Commencement Bay Nearshore/ Tideflats Superfund Site

Asarco Sediments/Groundwater Operable Unit 06 Ruston and Tacoma, Washington

Record of Decision

July 2000

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Acronyms and Abbreviations

AKART	all known available and reasonable methods of treatment
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirement
BMPs	Best Management Practices
CAD	confined aquatic disposal
CB/NT	Commencement Bay Nearshore/Tideflats (Superfund Site)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemicals of concern
CSF	cancer slope factor
CSL	cleanup screening level
DMA	Dimethylaniline or N,N-dimethylaniline
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
FS	Feasibility Study
ft/sec	feet per second
IRIS	Integrated Risk Information System
m/sec	meter per second
MCL	maximum contaminant levels
MHHW	mean higher high water
MSL	mean sea level
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System

NPL	National Priorities List
NTR	National Toxics Rule
O&M	operation and maintenance
OMMP	Operation, Maintenance, and Monitoring Plan
OU	Operable Unit
PQL	practical quantitation limit
PSAPCA	Puget Sound Air Pollution Control Authority
RAO	remedial action objective
RD/RA	remedial design/remedial action
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act of 1986
SMS	Sediment Management Standards
SQS	Sediment Quality Standard
TDS	total dissolved solids

PART I

Declaration

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Site Name and Location

Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site

Asarco Sediments/Groundwater Operable Unit 06

Tacoma and Ruston, Washington

U.S. Environmental Protection Agency (EPA) ID No. WAD980726368

Statement of Basis and Purpose

This decision document presents the Selected Remedy for Asarco Sediments/Groundwater Operable Unit 06 (OU 06) in Tacoma and Ruston, Washington. The Selected Remedy was chosen in accordance with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for this Site.

The State of Washington Department of Ecology (Ecology) concurs with the Selected Remedy.

Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The Asarco Sediment/Groundwater Operable Unit (OU 06) Site ("Site") is one of the operable units that specifically addresses contamination coming from, or related to, the Asarco Smelter Facility ("Facility") in Ruston and Tacoma, Washington. The Selected Remedy for the Asarco Sediments/Groundwater Operable Unit 06 includes the following elements:

Groundwater

Groundwater at the Asarco Facility was originally studied in an RI/FS concluded in 1993 (Hydrometrics, August 1993). The Asarco Tacoma Smelter ROD (OU 02 ROD) identified the selected remedy for onsite waste materials, contaminated soil, and surface water (EPA, 1995). However, the OU 02 ROD deferred a remedy decision for groundwater and called for further monitoring. This ROD for OU 06 identifies the Selected Remedy for groundwater.

Although the Selected Remedy for groundwater was not addressed by the OU 02 ROD, a number of elements in the OU 02 remedy will directly benefit groundwater quality. These elements include capture of shallow groundwater in selected areas, construction of a low-permeability cap across the Facility, and excavation of the most highly contaminated source materials (selected slag material and contaminated soils) and consolidation of these materials into an On-site Contaminant Facility. These OU 02 remedy elements will (1) remove a significant source of contamination that would otherwise impact groundwater quality and (2) significantly reduce the flow of contaminated groundwater to Commencement Bay by minimizing recharge of the shallow aquifer system (e.g., surface water controls and the low-permeability cap will reduce infiltration).

EPA has determined that additional remedial actions, over and above those already being implemented under OU 02, are not necessary to address groundwater under this ROD for OU 06. As a result this ROD summarizes the elements of the remedy for OU 02 that will benefit groundwater and identifies other elements of the groundwater remedy not previously addressed. These other remedy elements include finalization of the groundwater remedial action objectives (RAOs), identification of cleanup levels and groundwater point of compliance, and long-term monitoring requirements.

Specifically, the Selected Remedy for groundwater, as represented by the RODs for OU 02 and OU 06, includes the following elements:

- Reduce groundwater flow and related contaminant loading to Commencement Bay by removing the most significant source materials and limiting groundwater recharge to aquifers beneath the smelter portion of the Facility. Groundwater control will be achieved by intercepting groundwater with subsurface drains in selected locations, diverting surface water and installing a low-permeability cap over the smelter portion of the Facility. These controls will minimize infiltration and recharge of onsite aquifers. (These remedy elements are being accomplished under OU 02 cleanup.)
- Continue to monitor groundwater to evaluate the long-term effects that the Facility cleanup will have on future groundwater quality. (Addressed for the first time in this ROD for OU 06.)
- Implement institutional controls to restrict future use of Facility groundwater. (Addressed for the first time in this ROD for OU 06.)

Sediment

The Selected Remedy for marine sediments includes the following elements:

- Dredge contaminated sediment in the Yacht Basin and place the dredged sediment beneath a low-permeability soil cap to be constructed on the upland portion of the Facility (i.e., OU 02). The sediments will be contained under the low-permeability cap at an elevation such that groundwater will not come in contact with the sediment.
- Monitor the dredged area in the Yacht Basin to verify that it does not become recontaminated.
- Cap contaminated sediments in selected offshore areas.
- Monitor the sediment caps to confirm that they remain in place, continue to isolate the underlying contaminated sediment, become recolonized with healthy biological communities, and do not become recontaminated.

- Use institutional controls to prevent activities that could damage the sediment caps.
- Monitor the areas outside the capped and dredged areas to confirm that these areas meet RAOs.

The Selected Remedy for the Asarco Sediments/Groundwater OU 06 has been chosen to complement the remedy previously selected for OU 02 (EPA, March 1995). The OU 02 remedy is currently being implemented.

Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable with the following exceptions. The federal National Toxics Rule (NTR) standard for arsenic of 0.14 µg/L (40 CFR Section 131.36) is a relevant and appropriate requirement for groundwater but is being waived for reasons discussed in Part II of this ROD (Section 12.1.1 of the Decision Summary).

The Selected Remedy for OU 06 does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons:

- **Groundwater.** Groundwater treatment is not viable or cost-effective because source materials remain on the Site. Further, a pump and treat remedy for containment purposes would be inefficient due to the direct hydraulic connection that the Site aquifers have with the waters of Commencement Bay. Treatment would require groundwater extraction in perpetuity at very high pumping rates. The most significant source of groundwater contamination is the slag material that is present below the water table throughout most of the Facility. This source material will continue to leach contaminants to groundwater. The Selected Remedy focuses on restricting recharge to, and flow through, the affected water-bearing zones such that the volume of groundwater discharged to Commencement Bay is reduced to the maximum extent practicable.
- **Sediments.** Treatment technologies were evaluated for possible application to sediment cleanup, but were not carried forward because: (1) there are currently no effective and appropriate *in situ* treatment technologies (i.e., treating in place) for sediments similar to those at the Site, and (2) any *ex situ* treatment would require significant material handling (e.g., dredging, de-watering, transporting, processing) and treatment processing at extreme cost (e.g., construction costs could be as high as $75 million to $100 million), with little or no additional benefit to the effectiveness of the remedy.

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

Data Certification Checklist

The following information is included in the Decision Summary of this ROD (Part 2). Additional information can be found in the Administrative Record for this Site.

- Chemicals of concern and their respective concentrations—**Sections 5 and 7**.
- Baseline risk represented by the chemicals of concern—**Section 7**.
- Cleanup levels established for chemicals of concern and the basis for these levels—**Section 12**.
- How source materials constituting principal threats are addressed—**Section 11**.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD—**Sections 6 and 7**.
- Potential land and groundwater use that will be available at the Facility as a result of the Selected Remedy—**Section 6**.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, and the number of years over which the remedy cost estimates are projected—**Sections 9 and 12**.
- Key factors that led to selecting the remedy—**Section 12**.

Authorizing Signature

Chuck Findley
Acting Regional Administrator

Date

[Original signed by Chuck Findley on July 14, 2000]

PART II

Decision Summary

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Introduction

This Decision Summary provides a description of the site-specific factors and analyses that led to selection of the remedy for the Asarco Sediments/Groundwater Operable Unit 06 at the Commencement Bay Nearshore/Tideflats (CB/NT) Superfund Site. In identifying the Selected Remedy, the U.S. Environmental Protection Agency (EPA) considered many factors, including information about the Site background, the nature and extent of contamination, the assessment of human health and environmental risks, and the identification and evaluation of remedial alternatives.

The Decision Summary also describes the involvement of the public throughout the Remedial Investigation/Feasibility Study (RI/FS) process, and the environmental programs, regulations, and statutes that may relate to or affect the cleanup alternatives considered for this Site. The Decision Summary concludes with a description of the Selected Remedy and a discussion of how it meets the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Contingency Plan (NCP).

This Decision Summary is presented in 13 sections as follows:

- Section 1—Site Name, Location, and Description
- Section 2—Site History and Enforcement Activities
- Section 3—Community Participation
- Section 4—Scope and Role of Operable Units
- Section 5—Site Characteristics
- Section 6—Current and Potential Future Land and Resource Uses
- Section 7—Summary of Site Risks
- Section 8—Remedial Action Objectives
- Section 9—Description of Alternatives
- Section 10—Summary of Comparative Analysis of Alternatives
- Section 11—Principal Threat Waste
- Section 12—Selected Remedy
- Section 13—Statutory Determinations

Documents supporting this Decision Summary are included in EPA's Administrative Record for the CB/NT Superfund Site, Asarco Sediments/Groundwater Operable Unit 06.

1 Site Name, Location, and Description

The former Asarco copper and lead smelter facility (the "Facility") is located along the Commencement Bay shoreline in Tacoma and Ruston, Washington (Figure 1-1). The Facility is part of the CB/NT Superfund Site. This ROD addresses the Asarco Sediments/ Groundwater Operable Unit 06 (OU 06 or the "Site") at the Facility. The general boundary of OU 06 is shown in Figure 1-2. OU 06 is one of four OUs associated with the Facility. Additional information on the Facility OUs and their interrelationships is provided in Section 4. OU 06 is also one of seven OUs located within the larger CB/NT Superfund Site. The CB/NT Superfund Site was nominated to the National Priorities List (NPL) in 1982 and placed on the final NPL in 1983. The EPA identification number for the Site is WAD980726368.

EPA is the lead regulatory agency for the Site. The Washington State Department of Ecology (Ecology) has supported the EPA at the Site throughout the CERCLA process. One responsible party, Asarco, has publicly acknowledged its intent to conduct the cleanup for OU 06; however, a consent decree for the cleanup of OU 06 has not yet been negotiated.

1.1 General Facility Description

The Facility is located within the municipal boundaries of Ruston and Tacoma, Washington. The site is located on the northeast side of the Point Defiance Peninsula and borders Commencement Bay (Figure 1-1). The general area consists of steep slopes extending down to Commencement Bay producing bluffs along portions of the shoreline.

The onshore portion of the Facility is approximately 67 acres in size. In addition, approximately 30 acres of offshore intertidal and subtidal lands are under Asarco ownership. The State of Washington also owns a portion of the offshore lands within OU 06. State-owned aquatic lands are managed by the Washington State Department of Natural Resources.

Surface water features within the Facility boundaries include springs and seeps which emanate from the face of the shoreline bluff from shallow groundwater bearing strata, and impoundments in drainage bottoms south and west of the main plant complex. Elevation across the Facility ranges from sea level to as high as 250 feet above mean sea level (MSL). Steep drainages are located in the vicinity of railroad tracks that cross the Facility in an east-west direction. There are areas of dense vegetation, primarily on steep drainage slopes and along the bluff slope above Commencement Bay.

