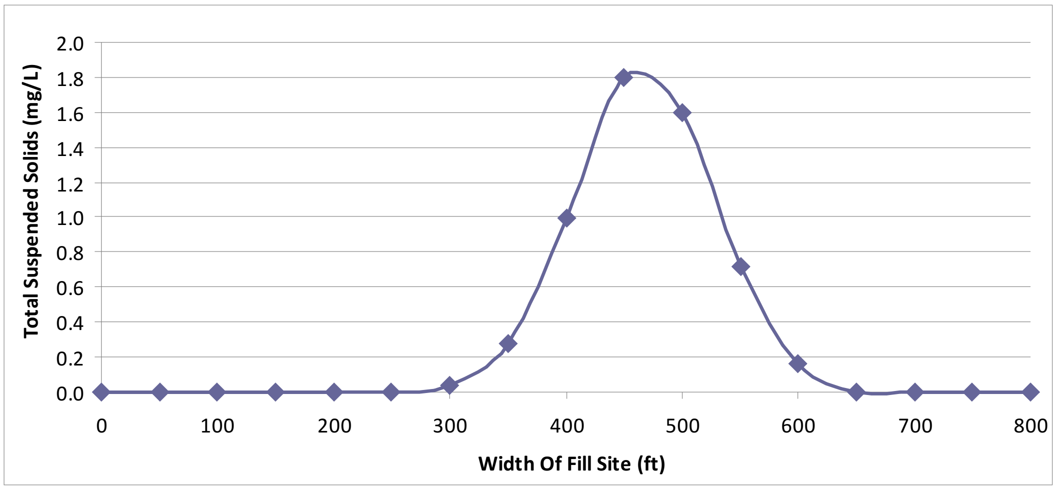
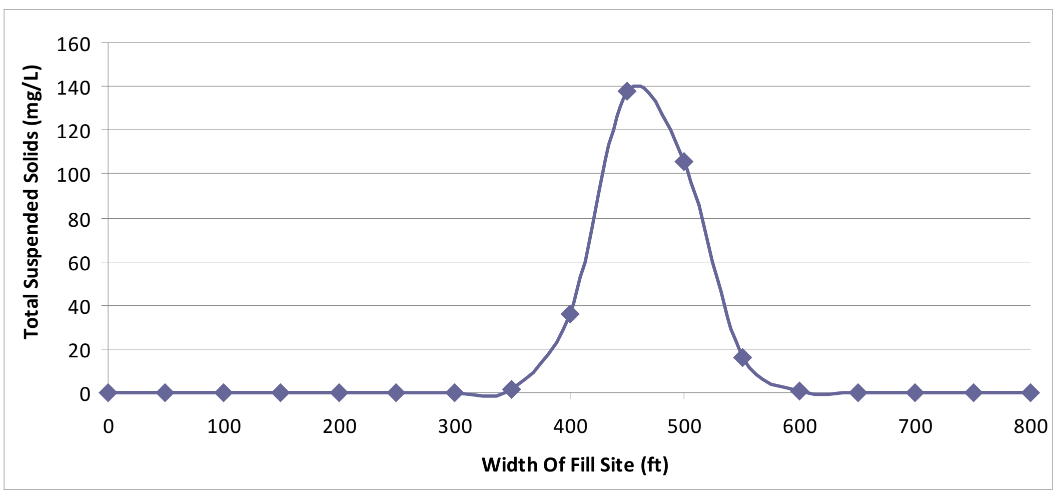


A. At 1 Foot Below Water Depth



B. At 15 Feet Below Water Depth



C. At 30 Feet Below Water Depth

7/21/08 heriksen 06034301-AF.cdr

Figure 5-10
Concentration of Total Suspended Solids as a Function of Distance from Dump Location for AOEC-C West
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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APPENDIX A

DRAFT CONSTRUCTION PLANS
(PROVIDED ON CD)

PREPARED BY KPFF CONSULTING ENGINEERS

APPENDIX B

REVIEW AND DESCRIPTION OF BEST MANAGEMENT PRACTICES

1 DESCRIPTION OF DREDGING AND DISPOSAL BEST MANAGEMENT PRACTICES

BMPs are the actual practices, including the forms, procedures, charts, software references, etc, used by dredgers to minimize the consequences of dredging and disposal on water quality. This section provides an overview of the available dredging BMP technologies, a review of previous investigations regarding their effectiveness, and the presentation of a toolbox for selecting the most appropriate BMPs for use in the Region.