Much of the Facility was constructed on slag fill, a waste byproduct of smelting arsenic- and lead-bearing ores. The slag fill was used to modify and extend the pre-existing shoreline by approximately 500 feet into Commencement Bay. In addition, the Breakwater Peninsula (see Figure 1-2) is composed of slag. The slag beneath the Breakwater Peninsula is up to 125 feet thick (Hydrometrics, January 1993). See Section 5.1 for additional information on the production and distribution of slag.

Prominent surface features on the Facility included a 562-foot-high stack and numerous buildings and structures associated with copper smelting and refining. The stack and most of the buildings have been demolished in recent years. A car tunnel, a railroad tunnel, and a pond formerly used for storage of process cooling water (the Cooling Pond) remain on the Facility. Also onsite is the Fine Ore Bins building, which is currently used to store demolition debris and contaminated soil that will eventually be moved to an onsite waste containment facility being constructed as part of the OU 02 remediation. The former Facility layout is depicted in Figure 1-3.

Surrounding land use is primarily suburban residential or recreational (Tacoma Yacht Club and Point Defiance Park) with commercial land uses nearby. Areas south and west of the plant complex consist primarily of single family residences. Shoreline areas to the southeast were previously industrial, but are currently developed as park areas, public fishing areas, and restaurants.

1.2 Groundwater Conditions

OU 06 includes groundwater beneath the Facility. The local occurrence and movement of groundwater on the Point Defiance Peninsula is dictated by the distribution and properties of glacially derived sediments that dominate the area geology. Glacial outwash deposits consisting of relatively clean sand and gravel form groundwater flow pathways. The complex glacial stratigraphy results in a number of isolated perched aquifers in the more permeable units separated by less permeable tills and lacustrine deposits. The fine-grained lacustrine sediments of the Kitsap Formation underlie the near-surface glacial outwash deposits and consist of silt and clay with few gravelly zones. The Kitsap Formation is not a groundwater flow pathway.

Shallow and deep aquifer systems[1] have been identified at the Facility (Figure 1-4). The deep aquifer is located approximately 70 to 100 feet below ground surface. The shallow aquifer is located within 10 to 50 feet of the ground surface. The deep and shallow aquifers are separated by the thick, low-permeability silt and clay of the Kitsap Formation. This low-permeability zone inhibits groundwater flow between the shallow and deep aquifer systems. Depending on location and depth, the shallow aquifer generally consists of sand and gravel alluvium (in the higher elevations in the southwestern portion of the upland Facility), slag fill (ranging up to approximately 45 feet thick near the shoreline), and native marine sands (underlying the slag). The shallow aquifer system beneath the Facility is largely recharged by infiltration of precipitation and surface water run-on and, to a minor extent, by lateral flow of groundwater from the southwest (Ruston area).

Groundwater beneath the Facility generally flows in a northeasterly direction toward Commencement Bay, the ultimate groundwater discharge point. Some shallow groundwater discharges to the ground surface as seeps and springs in the upper elevations of the site, specifically along the steeper slopes on the southwest side of the Facility.

[1] Various Site documents reference the slag, marine sand, and intermediate aquifers. All of these aquifers are considered to be within the “shallow aquifer system” as the term is used in this ROD.

1.3 Marine Sediments

OU 06 includes marine sediments that extend approximately 1,000 feet offshore into Commencement Bay. Intertidal and subtidal slopes range from relatively flat to steep inclines (slopes to approximately 50 percent). The steepest submarine slopes were generally formed by placing molten slag directly into the water where it hardened in massive forms. Water depths in the steepest gradient areas within OU 06 are up to approximately 300 feet deep.

Current patterns and water circulation in and around OU 06 were investigated as part of the Draft Phase 2 Refinement of *Options Report—Expanded Remedial Investigation and Feasibility Study* (Parametrix, December 1996) and the draft *Biological Assessment* (BA) of the Site (Parametrix, May 2000). Strong, tidally generated currents are characteristic of the area. Analysis of storm wave and tidal current conditions at the Site shows currents as high as 3.3 feet per second (ft/sec), or 1 meter per second (m/sec), occur near the bottom with tidal and wave forces acting in the same direction. Nearshore tidal currents could be higher, up to 4 ft/sec (1.24 m/sec.). The predominant flow patterns are westerly north of the Facility and southeasterly to the south of it. Water movement within the Yacht Basin is considerably less than that within adjacent areas outside the basin.

The marine sediments of interest occur in an area directly offshore of the Facility, extending into Commencement Bay. These sediments, seaward of the Facility, generally consist of coarse-grained material. Sediments inshore of the Breakwater Peninsula (Figure 1-2) in the Yacht Basin, tend to be more fine-grained.

Aquatic habitats in OU 06 include shallow and deep subtidal coarse sediment (including slag material), sand (with some slag particles), and mud communities. The coarse sediment habitats, particularly in the areas of larger slag particles function as rock and gravel substrates attracting fauna such as sea urchins, crab, shrimp, anemones, and scallops. The sandy sediment habitats include aquatic communities composed of tube-dwelling organisms, burrowing animals, and mobile epifauna (e.g. sea cucumbers, sea stars, sea urchins, snails and crabs). The mud habitats are characterized by burrowing and sediment-eating organisms. Figure 1-5 presents the locations of these habitats within OU 06.

Fish species commonly observed in the nearshore areas include juvenile and adult sanddabs (*Citharichthys* sp.), rock sole (*Lepidopsetta bilineata*), C-O sole (*Pleuronichthys coenosus*), English sole (*Parophrys vetulus*), buffalo sculpin (*Enophrys bison*), staghorn sculpin (*Leptocottus armatus*), striped surf perch (*Embiotica lateralis*), shiner surf perch (*Cymatogaster aggregata*), pile perch (*Rhacochilus vacca*), Pacific herring (*Clupea harengus pallasi*), gunnels (*Pholis* spp.) and mosshead warbonnets (*Chirolophis nugator*).

Macroflora commonly observed at the Site include red algae (*Callophyllis edentata*, *Gigartina* sp. Indet., and *Porphyra* sp. Indet.) and green algae (*Ulva, Monostroma* and *Enteromorpha* spp.), and kelp (*Laminaria saccharina* and *Nereocystis leutkeana*).

Listed and proposed threatened and endangered species that may be present within the general project area include:

- Chinook Salmon, Puget Sound Stock (*Oncorhynchus tshawytscha*)—Threatened
- Coho Salmon, Puget Sound Stock (*O. kisutch*)—Candidate species for listing

- Sea-run Cutthroat Trout (*O. clarki clarki*)—Proposed Threatened
- Bull Trout (*Salvelinus confluentus*)—Threatened
- Humpback Whale (*Megaptera novaeangliae*)—Endangered
- Steller Sea Lion (*Eumetopias jubatus*)—Threatened
- Leatherback Sea Turtle (*Dermochelys coriacea)*—Endangered

Of these, chinook salmon are considered to be a species of concern because the juveniles are expected to occur along the shoreline of the Site during their outmigration period (i.e., from February through July).

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2 Site History and Enforcement Activities

2.1 Historical Site Activities

From 1890 through 1912, the Facility was a lead smelter and refinery. Asarco, Inc., purchased the property in 1905. By-products of the smelting operations were refined to produce other marketable products, such as arsenic, sulfuric acid, and liquid sulfur dioxide. Asarco ended operations at the Facility in 1986.

The following is a brief chronological summary of operations at the former Asarco Tacoma Complex:

1890—Under ownership of the Tacoma Smelter Company, operation as a lead smelter commenced.

1902—Copper production commenced.

1905—Asarco purchased the smelter.

1917—The plant was rebuilt, a stack was constructed, and electrostatic precipitators were added.

1930—The blast furnace smelting operations were discontinued and replaced with reverberatories that produced slag as a by-product.

1974—A liquid sulfur dioxide plant began operation, using a dimethylaniline process.

1977—A baghouse was installed to handle dust from the arsenic kitchen and metallic arsenic plant.

1979—The electrolytic refinery ceased operation.

1985—Copper smelting operations were discontinued.

1986—Arsenic production was discontinued, and the Facility ceased all manufacturing operations.

Since 1987, Asarco has completed two phases of demolition activities at the Facility. Structures in the stack area associated with copper smelting and the production of both arsenic trioxide and metallic arsenic were demolished in 1987 and 1988. The majority of the remaining buildings and structures, including the smelter stack, were demolished during the period of 1992 to 1994. Much of the Facility (where historical manufacturing processes were located) has been leveled and, to some extent, graded. Remedial actions required by the OU 02 ROD began in 1999 when construction of the On-Site Containment Facility began. The remaining remedial action required for OU 02 and OU 06 (this ROD) will extend through 2005.

2.2 Historical Enforcement Activities

The history of regulatory activities affecting the former Asarco Tacoma Smelter began in the late 1960s with the passage of air emission standards by the Puget Sound Air Pollution Control Authority (PSAPCA). Although PSAPCA began regulating sulfur dioxide and arsenic emissions in 1968, variances to the standards were granted to Asarco until 1975. EPA requirements such as National Pollution Discharge Elimination System (NPDES) permits, which regulate point source water discharges, were applied in 1975. EPA also began enforcement proceedings in the early 1980s to regulate air emissions. Federal and state standards and variances continued to be issues of contention until the smelter closed in the mid-1980s.

In July 1983, EPA issued proposed standards for arsenic under Section 112 (National Emission Standards for Hazardous Air Pollutants) of the Clean Air Act. Inorganic arsenic had been designated as a hazardous air pollutant in 1980 and the Asarco Smelter was a major source of arsenic. The proposed standard for Asarco was modified to require better management practices in handling arsenic-contaminated materials. These regulations were never implemented due to a decision by Asarco to cease copper refining in 1985.

In September 1986, Asarco signed an Administrative Order on Consent with EPA pursuant to Section 106(a) of CERCLA, in which Asarco agreed to conduct a Remedial Investigation and Feasibility Study (RI/FS) and to perform immediate site-stabilization activities. Asarco's contractors began the RI/FS in 1987 under EPA oversight. Site stabilization, Phases I and II, were both conducted based on the information collected during the initial investigation of the Facility.

In December 1990, EPA issued a ROD for demolition of structures and construction of a surface water diversion system. Asarco agreed to perform this work in a Consent Decree dated May 18, 1992.

The field investigation and evaluation of remedial alternatives for a final RI/FS for OU 02 (including groundwater) was concluded by Asarco in 1993. The RI for the offshore marine sediments was concluded in 1996; the FS process was concluded in 2000. The results of both RI/FS processes were used to develop the remedy for OU 06.

The following is a brief chronological summary of CERCLA enforcement activities associated with the former Asarco Tacoma smelter.