1.1 Review of Available Technologies

Dredging BMPs can be separated into three main categories: silt curtains and gunderbooms, operational controls, and specialty dredging equipment (e.g., environmental buckets). The remainder of this section discusses each of these, along with the advantages and disadvantages for their use.

1.1.1 Silt Curtains and Gunderbooms

The objective when using silt curtains is to create a physical barrier around the dredge equipment to allow the suspended sediments to settle out of the water column in a controlled area. Silt curtains are typically constructed of flexible, reinforced, thermoplastic material with flotation material in the upper hem and ballast material in the lower hem. The curtain is placed in the water surrounding the dredge or disposal area, allowed to unfurl, and then anchored in place using anchor buoys. Silt curtains are most effective on projects where they are not opened and closed to allow equipment access to the dredging or disposal area. Because they are impermeable, silt curtains are easily affected by tides and currents and should not be used in areas with greater than 1-2 knot currents (Hartman Consulting Group 2001). Silt curtains can be deployed so that they extend to within 0.6 meters (2 feet) of the bottom, but this is seldom practical due to water currents. As such, most projects only use curtains that extend a maximum of 3 to 3.6 meters (10 to 12 feet) below the surface. Some of the key advantages of silt curtains are that, if they are deployed correctly, they can protect the adjacent resources and control surface turbidity. The main disadvantages for silt curtains are that they are not effective in high energy environments and they have no effect on bottom turbidity. A gunderboom works in a similar way, except that the curtain is made of a permeable geotextile fabric that allows the water to pass through, but filters out the particulates.

While silt curtains are typically deployed so that they extend downward through part of the water column, gunderbooms are designed to be installed from the water surface to the project bottom. The advantages with gunderbooms are that they allow unlimited curtain depth and permit unrestricted water flow while the disadvantages are that they are more expensive than silt curtains and can become clogged with silt.

1.1.2 Operational Controls

For dredging projects, operational controls are defined as modifications in the operation of the dredging equipment to minimize resuspension of materials. Operational controls can be employed with mechanical dredges, hydraulic dredges, hopper dredges or barges.

Example operational control methods for mechanical dredges include:

- Increasing cycle time – longer cycle time reduces the velocity of the ascending loaded bucket through the water column, which reduces potential to wash sediment form the bucket. However, limiting the velocity of the descending bucket reduces the volume of sediment that is picked up and requires more total bites to remove the project material. The majority of the sediment resuspension, for a clamshell dredge, occurs when the bucket hits the bottom.
- Eliminating multiple bites – when the clamshell bucket hits the bottom, an impact wave of suspended sediment travels along the bottom away form the dredge bucket. When the clamshell bucket takes multiple bites, the bucket loses sediment as it is reopened for subsequent bites. Sediment is also released higher in the water column, as the bucket is raised, opened, and lowered.
- Eliminating bottom stockpiling – bottom stockpiling of the dredged sediment in silty sediment has a similar effect as multiple bite dredging; an increased volume of sediment is released into the water column from the operation.

Example operational controls for hydraulic dredges include:

- Reducing cutterhead rotation speed – reducing cutterhead rotation speed reduces the potential for side casting the excavated sediment away from the suction entrance and resuspending sediment. This measure is typically effective only on maintenance or relatively loose, fine grain sediment.

- Reducing swing speed – reducing the swing speed ensures that the dredge head does not move through the cut faster than it can hydraulically pump the sediment.
- Reducing swing speed reduces the volume of resuspended sediment. The goal is to swing the dredge head at a speed that allows as much of the disturbed sediment as possible to be removed with the hydraulic flow. Typical swing speeds are 1.5 to 9 meters per minute (5 to 30 feet per minute).
- Eliminating the process of bank undercutting – dredgers should remove the sediment in maximum lifts equal to 80 percent or less of the cutterhead diameter.

Example operation controls for hopper dredges and barges include:

- Eliminating or reducing hopper overflow – eliminating or reducing hopper overflow reduces the volume of fine material that flows from the hopper in the overflow. One caution is that this control may significantly reduce project production for hopper dredges or when hydraulic dredging into a barge.
- Lowering the hopper fill level – lowering the hopper fill level in rough sea conditions can prevent material loss during transport.
- Using a recirculation system – water from the hopper overflow can be recirculated to the draghead and used to transport more material into the hopper.