1986 Administrative Order on Consent (AOC) for RI/FS and Phase I site stabilization signed.

1988 Phase I site-stabilization (demolition) activities completed.

1989 Draft RI/FS submitted.

1989 AOC for Expedited Response Action in Ruston/North Tacoma signed.

1990 Notice of Violation for RI/FS issued.

1990 Interim ROD for Phase II site-stabilization (demolition) and surface water controls issued.

1991 Additional investigation of soil and groundwater contamination commences.

1992 Notice of Violation resolved.

1992 Consent Decree for demolition entered in federal court.

1993 Two stipulated penalties for late draft FS submittals paid by Asarco.

1993 ROD for Ruston/North Tacoma Study Area issued.

1993 Unilateral Administrative Order for Ruston/North Tacoma Study Area issued.

1993 Final RI/FS report for OU 02 (including groundwater) submitted and approved.

1994 AOC for Groundwater, Surface Water, Soil and Marine Sediments monitoring and sampling signed.

1995 ROD for OU 02 signed.

1996 Remedial Design for OU 02 initiated.

1996 Phase 1/Phase 2 Expanded RI/FS Sediment Activities completed.

1997 Placement of pilot cap in a small portion of the offshore contaminated sediments area.

1999 Asarco Sediment/Groundwater Task Force concludes their evaluation of potential groundwater impacts to Commencement Bay waters and sediments.

1999 Remedial Action for OU 02 initiated.

2000 Year 2 Pilot Cap Monitoring Report completed.

2000 Refinement of the Proposed Remedy Report completed.

2.3 Key Documents

Documents related to the RI/FS for OU 06 are available in the Administrative Record. Key documents include the following:

- *Historical Summary of the Evaluation of Groundwater Remedial Alternatives, Asarco Tacoma Smelter Site* (Hydrometrics, June 2000)
- *Documentation of the Feasibility Study Process for the Sediments Portion of the Asarco Sediments Operable Unit* (Parametrix, January 2000)
- *Refinement of the Proposed Remedy Report* (Parametrix, January 2000)
- Copper in Nearshore Marine Water, Technical Memorandum (Parametrix, June 1999)
- Group 5 Technical Memorandum, Asarco Sediment/Groundwater Task Force (Hydrometrics, April 1999)
- *Draft Phase 2 Refinement of Options Report, Expanded Remedial Investigation and Feasibility Study* (Parametrix, December 1996)
- *Ecological Risk Assessment and Seafood Consumption Screening Risk Assessment* (Roy F. Weston, October 1996)
- *Phase 1 Data Evaluation Report and Phase 2 Sampling and Analysis Approach, Asarco Sediments Superfund Site, Expanded Remedial Investigation and Feasibility Study* (Parametrix, April 1996)

- *Phase 2 Refinement of Options Report, Asarco Sediments Superfund Site, Expanded Remedial Investigation and Feasibility Study* (Parametrix, December 1996)
- Draft Disposal Site Inventory (Parametrix, March 1995)
- *Supplemental Feasibility Study – Commencement Bay Nearshore/Tideflats Asarco Sediment Site* (Roy F. Weston, Inc., October 1993)
- *Asarco Tacoma Plant Remedial Investigation, Tacoma, Washington* (Hydrometrics, August 1993)
- *Asarco Tacoma Plant Feasibility Study, Tacoma, Washington* (Hydrometrics, August 1993)
- *Asarco Tacoma Plant Yacht Club Breakwater Remedial Investigation, Tacoma, Washington* (Hydrometrics, January 1993)

3 Community Participation

Throughout the CERCLA process, EPA has taken steps to inform and involve the public in activities at the Site. EPA conducted the activities summarized in this section because the agency believes that community participation in the decision-making process is a key element in achieving a successful remedy.

In addition to cleaning up contamination at the Site, the community has been very interested in the future use of the property. EPA's primary mission is to identify a Selected Remedy that protects human health and the environment. However, EPA believes this can be accomplished while concurrently considering the future development potential of the property.

In order to provide a variety of opportunities for public participation in the cleanup decision process, EPA developed a communications strategy in 1993 for its activities related to the overall Asarco Facility, including OU 6 which is addressed by this ROD. This strategy supplemented the existing Community Relations Plan, which included the larger CB/NT and South Tacoma Channel Superfund Sites.

EPA has complied with the specific requirements for public participation under CERCLA by publishing a Proposed Plan for public comment. The Proposed Plan, *Asarco Sediments/Groundwater Operable Unit 06* (Proposed Plan) was published on January 26, 2000 (EPA, January 2000a). A fact sheet summarizing the Proposed Plan was also published at that time. Both the Proposed Plan and fact sheet were made available at local information repositories. The initial public comment period went from January 26 through February 25, 2000. In response to a request from the Washington State Department of Natural Resources, the comment period was extended 30 days to March 27, 2000. During the comment period, EPA held a public meeting in Ruston, Washington, on February 10, 2000. EPA also published newspaper advertisements in the *Tacoma News Tribune* to announce the availability of the Proposed Plan, the comment period, and the public meeting. Comments received during the public comment period are summarized along with EPA's responses in the Responsiveness Summary (Part 3 of this ROD).

In addition to the February public meeting and comment period addressing the Proposed Plan for OU 06, the following outreach activities have been conducted by EPA in recent years to inform the public about remedial activities at other related and adjacent operable units (e.g., OU 02, Asarco Tacoma Smelter and Breakwater Peninsula, and OU 04, Asarco Off-Property [Ruston/North Tacoma Study Area]):

- **Small Group Meetings**. EPA staff has attended meetings with groups upon request to share information about the agency's cleanup proposal and to address the public's need for information about the Facility. These groups include Black Collective Association, Izaak Walton League, Association of Builders and Contractors, Tacoma Environmental Commission, National Association of Women in Construction, Association of General Contractors, American Institute of Architects Southwest Washington, Environmental Task Force of Tacoma-Pierce County Chamber of Commerce, Kiwanis Club, and Rotary Club.

- **Personal Interviews**. In November 1993, EPA staff met with individual citizens to better understand community concerns regarding the cleanup.
- **Availability Sessions**. In October, November and December 1993, EPA and Asarco held sessions for citizens to visit one-on-one with EPA and Asarco staff to discuss cleanup plans.
- **Community Workgroup Briefing**. On May 19, 1994, EPA held a meeting for the Ruston/North Tacoma Community Workgroup. This workgroup was formed in 1989 to provide an avenue for citizens to become involved in residential investigation and cleanup activities.
- **Public Meetings**. EPA held two public meetings in 1994 during the 90-day public comment period for the Proposed Plan addressing OU 02. As indicated above, a public meeting and 60-day public comment period were provided in early 2000 to present information about and respond to any comments concerning the preferred remedy for OU 06.
- **Periodic Briefings**. Briefings have been held for representatives from the Town of Ruston, City of Tacoma, Tacoma Environmental Commission, the Office of Congressman Dicks, and other interested local government officials.
- **Information Repositories**. EPA has established and periodically updates various local document repositories where citizens can review detailed information about EPA's Superfund activities. As new materials become available, they are added to these repositories. Documents reflecting public comments can also be found in these locations. The location and subject of the repositories are frequently advertised in fact sheets and in newspaper notices prepared by EPA.
- **Fact Sheets and Brochures**. EPA has periodically distributed fact sheets to members of the affected community to provide current information on the status of Facility activities.
- **Coordinating Forum**. The Ruston/North Tacoma Coordinating Forum was formed in March 1991 to facilitate discussion and coordination among the various entities involved and/or affected by the Ruston/North Tacoma Residential Study Area project. In July of 1993, the Forum turned its attention to evaluating cleanup options for the Asarco Tacoma Smelter.

  To address issues associated with cleanup and future redevelopment of the Asarco Smelter Facility, two subcommittees were formed from the Coordinating Forum. The two subcommittees addressed land use and technical issues, respectively. The subcommittees included members of the public and staff from regulatory agencies and other government and private organizations. Both subcommittees worked for over a year on issues related to developing a cleanup plan for the Facility. EPA participated directly in the technical subcommittee and received input from the land use subcommittee. Input from both of these subcommittees has been used by EPA to develop both the OU 02 and OU 06 RODs. The following parties participated in the subcommittees.

Land Use Subcommittee	**Technical Subcommittee**
Asarco, Inc.	Agency for Toxic Substances and Disease Registry
City of Tacoma	Citizens for a Healthy Bay
Metropolitan Parks District	Community Representative
Town of Ruston	Environmental Protection Agency
	Puget Sound Air Pollution Control Authority
	Puyallup Tribe of Indians
	Tacoma-Pierce County Health Department
	U.S. Fish and Wildlife Service
	Washington Fish and Wildlife Service
	Washington Department of Ecology
	Washington Environmental Council
	Washington Department of Health
	Members of the Land Use Committee

- **Technical Assistance Grant**. In 1991 EPA awarded a Technical Assistance Grant (TAG) to the Citizens for a Healthy Bay. Citizens for a Healthy Bay has used these funds to hire technical experts to review and comment on cleanup design documents, prepare information for the general public on cleanup work, and prepare information for non-English speaking people who may fish or work on Commencement Bay. Citizens for a Healthy Bay maintains an office in downtown Tacoma which is open to the public and serves as an information repository for the CB/NT Superfund Site. Citizens for a Healthy Bay also publishes a quarterly newsletter that addresses a wide range of environmental issues of potential concern to the citizens of Tacoma.

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4 Scope and Role of Operable Units

The CB/NT Superfund Site has been divided into seven OUs. Superfund sites are often divided into OUs to more easily address individual areas within a large site, accommodate differing site conditions and remedies, or schedule phases of investigations and cleanup actions. Of the seven OUs designated within the CB/NT Superfund Site, four OUs are associated with the Facility:

- **OU 02, Asarco Tacoma Smelter and Breakwater Peninsula**—Consists of the "upland" portion of the former Asarco Smelter Facility. The media of primary concern are surface water and soils (including mixtures of soil and waste materials).
- **OU 04, Asarco Off-Property (Ruston/North Tacoma Study Area)**—Consists of the properties in Ruston and Tacoma adjacent to the Asarco Facility that have been contaminated by airborne fallout of emissions from the former Asarco stack. The medium of primary concern is soil.
- **OU 06, Asarco Sediments/Groundwater**—Consists of marine sediments located offshore of the Asarco Smelter Facility and groundwater underlying OU 02. The marine sediments in the Yacht Basin adjacent to the Facility are also included. The media of primary concern are sediments and groundwater.
- **OU 07, Asarco Demolition**—Consists of the Asarco buildings and infrastructure (e.g., underground utilities) subject to demolition and within the boundaries of OU 02. There are no environmental media associated with OU 07.

The approximate boundaries of OUs 02 and 06 are shown in Figure 1-2. The groundwater portion of OU 06 extends beneath the entirety of OU 02, which is also indicated in Figure 1-2.

4.1 Selected Remedies for the Other Asarco OUs

This ROD addresses the Selected Remedy for OU 06, Asarco Sediments/Groundwater. EPA has previously selected the following remedies for the other three Asarco OUs.

4.1.1 OU 02, Asarco Tacoma Smelter and Breakwater Peninsula

The Selected Remedy for OU 02 focuses on removal of source materials (waste material and highly contaminated soils) from the former Asarco Smelter Facility. The excavated source materials are to be contained in an onsite engineered repository referred to as the On-Site Containment Facility. Capping, surface water controls, shoreline armoring, and habitat restoration in selected inter-tidal areas are also integral to the OU 02 remedy. The Facility will be covered with a low-permeability cap to significantly reduce infiltration and percolation of precipitation that would otherwise recharge the groundwater system. The shoreline armoring will reduce the potential for erosion and transport of slag into Commencement Bay where it could recontaminate sediments.

4.1.2 OU 04, Asarco Off-Property

The Selected Remedy for OU 04 involves removal of arsenic- and lead-contaminated soils from residential yards and public spaces in Ruston and North Tacoma. The remedial action program began in 1994 and is ongoing.

4.1.3 OU 07, Asarco Demolition

The Selected Remedy for OU 07 included the demolition of buildings and other structures within the boundaries of OU 02. At this writing, all demolition is substantially complete with the exception of the Fine Ore Bins building. The Fine Ore Bins building is currently used to stockpile demolition debris and contaminated soils destined for permanent containment in the On-Site Containment Facility. The Fine Ore Bins building will be demolished concurrent with future OU 02 remediation activities.

4.2 Relationship of the OU 02 and OU 06 Remedial Actions

EPA identified the Selected Remedy for OU 02 in a 1995 ROD (EPA, March 1995). Remediation of OU 02 began in 1999 and will be essential to the successful cleanup and long-term protection of groundwater and marine sediments included in OU 06. For example, OU 02 contaminants leaching to underlying groundwater in OU 06 are transported by prevailing groundwater flow to Commencement Bay where they are discharged and threaten marine waters and sediments. Similarly, erosion and transport of slag particles from the nearshore areas of OU 02 into Commencement Bay results in deposition of these materials onto, and eventual mixing with, existing sediments.

Many elements of the OU 02 remedy will have direct benefits to the quality of groundwater and marine sediments within OU 06. These beneficial elements include collection and diversion of groundwater and surface water in selected areas to the surface water treatment system, construction of a site-wide low-permeability cap, and removal of the mostly highly contaminated source materials (selected slag material and contaminated soils). In particular, the OU 02 remedy will significantly reduce the flow of contaminated groundwater to Commencement Bay by minimizing recharge of the shallow aquifer system (e.g., surface water controls and the low-permeability cap will reduce infiltration). An estimated 75 to 95 percent reduction in OU 06 groundwater flow and contaminant loading to Commencement Bay is expected from the OU 02 remedy.

5 Site Characteristics

Past smelting operations at the Asarco Facility have resulted in contamination of soil, groundwater, surface water, and marine sediments. Wastes generated by the former smelter, particularly slag, have acted as a continuing source of contamination to groundwater and marine sediments.

5.1 Production and Distribution of Slag

Slag was produced as a waste product during the smelting of copper from arsenic- and lead-bearing ores. The slag at the Site is generally composed of dark brown iron-rich silicates that include metals such as arsenic, copper, and lead. The slag is similar in appearance to volcanic rock. It is either massive or granular, depending on the way it was processed and placed on the Site. Massive slag is present where molten slag was poured directly into the waters of Commencement Bay. Contact with the cold water solidified the molten material in place. Granular slag was intentionally produced by passing molten slag through cold water streams to produce a sand- to gravel-sized material. This granular slag was then used as fill material throughout the Facility. The slag was used to extend the shoreline by approximately 500 feet outward into Commencement Bay. In addition, the Breakwater Peninsula (see Figure 5-1) is comprised entirely of slag.

5.2 Contaminant Source Areas

In addition to the slag, principal threats to human health and the environment posed by the Facility are the contaminated materials that occur within the six "source areas," as identified in Figure 5-1. These areas contain buried waste materials and have either the highest measured concentrations of contaminants in soils, are primary sources of contamination to groundwater and sediments, and/or comprise large amounts of contaminated material based upon the historical uses of these areas. These six areas are:

- Stack Hill
- Copper Refinery
- Cooling Pond
- Fine Ore Bins Building
- Arsenic Kitchen
- Southeast Plant Area

The slag material that underlies much of the Facility is characterized by high concentrations of arsenic and other metals, which can also impact the groundwater and sediment. The source materials in the above-referenced six areas are being addressed as part of the OU 02 remedial action and are therefore not covered by this ROD for OU 06.

5.3 Site Investigations

Under EPA's oversight, Asarco began an RI/FS in 1987. The following OU 06 media were investigated:

- Groundwater
- Marine sediments and biological environment
    - Marine sediment chemistry
    - Marine waters
    - Marine tissue (fish and benthic tissue)
    - Bioassays and benthic community structures

The RI/FS for groundwater was completed in 1993 and the RI/FS for sediments was completed in 1996.

In 1996, EPA formed the Asarco Sediments Groundwater Task Force (Task Force) to address the relationship between groundwater and sediment contamination. The Task Force addressed two questions:

1. "Does groundwater that is discharging from the Facility negatively impact the marine sediments and waters of Commencement Bay?"

2. "Would a sediment cap remain stable (e.g., stay in place) in the presence of strong currents in this part of Commencement Bay?"

The first question was addressed by the Asarco Sediments Groundwater Task Force (Task Force). The Task Force evaluated the impacts of discharging groundwater on the marine sediments and waters of Commencement Bay. The second question was addressed by the placement and monitoring of a pilot-scale sediment cap to determine how well the test cap would physically remain in place over a 2-year period (Parametrix, February 2000). The pilot-scale cap was constructed offshore of the Facility, immediately northeast of the Fine Ore Bins building (Figure 5-1). The purpose of the cap was to determine the physical, chemical, and biological characteristics of two sediment plots, one with a thickness of 30 centimeters and the other with a thickness of 60 centimeters.

The key site characterization findings relating to groundwater and marine sediments as determined by the RI/FS, Task Force, and pilot-scale sediment cap study are summarized in the following sections.

5.4 Groundwater

Groundwater conditions at the Asarco Facility were initially characterized in the late 1980s and early 1990s during the RI for the upland portion of the Facility. Since that time, monitoring of groundwater quality has continued throughout the Facility as part of the post-RI Monitoring Program. (The post-RI monitoring program includes sampling selected onsite wells on a bi-annual basis, usually in March and September.) A summary of groundwater quality conditions as indicated by the results from the post-RI monitoring program is provided below.

5.4.1 Shallow Groundwater

Groundwater at the Site occurs in the shallow and deep aquifer systems as discussed in Section 1 and depicted conceptually in Figure 1-4. Monitoring indicates that Site groundwater flows from the southwest to northeast and ultimately discharges to Commencement Bay. The general groundwater flow direction is depicted in Figure 1-4 and 5-1. Near the shoreline, groundwater levels constantly fluctuate in response to the tide in Commencement Bay.

Groundwater has been adversely impacted by direct contact with contaminated source materials or indirectly impacted by infiltrating waters transporting contaminants to groundwater. In turn, Site groundwater discharges to Commencement Bay and the Yacht Basin where the contaminants are released to the marine environment.

Figure 5-2 shows monitoring wells that either are, or have been, included in the post-RI monitoring program. Groundwater in the shallow aquifer system is contaminated by elevated concentrations of metals including arsenic, cadmium, copper, lead, nickel, and zinc. Historical data show that distribution of elevated metals concentrations are generally well represented by arsenic and copper results.

The natural groundwater background concentrations for arsenic and copper in the Tacoma vicinity are 6 and 40 micrograms per liter (µg/L), respectively (EPA, April 1993). Arsenic and copper have been detected above their respective background levels frequently. Arsenic concentrations have exceeded the background level of 6 µg/L in approximately 90 percent of the groundwater samples collected since the RI. For copper, nearly 40 percent of the samples have exceeded the background level of 40 µg/L. With a marine chronic criterion of 3.1 µg/L, copper is a concern with respect to the potential threat posed by groundwater discharging to Commencement Bay waters. Approximately 60 percent of the groundwater samples collected since the RI have exceeded the 3.1 µg/L marine chronic criterion for copper. Other metals also exceed applicable marine water or drinking water criteria, but less frequently and usually where either arsenic or copper is also elevated.

Figures 5-3 through 5-6 depict isoconcentration contours for dissolved arsenic and copper in the "slag" and "intermediate" wells based on samples collected during September 1999 (latest monitoring period for which data are available). Both the slag and intermediate wells monitor the shallow aquifer system as depicted in Figure 1-4. The slag wells are screened in slag and the intermediate wells are screened in either shallow alluvium, non-slag fill, or in the marine sands underlying the slag. Figures 5-7 and 5-8 show box plots depicting the range of arsenic and copper concentrations in the slag and intermediate wells during the post-RI monitoring period (1994 to 1999).

As evident in the above-referenced figures, historical arsenic and copper concentrations in groundwater range up to several tens of thousands of parts per billion in some locations. Concentrations are highest in and around the former smelter processing areas. Metal concentrations decrease approaching the Commencement Bay as evidenced by data from nearshore monitoring wells and shoreline monitoring stations. (The shoreline monitoring stations consist of sampling tubes located along the shoreline, which are intended to sample groundwater as close as possible to the point of discharge to Commencement Bay and the Yacht Basin.) September 1999 data for the shoreline monitoring stations indicate that arsenic concentrations range from 5 to 29 µg/L (Figure 5-3) and copper concentrations range from 4 to 23 µg/L (Figure 5-5). The reduction in metal concentrations near the shoreline is caused by dispersion and attenuation of the contaminants as they move toward the bay. Dilution effects due to seawater entering the nearshore portions of the aquifers also have a significant impact on the reduction in metals concentrations.

Samples from the nearshore areas of Commencement Bay provide yet another indication of how groundwater discharging from the site may be affecting marine surface water. Data collected by Asarco in September 1999 show that existing (pre-remedial action) copper concentrations in Commencement Bay water immediately adjacent to the slag shoreline face are below the 3.1 µg/L marine chronic criterion in most locations sampled. The exception is the Yacht Basin where samples exceed the copper marine chronic criterion as far as 200 feet from shore (measured copper concentration of 8.38 µg/L based on average of high and low tide samples collected in September 1999). This is not unexpected given the proximity of the Yacht Basin to the defunct Copper Refinery Area (see Figure 5-1), a source of copper contamination within the upland portion of the Facility.

The presence of oxygen in seawater that invades the nearshore portions of the aquifers has a favorable impact on the fate of arsenic by promoting its precipitation. Copper, however, responds differently than arsenic to the effects of the more highly oxygenated seawater. Copper tends to be more readily mobilized from the slag into the groundwater when dissolved oxygen levels increase; however, copper is still subject to dilution as groundwater mixes with seawater as it approaches Commencement Bay. In spite of the increased mobilization of copper in the presence of higher dissolved oxygen levels, the net effect is a reduction in copper concentrations in groundwater approaching the shoreline due to the dilution effect.

In the Southeast Plant Area (Figure 5-1), slag was placed over wood waste originating from a former sawmill operation. Later, Asarco used an organic chemical called dimethylaniline (N,N-dimethylaniline or DMA) in this area for the production of concentrated sulfuric acid and liquid sulfur dioxide. Shallow aquifer groundwater in this Southeast Plant/DMA area has some of the lowest pH values and highest copper and arsenic concentrations found at the Site (Figures 5-3 through 5-6). DMA-related organic compounds, such as aniline, are also present in the shallow aquifer system. Appendix A includes charts showing the trend of various DMA-related compounds with time. As discussed above for arsenic and copper, concentrations of DMA-related compounds are highest near the center of the Southeast Plant/DMA area and decline significantly near the Commencement Bay shoreline. For example, aniline is present at approximately 100,000 µg/L near the center of the Southeast Plant/DMA area (well MW-B37 in Figure 5-2) but is either not detected or detected at part-per-billion levels in samples collected from nearshore monitoring wells located directly downgradient. Data for DMA-related compounds are depicted graphically in Appendix A.