An operation control that can be effective with any type of dredge is to halt dredging during periods of extreme tidal fluctuation when currents are at their strongest point. Another, more generic, operational control is to only work within environmental work windows. Work windows are periods of time when listed species (e.g., California least tern) do not necessarily restrict dredging and disposal activities. Work proposed for times outside these windows requires consultation with the appropriate resource agencies. While this practice in itself will not reduce resuspension, it will reduce the potential for an environmental impact by eliminating the pathway for exposure with a sensitive species.

The main advantages with instituting operational controls are that they do not require installing additional equipment and they can be less costly than installing barriers. The

major disadvantages are that they provide a lower regulatory comfort level because the control measure is not usually visual as with a physical barrier like a silt curtain, and that they typically slow the project down and increase costs.

1.1.3 Specialty Dredging Equipment

The last category of dredging BMPs includes specialty dredging equipment and techniques designed to further reduce impacts from resuspended sediments. Examples include:

- Pneuma Pump - the Pneuma pump is used primarily for removal of fine-grained sediment. The Pneuma pump offers high solids concentration (up to 90 percent) in the dredge slurry, with minimal turbidity. Closed or Environmental Bucket - specially constructed dredging buckets designed to reduce or eliminate increased turbidity of suspended solids from entering a waterway.
- Large Capacity Dredges - larger than normal dredges designed to carry larger loads. This allows less traffic and fewer dumps, thereby providing fewer disturbances at a disposal site.
- Precision Dredging - dredging utilizing special tools and techniques to restrict the material dredged to that specifically identified. This may mean thin layers, either surficial or imbedded, or specific boundaries.

As with the operational controls described above, these specialty equipment options have the potential to reduce sediment resuspension, but also may increase costs.

1.2 Evaluation of Effectiveness of Best Management Practices

For nearly twenty years, the U.S. Army Corps of Engineers has been conducting research to develop techniques for reducing the rate of sediment resuspension during dredging through the development of new equipment and refinement of existing equipment (Raymond 1984). Numerous documents exist (USACE 1986; USACE 1988; Schroeder 2001; Herbich and Brahme 1991; and Hayes 1986) that discuss methods for selecting the proper equipment to reduce sediment resuspension rates depending on site conditions and the resulting effectiveness in the field.

Work conducted by the Corps in Boston Harbor on the effects of different bucket types concluded that "based on turbidity measurements, the conventional bucket produced the highest amount of sediment resuspension spread throughout the water column. Use of the cable arm bucket appeared to reduce sediment resuspension in the water column as the observed depth-averaged turbidity was 46 percent less than observed for the conventional bucket; insufficient total suspended solids (TSS) data were collected during the cable arm bucket operation to completely confirm this reduction, although the few data collected show an even higher reduction. The Enclosed bucket had the lowest overall turbidity and substantially less in the middle of the water column. Observed depth-averaged turbidity for the enclosed bucket was 79 percent less than observed for the conventional bucket. This compared well with observed TSS, which showed depth- averaged TSS concentrations for the enclosed bucket 76 percent less than for the "conventional bucket." However, if the appropriate type of sediment (e.g., soft) is not present, these reductions may not apply to other sites.

Several researchers (Schroeder 2001; Fort James Corporation et al. 2001; and Averett et al. 1999) have found that the use of silt curtains, when used properly, are effective in reducing off-site transport of resuspended sediment during dredging. Schroeder (2001) evaluated the differences in metal partitioning and losses with and without the use of silt curtains and predicted that dissolved metals concentrations would be less when the silt curtains were used. Other studies have shown that simply controlling resuspended sediments does not equate to reducing contaminant release during dredging. QEA and BBL (2001) found that even though silt curtains were very effective at reducing off-site transport of resuspended sediments, PCB concentrations downstream of the dredge location became elevated during the dredging of hot spots. Similar results were observed with mercury by Alcoa (2000).

These data suggest that dredging BMPs if properly applied and used in appropriate site-specific conditions can be effective at reducing suspended sediments in the water column and controlling losses of contaminants during dredging, but that with some chemicals, elevations in the water column can still occur.

1.3 Toolbox for Selecting Best Management Practices

As presented in Section 5.3.1, there are numerous BMPs available for use under various situations and for controlling various potential environmental impacts. To assist users in the selection of appropriate BMPs for specific situations and for use with specific dredging equipment a BMP selection flow chart and toolbox were created and are presented in Figure 5-2 and Table 5-2.