5.4.2 Deep Groundwater

In comparison to the shallow aquifer, elevated contamination of the deep aquifer is limited in extent and concentration. Contamination in the deep aquifer is present near a former production well that provided water for the Facility (see location in Figure 5-1). It is believed that metals migrated from the shallow aquifer to the deep aquifer through the well casing. This well was sealed in 1994 to inhibit the movement of contaminants between the shallow and deep aquifer systems. Arsenic and copper data from deep monitoring well MW-139A, located approximately 75 feet from the former production well, is shown in Figure 5-9 and shows a decreasing concentration trend over the last 9 years.

5.5 Marine Sediments and Environment

Since the Asarco Facility was first included in the CB/NT Superfund Site, many studies have been completed to characterize and assess the potential effects of sediment contamination to human health and to the environment. In 1996, an expanded RI/FS investigation of offshore sediments was completed to better define contaminant effects at the site. Analyses of samples collected at the Facility as part of these investigations included sediment chemistry (inorganic and organic chemical analyses), surface water chemistry, pore-water chemistry, fish tissue analyses, benthic tissue analyses, bioassays, and benthic community structure analyses. A brief summary of these results are provided below; specific details can be found in *Phase 1 Data Evaluation Report and Phase 2 Sampling and Analysis Approach, Asarco Sediments Superfund Site, Expanded Remedial Investigation and Feasibility Study* (Parametrix, April 1996); *Phase 2 Refinement of Options Report, Asarco Sediments Superfund Site, Expanded Remedial Investigation and Feasibility Study, Appendix A – Phase 2 Data Evaluation Report* (Parametrix, December 1996); and *Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats Asarco Sediments Site* (Roy F. Weston, Inc., October 1993).

5.5.1 Marine Sediment Chemistry

The Washington State Sediment Management Standards (SMS) are used to evaluate contaminated sediments. The long-term goal of the SMS is "to reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination." To this end, the SMS include numerical standards for chemical and biological effects for the protection of marine animals living in the sediments (the "benthic community").

The SMS defines two levels of chemical and biological criteria. The most stringent level, the Sediment Quality Standard (SQS), corresponds to the long-term goal of "no adverse effects" on the benthic community. The less stringent level, the Cleanup Screening Level (CSL), corresponds to "minor adverse effects" on this community. At contaminant levels above the CSL, more significant effects are predicted, and a sediment cleanup decision is required.

The chemical criteria are numerical values derived from Puget Sound test data. The test data revealed specific adverse biological effects associated with chemical concentrations. Cleanup areas may be defined using chemical criteria alone. However, the SMS recognize that the chemical data may not accurately predict biological effects for all sediment locations. Biological testing (bioassays and benthic evaluation), allowed under the SMS, can be conducted to determine whether biological effects predicted by the chemical concentrations are occurring. The biological testing must include two tests for acute toxicity to marine organisms and one for chronic biological effects. If all three biological criteria are met for a given area, this area is not included in the cleanup area and does not require cleanup under the SMS for the protection of benthic organisms. Failure to meet the biological criteria, confirms the potential for adverse impacts to the benthic community.

During the Supplemental FS, 100 surface sediment stations were sampled for sediment chemical data. During the Phase 1 Expanded RI/FS a total of 62 sediment stations were sampled for chemical, physical and biological characteristics in order to identify an appropriate remedy for sediments. An additional 10 subsurface sediment samples were analyzed for chemistry and conventional parameters during the Phase 2 Expanded RI/FS. Figure 5-10 presents the sediment station locations from which these samples were collected.

Eleven inorganic chemicals were analyzed in surface sediment samples: arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, zinc, and mercury. Nine inorganic chemicals were analyzed in the subsurface sediments: arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc, and mercury. Table B-1 in Appendix B summarizes the inorganics data obtained during the RI/FS. Tables B-2 and B-3 present the metals results from the Expanded RI/FS Phase 1 and 2 data evaluations, respectively (Parametrix, April 1996 and December 1996). Inorganics were detected in sediments at significant concentrations in areas of the Site. Arsenic, cadmium, chromium, copper, lead, mercury, silver and zinc were found in sediments at concentrations above the SMS. Chemicals of concern (COCs) in sediment were determined to be arsenic, copper, lead, and zinc. These metals or metalloids were contaminants with the highest concentrations encountered in surface and subsurface sediments. Concentrations of arsenic found in sediment samples were as high as 26,410 milligrams per kilogram (mg/kg). Maximum concentrations of the other three COCs are summarized in Table 5-1. Figure 5-11 presents the sediment station locations where samples with sediment chemistry in excess of state cleanup criteria were collected. A significant amount of slag was found in sediment samples off the Breakwater Peninsula and immediately off the former smelter property. Slag contains the highest concentrations of metals including arsenic and lead but in a rock-like form.

Although numerous sediment samples at the site contain high concentrations of metals and metalloids, there is site-specific evidence (e.g., pore water chemistry, pore water bioassays, sequential extraction of slag) that bulk sediment chemistry results are not indicative of actual toxicity or are a reliable measure of the extent and magnitude of contaminant effects. This is because the bioavailability of metals and metalloids in slag to potential receptors may be low. Therefore the chemistry may have high concentrations yet the biological community could be healthy.

Tables B-4 and B-5 in Appendix B summarize the organic compounds detected in subsurface sediments from the Site. Out of 24 organic compounds tested, only individual polynuclear aromatic hydrocarbons and phthalates (butyl benzyl and bis-2-ethylhexyl) were detected above the SMS. No organic COCs were identified at the Site because the detections of these compounds were isolated and did not suggest a defined area of contamination. Furthermore, their limited occurrence corresponded to sediment sample stations that exhibited inorganic chemical contamination. Therefore it is believed that remedial responses for the inorganics would address incidental contamination by organics.

5.5.2 Marine Waters

Marine surface water samples have been collected from various locations offshore of the Facility over a period of years. Recent sampling conducted in March, April, and September

1999 indicates that only copper exceeds its corresponding marine chronic criteria for surface water (Parametrix, June 1999; Hydrometrics, March 2000). Sediment pore-water samples were previously collected from 11 stations at the Site and 2 reference stations in 1994 and 1995. The chemicals detected above EPA's marine acute and chronic criteria included arsenic, copper, and ammonia (Parametrix, April 1996).Table B-6 in Appendix B presents the chemistry results for sediment pore water.

5.5.3 Marine Tissue

Rock Sole (*Lepidopsetta bilineata*) whole fish and fillet samples were collected from five sample stations at the Site and a reference site (Browns Point, east of the Site). The whole-fish body results indicated consistent detections of arsenic, chromium, copper, and lead at levels higher than the reference sample (see Table B-10 and B-11 in Appendix B). The fillet sample results revealed arsenic and copper at concentrations substantially greater than the reference sample.

Benthic invertebrate samples were analyzed for nine metals (arsenic [including As^{+3}, As^{+5}, and total As], cadmium, chromium, copper, mercury, nickel, lead, silver, and zinc. The benthic organisms tested were sea cucumbers (*Stichpus californianus*), sea slugs (*Evasterias troschelii* and *Mediaster aequalis*), and sand shrimp (*Crangon alas kensis*). Table B-12 (Appendix B) presents the results of these tissue analyses.

As presented in Table B-12, arsenic, copper, and lead were consistently detected at levels above background in tissue samples obtained from the Site.

5.5.4 Bioassays and Benthic Community Structures

Bioassays are acute and/or chronic tests that measure the response of a living organism to a test substance such as a suspected contaminant. Sediment bioassays were conducted using samples from 62 stations across the Site, and included three different tests: amphipod, echinoderm larvae, and polychaete growth tests. Table B-7 and B-8 in Appendix B contains the results of these tests. The results of these tests indicate that the majority of bioassay results exceeding SMS occur immediately off the shoreline of the former Smelter Facility. Figure 5-12 depicts the locations of the areas where bioassay results exceeded SMS criteria.

Benthic infauna form the base of many marine food chains; therefore, their overall health, as indicated by abundance and diversity, is a good measure of the health of the sediment ecosystem. Impacts to benthic communities were evaluated using measures of abundance, richness, and diversity. The sediments that suggested moderate to severe impacts (i.e., multiple exceedances of the state sediment biological effects criteria) occurred immediately off the shoreline of the former Smelter. These effects included abundance and richness depressions, diversity indices less than their reference, community structures suggestive of impacts, and/or species-level data suggestive of impacts. Tables B-8 and B-9 in Appendix B summarize the biological data obtained from benthic infauna abundance studies for the Site.

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6 Current and Potential Future Land and Resource Uses

The Asarco Smelter terminated operations in the mid-1980s. Since that time, most of the former the buildings and structures have been demolished as part of the remedial action for OU 07 (Asarco Demolition; see Section 4). The Fine Ore Bins building (Figure 5-1) still exists and is used to store demolition debris and contaminated soil until the On-Site Containment Facility is ready to accept these materials. The Smelter property is also used to stockpile contaminated soils excavated from OU 04 (Asarco Off-Property). These contaminated soils are contained and protected by temporary covers. Construction activities associated with the OU 02 remediation began in 1999 and will be substantially complete in 2003 with final completion in 2005.

6.1 Proposed Development Plans

Proposed upland development at the Facility has been the subject of seven years of land use planning focusing on coordinated cleanup and redevelopment. The resulting Master Development Plan (Merrit+Pardini/Sasaki Associates, August 1997) adopted by Asarco, the City of Tacoma, Town of Ruston, and Metropolitan Park District of Tacoma in 1997 describes the basic framework of redevelopment. The following seven fundamental elements of the plan complement Facility cleanup:

- **Development Sites**. The Master Plan provides for development of seven fully served "pad ready" development sites totaling approximately 37 acres. These sites will accommodate commercial to light industrial development including buildings, parking, and landscape areas, controlled by local zoning.
- **Parks and Pedestrian Promenade**. The Master Plan includes a publicly accessible waterfront promenade and system of park areas connecting the existing waterfront walkway on Ruston Way to the south with Point Defiance Park to the north. The promenade and associated pedestrian areas will be concrete paved. The shoreline on the Commencement Bay side of the promenade will be armored to prevent shoreline erosion. Other park areas are to be turf and plant bed areas.
- **Streets and Utilities**. The Master Plan makes provision for new streets and utilities to serve all of the development sites and parks envisioned by the plan. Asarco will construct streets and utilities to prevailing municipal design standards.
- **Ruston Promontory Park**. The Master Plan includes development of a new 4-acre public view park located on a promontory over the capped On-Site Containment Facility. The Promontory Park will include both paved and turf areas. Steep embankment slopes on the sides of the promontory will be treated with erosion control plantings.
- **New Boat Ramp and Peninsula Park**. The Master Plan includes development of new parks on Metropolitan Park District land, including a day-use park on the breakwater peninsula, and renovation of the boat ramp/boat launching facility near the existing Washington State ferry dock. Park areas will consist of a combination of paved and turf areas, with some plant beds and a few smaller park structures. Site development plans do not call for any change in the future use or operation of the Yacht Basin.

- **Re-vegetated Steep Slopes**. As part of site cleanup, Asarco will establish vegetative cover on slopes facing Commencement Bay. The re-vegetation effort will meet EPA requirements for capping steep slopes and will attempt to reestablish the appearance of forested hillsides similar to those to the north and south of the site.
- **Shoreline Restoration and Protection.** Approximately 7 acres of shoreline along the Breakwater Peninsula will be enhanced with clean natural rock riprap and "fish mix" (a substrate that enhances juvenile salmonid habitat). The shoreline adjacent to the entire Facility will be armored and extend to the mean higher high water (MHHW) level to protect the upland low-permeability cap to be constructed under OU 02. A slag beach will be excavated to create 1.2 acres of new intertidal habitat. This will produce a more biologically enhanced and productive habitat.