Using the flow chart in Figure 5-2, a potential dredger or project sponsor would first select the method of dredging to be used (e.g., mechanical or hydraulic) since the available BMPs are specific for each. Next, the user selects the environmental issue of concern, and then answers some simple questions about the site conditions, thus revealing a selection of potential BMPs. There is also a list of key site conditions for each group of BMPs presented that may influence the effectiveness of the method and that should be further investigated.

Once potential BMPs have been identified, the user may then move on to Table 5-2 where each BMP option is described in more detail, including a summary of technical limitations and site constraints, potential advantages and disadvantages, and effective and ineffective applications. The goal for developing these tools is to provide the user sufficient information for proactively identifying potential environmental concerns and recommending BMPs to minimize the impacts.

This is an excerpt from *Los Angeles Regional Contaminated Sediments Task Force: Long-Term Management Strategy.*

APPENDIX C

EXPECTED WATER QUALITY MONITORING REQUIREMENTS

This appendix presents a detailed discussion of a proposed water quality monitoring program and quality assurance program for the Port of Long Beach (Port) West Basin Installation Restoration (IR) Site 7. The program that is presented herein is consistent with typical 401 Water Quality Monitoring Certifications issued by the Regional Water Quality Control Board in this area. This monitoring plan is well suited to projects that involve dredging and disposal of contaminated sediments and has strong and successful precedents in the region.

The objective of this IR Site 7 Water Quality Monitoring Plan and Construction Quality Assurance Plan is to describe the proposed procedures for monitoring water quality parameters at the project site during dredging and disposal operations as well as ensure the construction design documents are properly implemented. This appendix discusses the physical process of mechanically dredging the sediment and placing it into scows for transport to the Pier G nearshore Confined Disposal Facility (CDF). Disposal of sediment within the CDF is authorized by the U.S. Army Corps of Engineer's (USACE's) Permit No. 200100395 and Order No. 01-042 (File No. 01-009) from the Los Angeles Regional Water Quality Control Board. These approvals contain numerous permit conditions including requirements for agency notification, implementation of standard dredging and disposal best management practices (BMPs), and general reporting requirements. Therefore, the Port will be required to comply with one or more operational (e.g., BMPs) and/or institutional controls to minimize water quality impacts during dredging operations.

1 CONSTRUCTION MONITORING AND POST-DISPOSAL REQUIREMENTS

Nearshore CDFs constructed using contaminated sediments as fill material have been constructed by both ports in San Pedro Bay for many years. This approach has been the standard method for disposing of contaminated dredged material in the Los Angeles Region and is the preferred method by CSTF. Examples of regional CDFs include the Pier 400 construction project and Pier Echo at the Port of Los Angeles (POLA) and the Slip 2 project at the Port. In both instances, dikes were constructed across the entrance to the slip or around the perimeter of the disposal area with open areas to allow vessel traffic. Sediments were then placed into the fill area, initially via bottom-dump scow and then hydraulically as the fill area became too shallow to allow access via scow. As the sediment accumulated in the fill area, the dike walls were increased in height until they broke the surface of the water. Weirs were then used to drain the remaining water from the fill area. After dewatering, the fill areas were

dewatered using surcharge material and wick drains and then covered with asphalt and developed to support various port facilities.

1.1 Pre-dredging Planning

At least 1 week prior to initiation of dredging and disposal operations, a pre-project planning meeting will be held to discuss the schedule and logistics of the planned activities. Specific topics of discussion for the pre-project planning meeting include the following:

- Identify points of contact for all parties involved in the project including emergency contact numbers for the Port, USACE, U.S. Coast Guard (USCG), and local emergency services
- Review the construction specifications and anticipated project schedule
- Review the environmental monitoring requirements for the project, if applicable, and contact numbers for field sampling staff
- Review health and safety requirements and communication between field contractors
- Discuss reporting requirements for the project

1.2 Construction Monitoring

Using the results of the extensive field monitoring conducted for the Contaminated Sediment Task Force (CSTF) Pilot Capping Study as a general example of successful disposal and capping operations, construction monitoring for contaminated sediment dredging and disposal at West Basin IR Site 7 will focus on two main objectives:

- Ensure that significant quantities of contaminated sediments are not deposited outside of the designated CDF facility
- Ensure that chemical releases from the sediment do not occur during dredging and disposal at levels that pose a potential ecological risk to resident aquatic organisms

To achieve these objectives, the following field and laboratory parameters will be monitored during and immediately after construction:

- Field operations will be monitored and documented to ensure proper equipment placement prior to dredging and volumes/depths for all material placed into the CDF facility.

- Water column turbidity monitoring (as an estimate of total suspended solids [TSS]) shall be conducted, as described in Section 5.3.3 of the *Draft Remedial Action and Design Report*, at reference and down-current locations to assess sediment transport during dredging operations.
- Water column samples will be collected, as described in Section 5.3.3 of the *Draft Remedial Action and Design Report*, and analyzed for dissolved and particulate metals to monitor for chemical release and transport during dredging operations.
- During dredging operations, silt curtains will be used to minimize suspended sediments by isolating the active dredging site from the rest of the Port.

1.2.1 Water Column Monitoring and Observations

Water column monitoring will occur at set distances directly upcurrent and downcurrent from the dredging operations, safety permitting. The proposed upcurrent sampling location will be 100 feet from the silt curtain, and the proposed downcurrent sampling distances for each operation will be 100 and 300 feet from the silt curtain. Samples will also be collected from a control site in an area not affected by dredging operations. The nearest sample will be collected within one hour of the initiation of dredging.

At each monitoring station, measurements for light transmission, dissolved oxygen, and pH will be taken at 6-foot intervals throughout the water column. Measurements for TSS will be conducted at mid-depth. During the first 2 weeks of dredging, sampling will be conducted two times per week and then weekly thereafter.

Water column light transmittance values from 300 feet downstream and at the control station will be compared at 3 feet below the water surface, 3 feet above the bottom, and mid-way between these two points. If the difference in percent light transmittance between these two stations for any of the sampling depths is 30 percent or greater; additional water samples will be collected at mid-depth and will be analyzed for trace metals, DDTs, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

Color photographs will also be taken at the time of samplings in order to record the presence and extent of visible effects due to the dredging operations.

Physical observations noting direction and estimated speed of currents; general weather conditions and wind velocity; tidal stage; appearance of trash, floatable material, grease, oil or oily slick, or other objectionable materials; discoloration and/or turbidity; and odors will be made and logged daily during dredging operations.

1.2.2 Construction Operations Monitoring

Proposed monitoring procedures to meet the objectives related to the CDF include:

- Recording tonnage/volume of sediment dredged and placed within the CDF facility
- Tracking location of sediment placement within the CDF facility
- Implementing a Confirmatory Sampling Plan to ensure only "clean" (below SMO criteria) surfaces remain after dredging has been completed
- Tracking operational information such as dredge production rates, downtime, and scow discharge time
- Completing a bathymetric survey of the CDF facility after the sediment has been placed to ensure that the material has been placed properly within the facility

2 CONTINGENCY PLANS

Environmental and maritime safety is of primary importance in IR Site 7 dredging and disposal operation. This plan has been developed with these factors in mind. However, it is recognized that unforeseen events can occur. Sound plans of action are required to assure consistent and appropriate actions are taken to address such events.

2.1 Emergency Notification Procedures

The contractor's field safety plan shall include specific points of contact in the event of emergencies. During the pre-construction meeting, the contractor will be given 24-hour emergency numbers for the Port, USACE, U.S. Environmental Protection Agency (USEPA), USCG, and the Long Beach Police Department.

2.2 Incidents and Unusual Occurrences

The Port, which is responsible for the operation and management of the CDF facility, will work with the contractors to establish safe working conditions within and around the CDF facility. At the pre-construction meeting it will be emphasized that the contractors, tugboat captain, and USACE-certified inspector are the first line of defense for assuring safety and compliance at the site. It will be emphasized that no activities should be started if the potential for problems appears possible and that any ongoing dredging and disposal activities should be ceased once the potential for problems arises. It is anticipated that most remedies will be precautionary (e.g., wait for better weather, repair dredging and disposal equipment, alter dredging and disposal equipment, alter dredging and disposal methods, coordinate conflicting activities among separate users of the Port, etc.).

If incidents and/or unusual occurrences related to environmental protection (such as spills) or maritime safety do occur, the contractor and Port will immediately assess the situation and will make an immediate decision as to whether the specific dredging and disposal activity needs to be temporarily ceased. Remedies will be identified and provided to the Port and, if necessary, the USACE and USCG for their concurrence. The contractor will be required to provide details on how the incident occurred and what immediate steps were taken to limit the extent of the impact. The contractor will be required to report on immediate actions and notifications made. The Port will assess this information and evaluate the proposed remedy of the occurrence.