In addition to the uses identified in the Master Plan, there has recently been discussion by Asarco about the possibility of incorporating residential use into the site development plans. At this time, EPA has not been presented with specific plans for residential use. The appropriateness of residential uses would be subject to evaluation under the requirements of the existing OU 02 ROD. Should residential use occur, it is not expected to affect the remedy for marine sediments and groundwater as addressed by this ROD for OU 06.

6.2 Potential Groundwater Use

Groundwater at the Asarco Facility is not currently used for drinking water or industrial purposes. Groundwater in the shallow and deep aquifer systems is classified as either Class II (potable; not currently used for drinking purposes) or Class III (non-potable due to total dissolved solids [TDS] in excess of 10,000 mg/L). In general, shallow groundwater located within approximately 400 to 500 feet from the shoreline has TDS concentrations greater than 10,000 mg/L and is therefore deemed Class III. Shallow groundwater in certain areas located further than approximately 400 to 500 feet from the shoreline has TDS concentrations less than 10,000 mg/L. However, there are no known water-bearing zones of adequate transmissivity in the shallow aquifer system to provide dependable and significant yield to a water production well.

Based on the monitoring wells screened in the deep aquifer, TDS concentrations in the deep aquifer are less than 10,000 mg/L indicating Class II groundwater. The former Asarco water production well (abandoned and sealed in 1994) was screened in the deep aquifer indicating this water-bearing zone is adequately transmissive to yield significant quantities of water.

Based on the proposed plans listed earlier in this section, there is no reason to believe that site development will alter the classification or potential use of groundwater in the shallow or deep aquifer systems. Drinking water for the Asarco Facility and for the surrounding residential and commercial areas is, and will continue to be, supplied by Tacoma Public Utilities.

6.3 Marine Use

The Site is not commonly used for recreational harvesting of shellfish and finfish. A recreational salmon fishery is located offshore of the northern portion of the Breakwater Peninsula. In addition, usual and accustomed fishing for the Puyallup Tribe occurs in this area. Recreational boating services are provided by the Tacoma Yacht Club and the Breakwater Marina. Marine sediment conditions will be preserved and restored and will continue to provide habitat for biological resources. Present and future recreational, commercial, and tribal fishing will continue.

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7 Summary of Site Risks

Baseline risk assessments were performed as part of the RIs for OUs 02 and 06 to address both human health and ecological risks. A baseline risk assessment estimates what risks a site poses if no actions are taken. It provides the basis for formulating and implementing an action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessments performed for the Site. Section 7.1 summarizes the human health risk assessment findings including risks from groundwater and seafood ingestion. Section 7.2 discusses the ecological risk assessment findings including risks to aquatic receptors from groundwater and sediments.

7.1 Human Health Risk Assessment

Separate human heath risk assessments were performed for groundwater and marine sediments. Potential health risks associated with all site media (including groundwater) were addressed in a risk assessment performed for the upland portion of the Facility (Kleinfelder, December 1992). The 1992 risk assessment was completed in accordance with national and regional EPA risk assessment guidelines in effect at the time. The 1992 risk assessment evaluated potential risks from exposure to contamination in soil, slag, surface water, air, and groundwater. The findings of the 1992 risk assessment pertinent to groundwater are summarized in Section 7.1.1.

Section 7.1.2 discusses a seafood ingestion study (Roy F. Weston, October 1996) that was conducted as a supplement to the CB/NT RI/FS and included sediment chemical and biological data collected by Asarco. Additional chemical and biological data from the expanded RI/FS were also used to evaluate potential contaminant effects and associated risks to subsistence and recreational fisherpersons who may ingest fish from the waters adjacent to the Site.

7.1.1 Groundwater Risks

The risk assessment identified chemicals of concern (COCs) in groundwater based upon a screening evaluation that compared the maximum concentration a chemical detected in groundwater to a health-based concentration. The screening evaluation was based on the frequency of detection, toxicity, persistence, and mobility of these COCs.

COCs in groundwater that potentially present risk to human health were also evaluated under two scenarios. First, for groundwater classified as potable (i.e., Class II groundwater), the COCs were evaluated by comparison to drinking water criteria. This resulted in the selection of antimony, arsenic, beryllium, cadmium, chromium, copper, lead, manganese, nickel, and silver as COCs. Second, for groundwater not suitable for drinking due to total dissolved solids (TDS) content higher than 10,000 mg/L (i.e., Class III groundwater), the COCs were selected for their potential to migrate into Commencement Bay and impact humans who might consume seafood (i.e., via groundwater discharge and bioaccumulation in marine life). Seven metals (arsenic, beryllium, copper, lead, manganese, mercury, and zinc) were selected as COCs for the second scenario.

Potential human health impacts associated with ingestion of or direct exposure to groundwater were estimated for a hypothetical residential setting and for industrial and commercial workers. The risk assessment results showed that estimated cancer risks and non-cancer health effects from the Site are the highest under the residential use scenario from drinking Site groundwater. Hypothetical residents exposed to the maximum groundwater concentration from birth to age 30 (the reasonable maximum exposure or RME) have total excess cancer risks on the order of 10^{-3} to 10^{-1} and noncarcinogenic hazards of 8 to 1,019 depending on the area of the Site. Risks from drinking water, however, were second to soil ingestion risks for all receptors. Drinking water was only evaluated quantitatively at the wells where the two highest carcinogenic and noncarcinogenic risks were located. Arsenic is responsible for virtually 100 percent of the carcinogenic risk in groundwater with an excess cancer risk of 4×10^{-2}, and 90 percent of the noncarcinogenic hazard (total hazard index of 181).

Potential acute hazards from fish exposed to chronic, undiluted concentrations in groundwater were also considered in the human health risk evaluation of groundwater. Results of a screening comparison showed hazards to recreational fisherpersons from four metals: arsenic, mercury, manganese, and beryllium.

Human health risks associated with dimethylaniline (N,N-dimethylaniline or DMA) and related breakdown products (methylaniline [N-methylaniline] and aniline) were evaluated qualitatively in the 1992 risk assessment. As stated in Section 5.4.1, DMA-related compounds occur in Class III groundwaters at the Site. The risk assessment acknowledged that such groundwater is not suitable as a drinking water source. However, the Class III groundwater was considered a hypothetical drinking water pathway for purposes of assessing risks associated with DMA and related compounds. The human health threat was found to be low. Further, exposure and hazards to recreational fisherpersons due to the release of DMA to Commencement Bay by the discharge of Class III groundwater from the Facility was also found to be minimal (Kleinfelder, December 1992).

The complete human health risk assessment is presented as Appendix M of the RI report (Hydrometrics, August 1993). A summary of the 1992 risk assessment is also presented in Section 6 of the 1995 ROD for OU 02 (EPA, March 1995).

7.1.2 Seafood Ingestion Risks

A human health screening risk assessment was performed to address risks attributed to consumption of fish taken from waters at and adjacent to the Site (Roy F. Weston, October 1996). It was assumed that human consumption of fish was the most likely and only route of exposure associated with contaminated sediment and surface waters of Commencement Bay. Only ingestion was considered because dermal contact with the sediments or respiratory exposure to sediment vapors was considered improbable for saturated sediments. It was also assumed that fishing for demersal resident finfish (e.g., sole, sculpin, etc.) would be similar to the fishing opportunities and access provided at the public pier (south of the Asarco Facility on Ruston Way). Salmon were not addressed, as these fish are transient and mobile.

Samples of rock sole (whole body and fillets) were collected from five areas near the Asarco shoreline as well as from one reference area near Brown’s Point. Rock sole were selected because they are one of the few species that could be readily obtained at the Site and are year-round residents within the area. All of the samples were analyzed for several metals. The samples from Brown's Point were used to represent background conditions and assess if concentrations of metals in the fish from the water offshore of Asarco are above background levels. Because the sample fish catch was limited and because only one background sample was available, this assessment was considered a screening analysis.

Tables B-10 and B-11 in Appendix B summarize the chemical concentrations detected in the sole body and fillet tissue respectively. The inorganic arsenic level in the Brown's Point sample (0.034 mg/kg) was less than the average of the five samples (0.056, range of 0.022 to 0.083 mg/kg) collected from the waters at and adjacent to the Site, but it was higher than and/or comparable to the level found in two of the five individual Asarco samples (0.022 and 0.038 mg/kg). Arsenic was the only metal evaluated in the risk assessment because it was the only contaminant detected in all of these fish samples that exceeded its respective risk-based screening concentration developed by EPA Region III (EPA, October 1995).

For the risk assessment, cancer risks and non-cancer health impacts from inorganic arsenic were estimated using the maximum fish concentration found in the five samples. This maximum arsenic concentration was then used to assess the risk associated with a range of fish ingestion rates (e.g., ingestion rates for subsistence and recreational fisherpersons). The low end of this range (1 gram per day of fish) was selected to represent the consumption of an infrequent sports fisherperson, who might eat fish from the waters at and adjacent to the Site a few times a year. A high-end assumption (292 grams per day of fish over 24 years; 350 days per year) was selected to represent the consumption of a subsistence fisherperson.

The potential non-cancer health impacts were evaluated by comparing the exposures calculated from eating fish to EPA's Reference Dose (RfD). The RfD represents an exposure level that an individual may be exposed to without experiencing any health impacts. All of the exposures, using the range of ingestion rates (infrequent sports fisherperson ingesting 54 grams/day to subsistence fisherperson ingesting 292 grams/day), were below the RfD for both the Site and reference samples. Therefore, non-cancer health impacts from eating finfish are considered unlikely.

The potential cancer risks estimated for the sports fisherperson from eating fish taken from waters at or adjacent to the Site was about $6x10^{-6}$, while the potential cancer risks for the subsistence fisherperson was estimated to be approximately $2x10^{-4}$.

A risk assessment was also done using the Brown's Point reference sample. The estimated cancer risk for a subsistence fisherperson for this reference sample was approximately $7x10^{-5}$. Therefore, the cancer risks from consuming fish taken from waters at or adjacent to the Site appear to be slightly higher than that from consuming fish from the reference area. This conclusion, however, is somewhat uncertain because of the limited sampling done in the reference area.

7.1.3 Summary of Human Health Risk Uncertainties

Every aspect of a risk assessment contains sources of uncertainty. "Typical" risks are calculated as a comparison to provide conservative estimates. Some of the uncertainties for the human health risk assessments result from the following factors:

- The amount and type of fishing that may occur at the Site in the future is uncertain.
- The assumption that cancer risks are higher at the Site may be a disputed conclusion because comparable sampling data available for the reference area is limited.
- In the human health risk assessment for sediments, health-protective assumptions (e.g., subsistence ingestion rates, maximum fish contaminant levels) were used to estimate the potential cancer risk and non-cancer health impacts. The impacts from consuming rock sole from the water adjacent to the Site are believed to be conservative.
- There is a lack sample data representing additional species of finfish and other aquatic life from near the Site that may be consumed by humans.

7.2 Ecological Risk Assessment

Ecological risk was evaluated by the Asarco Sediment/Groundwater Task Force. Sections 7.2.1 and 7.2.2 describe the associated findings for groundwater and sediments, respectively.

7.2.1 Groundwater

As addressed in Section 5.1.1, Site groundwater ultimately discharges to Commencement Bay. Therefore, possible groundwater-related risks to aquatic life in the waters and marine sediments of Commencement Bay were evaluated.

In 1996, the Asarco Sediment/Groundwater Task Force was formed to conduct additional evaluations related to groundwater and its potential impact on the aquatic life in Commencement Bay. The Task Force, consisted of personnel from EPA, Ecology, National Oceanic and Atmospheric Administration (NOAA), and other Trustee agencies. Specifically, the Task Force considered possible effects of metals loading to marine sediments and bay waters under both pre- and post-remediation conditions.

The RI/FS process considered a wide range of organic compounds and metals that could potentially affect ecological receptors. With respect to organics, the RI and post-RI groundwater monitoring determined that, with the exception of compounds related to DMA (e.g., aniline) present in the Southeast Plant/DMA area, organic constituents are detected infrequently and typically at low concentrations (See Section 5 and Appendix A). The risk assessment work conducted during the RI indicated that DMA-related compounds do not accumulate in fish and have a negligible contribution to human health risk. Monitoring data collected over the years since the RI indicate that the concentrations of DMA-related compounds decrease to very low or non-detectable levels before they reach Commencement Bay. Organic constituents are therefore not considered COCs for OU 06, due to their isolated numbers and distribution, low concentrations near the shoreline, and negligible risk.

Specific inorganics in groundwater have been regularly evaluated through the RI/FS process and the post-RI groundwater monitoring program. Most recently, the Asarco Sediment/Groundwater Task Force re-assessed the list of COCs by reevaluating the following metals: arsenic, cadmium, copper, lead, nickel, and zinc. Based on modeling and post-RI monitoring data, the Task Force determined that arsenic and copper represent the primary COCs for groundwater discharging to Commencement Bay (Hydrometrics, April 1999).

The findings of the Task Force regarding the impact of groundwater on the sediments and waters of Commencement Bay are summarized as follows:

- Under current (pre-remediation) conditions, metals loading (in particular arsenic and copper) to Commencement Bay by groundwater and surface water discharges results in potential risks to aquatic organisms in the water column as indicated by exceedance of applicable water quality criteria.
- Contaminants present in marine sediments at the Site are believed to be primarily associated with historical contaminant sources other than groundwater (e.g., historical surface water discharges and erosion and deposition of slag particles). However, the Task Force did not attempt to quantify the importance or magnitude of these historical contaminant sources.

7.2.2 Sediment

Based on information obtained during the Asarco Remedial Investigation (RI), EPA recognized that the Asarco OU 06 Site had characteristics that set it apart from other Operable Units in the Commencement Bay/Nearshore Tideflats area. Asarco sediments are different from most other sediments in Commencement Bay due to the presence of slag. Slag has high concentrations of metals, but these metals are bound in a rock-like form, which are not necessarily available to the benthic community. Therefore, the sediment chemistry could have high concentrations, yet the biological community could be healthy. This difference was first noted in the Commencement Bay/Nearshore Tideflats ROD (EPA, September 1989) and later in the Upland Smelter Facility ROD (EPA, March 1995). The difference was further addressed by the Sediment Design Group, with representatives from EPA, Ecology, and NOAA.

Supplemental marine sampling and analyses conducted at the Asarco Sediments Site (OU 06) in 1989 and 1990 more clearly defined the peripheral areas where biological effects were observed (Parametrix, 1990 and 1991). An additional supplemental marine survey determined that benthos in the Yacht Basin were exhibiting toxic effects; however, it could not be determined what caused these effects. EPA produced a Supplemental Feasibility Study (SFS) that was based on this previously collected data (Roy F. Weston, October 1993).

To further define the areas and types of chemicals associated with potential contaminant effects, EPA, Asarco, and agencies participating in the Asarco Sediment/Groundwater Task Force agreed that an expanded RI/FS should be conducted. The chemical and biological data used to complete the SFS and the Expanded RI/FS investigations were obtained from 62 sampling stations in the offshore area (Figure 5-10). EPA used the data from these 62 sampling stations to characterize potential ecological risks as presented in the *Ecological Risk Assessment* and *Seafood Consumption Screening Risk Assessment* (Roy F. Weston, October 1996).

All of the data and evaluation measures were correlated and used in a "preponderance-of-evidence" approach to more fully identify current and potential impacts and risks to aquatic receptors. Because of the presence of slag, the bulk sediment chemistry results may not be representative of the actual toxicity of the sediments. Based on this difference between sediments at the Asarco Sediments Site and most other sediments in Commencement Bay, the Sediment Design Group relied upon best professional judgement, and gave greater weight to the benthic evaluation than to the chemistry and bioassay data. Table C-1 in Appendix C presents a summary of the chemical and biological factors that were used to define potential ecological risk. This was accomplished by developing a range of possible impacts that were based in part upon state SMS biological and chemical criteria. A total of five impact categories were assigned to the Site. The locations of these five categories are plotted by sediment station in Figure 7-1. The relative locations of the categories at the Site were then assembled into three zones called Impact Stations, which are described as follows:

- **Non-Impacted/Minimally Impacted Stations.** Approximately 61 percent of the stations are within the non-impacted/minimally impacted stations (Figure 7-1). The non-impacted and minimally impacted stations fall into three subcategories:
    - Stations that are considered to be currently unimpacted and pose no potential future risks to the aquatic organisms (e.g., fish and other bottom-dwelling animals) because contaminant concentrations were below state SQS.
    - Stations that are considered to have no current impacts, but may have impacts in the future (i.e., these stations have chemical concentrations greater than state standards but biological testing showed no adverse impacts).
    - Stations that have a current minimal impact and may have impacts in the future (i.e., these stations had minor biological CSL exceedances, but no chemical CSL exceedances).
- **Moderately Impacted Stations.** Moderately impacted stations are those that have a limited number of adverse biological impacts (i.e., a bioassay result indicated an impact of benthic abundance in a sediment sample that was significantly different from a reference sample), but the overall health of the biological community does not appear to be substantially impacted. For example, there were stations that had chemical and bioassay exceedances above corresponding SMS criteria, but a healthy biological community. These stations included approximately 28 percent of the locations sampled (Figure 7-1).
- **Severely Impacted Stations.** Stations were considered severely impacted when sediment chemical concentrations exceeded CSLs and multiple biological impacts (e.g., more than one biological test exhibited a significant effect) were observed. In addition, every station that had a benthic community structure that indicated a stressed environment was included in this category. Approximately 11 percent of the stations (170,000 square yards or approximately 35 acres) exhibited these characteristics. The severely impacted stations are shown in Figure 7-1.

7.2.3 Summary of Ecological Risk Uncertainties

As mentioned previously, every aspect of a risk assessment contains sources of uncertainty. The uncertainties associated with the ecological risk assessment are summarized as follows:

- The chemical analytical laboratory detection limits differed over time.
- The bioassay laboratory sample handling methods and testing procedures differed over time.
- Ample benthic data from site investigations are not available.
- Sample results were assumed to represent conditions over larger areas than the samples that were collected.
- The benthic community was assumed to be continuously exposed to a prescribed level of contaminants, even though there is variability in contaminant distribution at the Site.
- Bioassays, since they are performed in a laboratory, do not necessarily represent Site conditions.
- There were small variations observed between the reference area conditions and Site conditions.

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8 Remedial Action Objectives

The groundwater and sediment investigations for OU 06 have identified contamination from the release of hazardous substances to the environment that may present an imminent and substantial endangerment to public health, welfare or the environment. The need for action was determined based on the results of the human health and ecological risk assessments. In addition, contaminant levels in groundwater exceed Washington State's Model Toxics Control Act (MTCA) standards and marine water SQSs and marine sediments are contaminated at levels above the state SMS. The remedial action objectives (RAOs) for OU 06 are presented below.

8.1 Groundwater

EPA's RAOs for groundwater are as follows:

- Prevent ingestion of groundwater containing contaminant concentrations above federal maximum contaminant levels (MCLs) or above risk-based goals for those substances for which MCLs have not been established and prevent direct contact with groundwater containing contaminant concentrations above applicable risk-based goals.
- Prevent discharge to Commencement Bay of groundwater containing contaminants at concentrations exceeding applicable marine surface water quality standards, risk-based levels protective of human health, or background concentrations (if background concentrations are higher than the applicable standards).

The RAOs for groundwater are based on the intended site development uses described in Section 6 and consistent with applicable or relevant and appropriate requirements (ARARs) described in Section 13.

The first RAO for groundwater protects human health by limiting groundwater ingestion and contact. In particular, the RAO addresses the potential risk associated with human exposure to arsenic, the primary human health risk driver identified in the risk assessment (Section 7.1).

The second RAO protects marine life in Commencement Bay by limiting contaminants in groundwater such that marine chronic criteria are not exceeded at the point of groundwater discharge to marine waters. In addition, risk to human health through the fish consumption pathway is addressed by limiting the concentration of contaminants available to marine organisms.

Specific groundwater cleanup levels protective of human health and the environment are discussed in Section 12.

8.2 Sediment

EPA's RAO for sediment is as follows:

- Restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above Washington State SMS (WAC 173-204).

The RAO for sediment is based upon predicted offshore uses as described in Section 6 and is consistent with ARARs (see Section 13).

The RAO protects human health by restricting and limiting contaminant concentrations available to marine biological resources that could be a source of seafood for recreational and subsistence users.

The RAO protects marine life in the sediments of Commencement Bay by limiting exposure to contaminated sediments by capping and dredging and by inhibiting discharge of contaminated groundwater to the bay.

Sediment cleanup levels that are protective of human health and the environment are discussed in Section 12.

9 Description of Alternatives

The various feasibility study documents prepared by Asarco and EPA identify a range of alternatives to address the Sediments/Groundwater OU 06. These alternatives include active cleanup options (e.g., capping and dredging) and institutional controls (e.g., limiting access).

An Operation, Maintenance, and Monitoring Plan (OMMP) is necessary to ensure the continued effectiveness of any remedy. Important components of the OMMP include maintaining the integrity of the remedy and monitoring the sediments to verify they are meeting the RAOs. Expectations for this long-term monitoring program are summarized in Section 12 of this document; a detailed OMMP will be prepared in parallel with the remedial design/remedial action (RD/RA) process, with a final long-term monitoring program in place by the time the remedial action is complete.

9.1 Groundwater

The groundwater alternatives discussed in this section were originally presented in the *Asarco Plant Feasibility Study* for OU 02 (Hydrometrics, August 1993). The alternatives addressed in the 1993 FS were reviewed again in 2000 in light of groundwater information that has become available in the intervening seven years (see *Historical Summary of the Evaluation of Groundwater Remedial Alternatives*; Hydrometrics, June 2000). Certain elements of the groundwater alternatives presented here are actually part of the Selected Remedy identified in the 1995 ROD for OU 02 (EPA, March 1995). For example, contaminant source removal, surface water controls, and site capping are part of the Selected Remedy for OU 02. Although these remedy elements are required to meet the RAOs for OU 02, they also directly benefit the OU 06 groundwater present immediately beneath OU 02. Specifically, these OU 02 remedy elements will minimize transfer of contaminants from source materials to groundwater and reduce the contaminant load discharged to Commencement Bay through groundwater. See Section 4 of this ROD for more information on the relationship between the four OUs associated with the Asarco Facility, including the close relationship between OUs 02 and 06.