The engineer will perform environmental monitoring during all specified disposal activities. The results of this monitoring will be reported to the Port and USACE. The Port and USACE will evaluate these results and work together to determine whether operations are environmentally sound. The results of environmental monitoring may require operational methods to be modified to help meet the determined goals.

Any change in dredged material disposal techniques, methods, or equipment must receive prior approval from the Port and USACE. Modifications to environmental permits may be required. If it becomes impractical to meet the criteria, considering the environmental and physical conditions within the site and equipment and methods available to the contractor, then engineering solutions may be considered and proposed. Modifications to the proposed actions and notifications described above will be made as lessons are learned in the operation and management of the site.

APPENDIX D

DEVELOPMENT OF CONFIRMATORY SAMPLING PLAN

The selection of the number of confirmatory samples to be obtained from each dredging area is dependent on several factors including the intent of the sampling, variability in the data or assumed variability, and the level of error that is considered acceptable. These values, particularly the acceptable level of error, are based both on the professional judgment of the designers, on local regulatory precedent, and on applicable guidance (i.e., Applicable or Relevant and Appropriate Requirements [ARARs]).

For initial design purposes, Anchor Environmental CA, L.P. (Anchor), has developed a generalized Confirmatory Sampling Plan that is cost-effective but still provides a meaningful result with a high degree of confidence that cleanup conditions are properly evaluated. It is based on using an area-weighted average approach in interpreting the results of the confirmatory samples. This same approach has significant precedent for similar high-profile cleanup projects; for example, it has been used and accepted for the Lavaca Bay cleanup project in Texas, the Lower Fox River and Green Bay cleanup sites in Wisconsin, and the Hudson River PCBs Superfund site in New York. As such, this approach is considered highly applicable to the Installation Restoration (IR) Site 7 project as well.

1 STATISTICAL PROPERTIES OF EXISTING SEDIMENT DATA

Table D-1 provides a statistical summary of the variability of existing site data for the major chemicals and compounds of interest (i.e., copper, lead, mercury, silver, and zinc). For AOEC-C (West and East), the variability (e.g., standard deviation) is relatively low and the average concentration is significantly lower than the Sediment Management Objectives (SMOs). In area AOEC-A, however, there are several chemicals with relatively high standard deviations and overall averages are closer to (although still below) the SMOs. See, in particular, the values for copper, lead, and zinc, which are more than 50 percent of the SMO values. This data indicates that there is a greater potential for localized "hotspots" in AOEC-A.

Table D-1
Statistical Summary of Existing Site Data

AOEC Area	Analyte	Maximum Value mg/kg	Average mg/kg	Standard Deviation mg/kg	95 Percent UCL mg/kg	ERL mg/kg	ERM mg/kg	Action Level (SMO)	N^{ALT}	MDD^{ALT1}	$Average^{ALT2}$	Standard $Deviation^{ALT2}$	N^{ALT2}	MDD^{ALT2}
Area AOEC A	Copper	603	117	139	149	34.0	270	254	7	120	--	--	--	--
	Lead	449	51.9	89.0	72.8	46.7	218	100.0	24	40	33	41	6	62
	Mercury	3.04	0.439	0.665	0.595	0.150	0.710	0.900	10	0.40	--	--	--	--
	Silver	1.57	0.306	0.361	0.390	1.00	3.70	3.50	15	3.1	0.263	0.3	2	3.2
	Zinc	1590	201	259	261	150	410	307	54	76	147	118	7	138
Area AOEC C-East	Copper	154	45.8	41.7	55.4	34.0	270	254	2	200	--	--	--	--
	Lead	84.8	17.2	22.0	22.3	46.7	218	100.0	2	80	--	--	--	--
	Mercury	0.881	0.173	0.214	0.222	0.150	0.710	0.900	2	0.70	--	--	--	--
	Silver	0.676	0.217	0.213	0.266	1.00	3.70	3.50	2	3.3	--	--	--	--
	Zinc	257	97.5	67.9	113	150	410	307	2	190	--	--	--	--
Area AOEC C-West	Copper	267	54.1	51.5	65.6	34.0	270	254	2	190	--	--	--	--
	Lead	148	22.9	28.5	29.3	46.7	218	100.0	2	74	--	--	--	--
	Mercury	1.60	0.273	0.342	0.350	0.150	0.710	0.900	2	0.59	--	--	--	--
	Silver	1.19	0.233	0.257	0.291	1.00	3.70	3.50	2	3.2	--	--	--	--
	Zinc	457	116	79.4	133	150	410	307	2	170	--	--	--	--

Notes:
MDD = Minimum Detectable Difference ('grey region')
ALT1 = alternate sampling strategy 1

Sampling plan conditions:
ALT1 (sample placement would be randomized or grid)
Ho: Residuals > Action Level (i.e., site is 'dirty')
Ha: Residuals < Action Level
a = 0.1
b = 0.2
MDD = action level - 1.15*average concentration
ALT2 - Same conditions as ALT1 with following modifications:
Four sample outliers removed (A-03 0-1, A-03 1-2, A-03 2-1, A-07 1-2) for lead, zinc, and silver
Average and standard deviation recalculated for lead, zinc, and silver with outliers excluded
MDD recalculated using updated average values for lead, zinc, and silver

2 ANALYSIS OF SEDIMENT STATISTICS

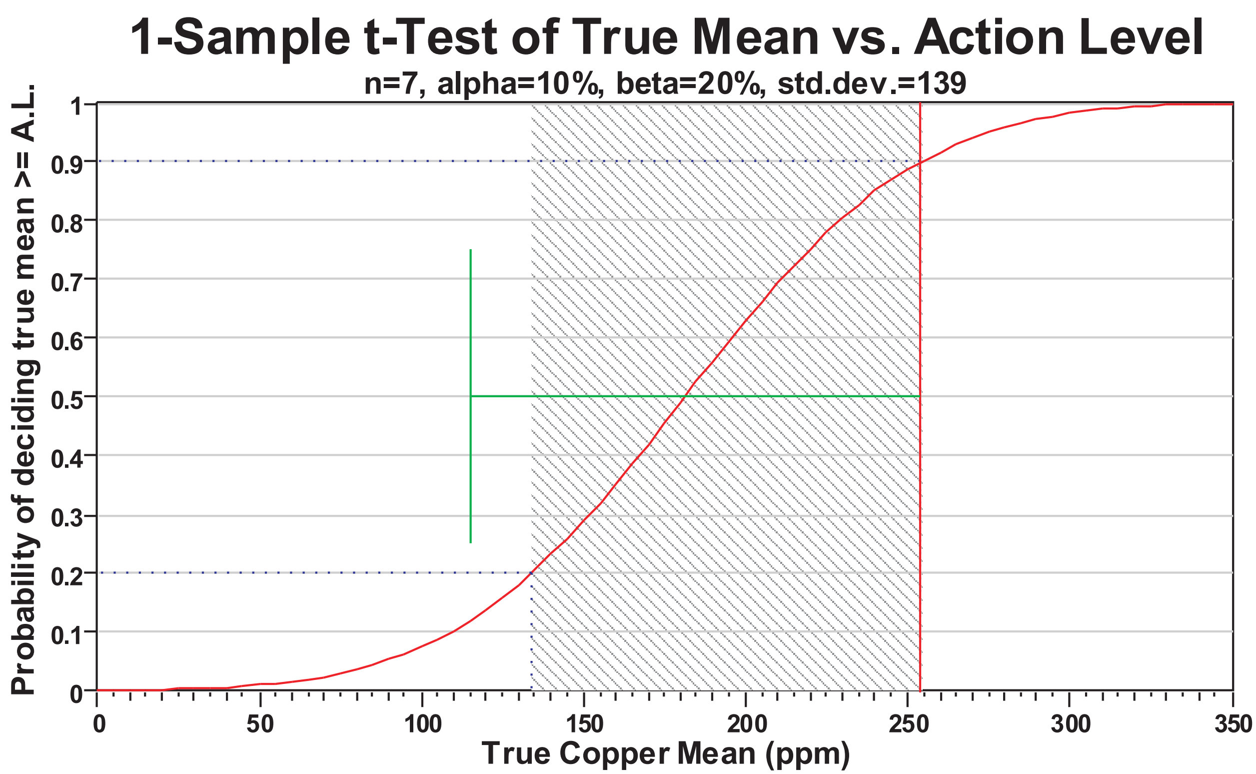
The information presented in Table D-1 was evaluated with the objective of determining if the average concentrations of sediment remaining after dredging would be likely to exceed the SMO for copper, lead, mercury, silver, zinc, polycyclic aromatic hydrocarbon (PAH), polychlorinated biphenyl (PCB), and dichlorodiphenyltrichloroethane (DDT). The following assumptions and analytical strategies were applied to this evaluation:

- Assume samples will taken within the lateral footprint of the dredging area
- Use a randomized or grid design to collect sufficient number of samples to characterize residuals and meet the objective described above:
- Assume that the data will fit a normal distribution (or close to it)
- Hypothesis to be tested:
  - Ho (null): Average [Residuals] less than SMO
  - Ha (alternative): Average [Residuals] greater than SMO
    - This hypothesis assumes the site is "dirty" and it needs to be proven that it is not. (The data seem to indicate it is not based on the historical data but usually agencies will require this assumption to be conservative)

Furthermore, the following assumptions were made when interpreting the statistical results (i.e., the Decision Error Assumptions):

- Alpha = 0.1 (This means that there is a 10 percent probability rejecting a true null hypothesis; falsely rejecting the assumption that the site is "dirty"; Type I error)
- Beta = 0.2 (This means there is a 20 percent probability of accepting a false null hypothesis; falsely accepting the assumption that the site is "dirty" when it is really clean; Type II error)
- Minimum Detectable Difference = SMO – 1.15*Average Historical Concentration (This means that if the 'true' average of the site between the average historical concentration (plus 15 percent) and the SMO, it would be "too close to call" and the data may not be sufficient to correctly identify the Site as clean)
  - All the above values are professional judgment and are related to the data quality objectives of the sampling
- Assumes that the statistical variation in sediment remaining after dredging (including residuals) is equivalent to the variation of available samples (Figure D-1).

Figure D-1 is graphical representation of how this statistical analysis was conducted. In this example, copper concentrations from area AOEC-A are evaluated.



Notes:

1. The SMO for copper (254 mg/kg) is vertical red line.
2. Green Error Bar is the standard deviation for copper concentrations in AOEC-A (139 mg/kg)
3. Shaded error is the MDD (Action Level -1.15*Avg=120; in this case from 134 to 254)
   a. Thus if the true average is between 134 and 254 ppm, there is a unknown or 'too close to call' chance that we would say the site average exceeds the SMO of 254
4. Lower blue dotted line is beta, below this line (134 ppm) there is a 20% chance we would incorrectly conclude the site average exceeds the SMO of 254
5. Upper blue dotted line is alpha, there is a 10% probability that we would conclude the site average is less than the SMO of 254 ppm when in fact it is not.

Figure D-1
Example Statistical Analysis for Confirmatory Sampling Design
Remedial Action Plan and Design Report
IR Site 7 (West Basin)
Port of Long Beach, CA

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3 SUMMARY OF CONCLUSIONS REGARDING FREQUENCY OF CONFIRMATORY SAMPLES

For AOEC-C East and West, the number of confirmatory samples indicated by the statistical analysis is relatively low (N = 2). In order to increase the level of statistical confidence in the results, the number of confirmatory samples in this area will be increased to four.

For AOEC-A, the concentrations of zinc and lead and their relatively high standard deviations imply needing a high number of confirmatory samples (up to 54), which is not practical in the field. The individual sample points in AOEC-A were studied further in an attempt to identify possible chemical “hotspots” that could be treated independently of the rest of the dredging area.

A review of the existing data indicates that some outliers exist in the data set used to estimate the variability and average concentrations of lead and zinc in this area of the site. In particular, a statistical outlier analysis using ProUCL software (which applies the Dixon’s Test) identified four potential outliers for lead and zinc, at sample locations A-03 0-1, A-03 1-2, A-03 2-3, and A-07 1-2. These sample locations also included two outliers identified for silver, A-03 1-2 and A-07 1-2. These outliers were judged to be areas warranting individual attention during the confirmatory sampling program.

For the rest of AOEC-A, the outlier samples were subtracted from the existing data set and the average and standard deviation were recalculated. Using these values, the power analysis and sampling design was rerun. Decreases in both the average and variability (i.e., standard deviation) resulted in significantly less samples being potentially necessary to achieve the confirmatory sampling objectives (see alternative sampling design No. 2 in Figure D-1).

Based on this analysis the following is recommended for AOEC-A:

- Confirmatory sampling should include 10 randomly or grid based samples to provide adequate power to address the sampling objectives for all metals and organics
- two additional samples should be taken specifically at sample locations A-03 and A-07 to confirm that elevated levels of zinc, lead, and silver at these locations have been removed

Because the organics were all non-detected and therefore well below the SMO, developing the sampling design based on metals concentrations will also be adequate for the organic compounds.