Table 9-1 presents four remedial action alternatives identified for OU 06 groundwater. As discussed above, this list is based on alternatives that were first identified in the 1993 FS and later refined in the *Historical Summary of the Evaluation of Groundwater Remedial Alternatives* (Hydrometrics, June 2000).

9.2 Sediment

In evaluating cleanup action alternatives, the EPA relied on the SMS that considers net environmental impacts, technical feasibility, and cost (WAC 173-204-570(4)). Based on the unique nature of slag (i.e., metal contamination not necessarily available to the biological community), and as the benthic community is a good measure of the health of the sediment ecosystem, the benthic results were used to identify the most highly impacted areas where remedial action is necessary. The severely impacted sediment stations (Figure 7-1) are identified as the "Contaminant Effects Area" (Figure 9-1). Active remediation is necessary in the Contaminant Effects Area.

The presence of relatively healthy benthic communities in areas outside of the Contaminant Effects Area suggests that active cleanup outside of the Contaminant Effects Area may not be appropriate. Active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated. The moderately impacted sediment stations (Figure 7-1) are identified as the "Moderate Impact Area" (Figure 9-1) and will not receive active remediation. Monitoring is deemed the most appropriate action for the Moderate Impact Area.

Five general remedial action alternatives were considered for the marine sediments in the Contaminant Effects Area. These were:

- No action—No action is taken.
- Natural Attenuation—Reliance on natural deposition of clean sediment over time to cover the contaminated sediment.
- Capping—Covering contaminated sediments with clean material to prevent exposure of humans and marine organisms to contaminants.
- Dredging and Nearshore Confinement—Dredging of contaminated sediment and placement of spoils in a nearshore confined aquatic disposal (CAD) facility.
- Dredging and Upland Disposal—Dredging of contaminated sediment and placement of spoils under the low-permeability upland cap being constructed as part of the remedial action for OU 02.

The Contaminant Effects Area was divided into different remediation areas (Nearshore/Offshore, Yacht Basin, Northshore, and the Breakwater Peninsula), as shown in Figure 9-2. The areas were identified based on the specific characteristics of each remediation area and the potential ability to implement sediment cleanup technologies in those areas. The alternatives considered for the Nearshore/Offshore, Yacht Basin, and Northshore areas are summarized in Tables 9-2 through 9-4. The following discusses the remedial action alternatives that are not suitable for a particular remediation area, including the impracticability of remediating sediments offshore of the Breakwater Peninsula.

9.2.1 Nearshore/Offshore and Northshore Area

All five cleanup technologies listed above are considered possible in the Nearshore/Offshore and Northshore areas (Tables 9-2 and 9-4).

9.2.2 Yacht Basin

Due to navigation concerns, capping was not considered possible for the Yacht Basin (Table 9-3) because a sediment cap would decrease the depth of the waters and potentially interfere with marine navigation.

9.2.3 Breakwater Peninsula

The Breakwater Peninsula area comprises the sediments east of the Breakwater Peninsula (Figure 9-2), which is approximately 85,000 square yards or 17.5 acres. The sediment depth off the Breakwater Peninsula in some areas is almost 100 feet deep (within 200 feet from shore). The subtidal slope in this area can be up to 50 percent. The stability of a cap on such steep slopes is questionable, and the construction of a nearshore facility on such a slope would be very difficult (e.g., making a berm stable on a steep slope is difficult). In addition, dredging is not possible because the entire peninsula would need to be removed to provide a post-dredging slope that is flat enough to be stable. Although capping or dredging of the Breakwater Peninsula is not feasible, shoreline armoring will be placed in the intertidal areas where possible, as part of the OU 02 remedy. This will greatly reduce the erosion of slag in this high-energy area.

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10 Summary of Comparative Analysis of Alternatives

Nine criteria have been used to evaluate the different remediation alternatives individually and against each other in order to select a cleanup remedy. A selected remedy must meet the first two "threshold" criteria. EPA uses the next five criteria as "balancing" criteria for comparing alternatives and selecting a preferred remedy, which is presented in the Proposed Plan. After public comment on the Proposed Plan, EPA may alter its preference on the basis of the last two "modifying" criteria.

The nine criteria are summarized below.

Threshold Criteria

1. **Overall Protection of Human Health and the Environment**. How well does the alternative protect human health and the environment, both during and after construction?
2. **Compliance With Applicable or Relevant and Appropriate Requirements (ARARs).** Does the alternative meet all ARARs from state and federal laws? Does the alternative qualify for an ARAR waiver?

Balancing Criteria

3. **Long-Term Effectiveness and Permanence**. How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the Site?
4. **Reduction of Toxicity, Mobility, or Volume Through Treatment**. Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substance?
5. **Short-Term Effectiveness**. Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative? How fast does the alternative reach the cleanup levels?
6. **Implementability**. Is the alternative both technically and administratively feasible? Has the technology been used successfully on other similar sites?
7. **Cost**. What are the estimated costs of the alternatives?

Modifying Criteria

8. **State/Tribal Acceptance.** What are the state's and tribes' comments or concerns about the alternatives considered and about EPA's Preferred Alternative? Do the state and tribes support or oppose the preferred alternative?
9. **Community Acceptance**. What are the community's comments or concerns about the Preferred Alternative? Does the community generally support or oppose the Preferred Alternative?

The remainder of this section addresses the remediation alternatives listed in Section 9 in the context of the nine criteria.

10.1 Overall Protection of Human Health and the Environment

10.1.1 Groundwater

All of the groundwater alternatives, except the no action alternative, are protective of human health. Institutional controls will prohibit the use of contaminated groundwater at the Facility. The groundwater discharging to Commencement Bay may exceed the National Toxics Rule (NTR) for fish consumption (0.14 µg/L for arsenic). However, a risk assessment based on data from fish tissue samples collected during the sediment RI indicates slightly higher risks from Site contaminants to people consuming large quantities of fish from the Site as compared to the Reference site. This risk assessment information is based on pre-remediation conditions where groundwater samples collected from wells adjacent to the shoreline indicate arsenic at concentrations of approximately 10 to 30 µg/L. Thus, any human health risk is expected to decline further after remediation is complete. In addition, contaminant concentrations at OU 06 are expected to be reduced by the cleanup activities. The remedial alternatives involving active groundwater treatment would likely be more protective than capping and groundwater interception (where groundwater is pumped/treated or treated *in situ*) since groundwater contaminant levels will be further reduced. The no-action alternative is not protective of human health and thus is not evaluated further.

At present, the quality of groundwater discharging to Commencement Bay is not considered protective of the environment. Specifically groundwater discharging to the Bay contains metals (primarily copper) in excess of their respective marine chronic criteria. Therefore, the no action alternative is not considered protective. Alternative GW-C (Pump/Treat and Discharge to Outfalls) would likely reduce metal loading to the Bay to acceptable levels with properly located extraction wells. Alternatives GW-D (*In situ* Groundwater Treatment) and GW-E (*In situ* Treatment by Seawater Injection) are best suited to precipitate arsenic by oxidation. However, these alternatives may not effectively reduce copper concentrations because copper becomes more mobile as oxygen levels increase. Alternative GW-B, the Preferred Remedy identified in the Proposed Plan (EPA, January 2000a) is believed to have the greatest likelihood of reducing metals loading to Commencement Bay by minimizing groundwater discharge by an estimated 75 to 95 percent.

10.1.2 Sediment

Protectiveness is based on how clean the remaining surface sediments will be following cleanup. The assumption that lower contaminant concentrations result in higher sediment quality was primarily used to rank the alternatives for overall protection. All of the sediment alternatives, including the No Action alternative, are believed to be protective of human health based on a screening risk analysis (see Section 7.1.2) performed for the Site. The No Action alternative is not protective of the environment and is therefore not further evaluated under the nine criteria. Capping and dredging, however, are expected to achieve EPA's and Ecology's acceptable risk criteria.

Natural Recovery. Natural Recovery was evaluated as part of the RI/FS (Parametrix, December 1996). Evaluations determined that recovery of the sediments to concentrations lower than the cleanup levels would not occur within a reasonable time frame as defined by the SMS (i.e., less than 10 years). Natural Recovery cannot occur within a reasonable time frame because there is not sufficient sedimentation in this area to cover existing contaminated sediment within the 10-year time frame. The Natural Recovery alternatives (S-1B, S-2B, and S-3B [Tables 9-2, 9-3, and 9-4]) are not considered protective of the environment because they would not prevent aquatic organisms from coming into contact with the contaminants for many years, if ever. Therefore, the natural recovery alternatives are not evaluated further under the nine criteria.

Capping Versus Dredging. Capping is the most protective alternative in the Nearshore area, where the depth of contamination is very deep because the shoreline is constructed of slag. Dredging of this area would be difficult due to concerns regarding the stability of subtidal slopes. Furthermore, dredging would inevitably encounter and expose the slag that is impracticable to remove in its entirety. Therefore, the highest degree of protectiveness would be provided by capping the contaminated sediments in the Nearshore, Offshore, and Northshore areas with clean sediment imported from another location (note that the Northshore area may be dredged depending on remedial design considerations).

10.2 Compliance with Federal and State Environmental Standards

10.2.1 Groundwater

Modeling performed by the Task Force indicates that state and federal laws applicable to protection of marine water quality may not be currently achieved in Commencement Bay waters within a few feet of the shoreline for all metals (Hydrometrics, April 1999). Although model results did indicate some metal concentrations above marine chronic criteria, the Task Force placed more emphasis on empirical data rather than model predictions in assessing current and potential impacts from groundwater discharge. The Task Force concluded that with the exception of copper, groundwater discharge currently does not cause metal concentrations to be higher than marine chronic criteria. Under the Alternative GW-B, metals concentrations in groundwater flowing toward the shoreline are expected to decrease in future years in response to the site-wide changes (i.e., reduced groundwater discharge) affected by the cleanup. These changes are expected to allow all groundwater ARARs to be met in the future.

Alternative GW-C (Pump/Treat and Discharge to Outfalls) is likely capable of achieving ARARs at the point of compliance with properly located extraction wells. It is not certain if Alternatives GW-D and GW-E (*In situ* Treatment by Seawater Injection and Pump/Treat and Discharge to Outfalls, respectively) would achieve groundwater ARARs. The Task Force findings suggest that these two alternatives could actually increase the copper loading to Commencement Bay by raising redox conditions in the groundwater system (the mobility of copper increases with the dissolved oxygen content).

10.2.2 Sediment

For sediments, the RAO is to restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above Washington State SMS. An isolating cap would achieve the standards, as long as it stayed in place as a physical barrier and does not become recontaminated. Institutional controls would help ensure that the integrity of the cap is maintained. The dredging/nearshore confinement and dredging/upland disposal alternatives would also meet the standards if all of the contaminated sediments could be removed. Dredging in the Nearshore/Offshore area would be less likely to meet ARARs than dredging in the Yacht Basin, since removing all of the contaminated material in this area would be impossible.

The Clean Water Act Section 404 criteria will be met, including any potential need for mitigation and related Endangered Species Act requirements. This is being addressed as part of the Clean Water Act Section 404 analysis and will be completed concurrently with this ROD.

10.3 Long-Term Effectiveness and Permanence

10.3.1 Groundwater

All of the alternatives will minimize generation of contaminated groundwater by reducing groundwater recharge, flow through contaminated source areas, and ultimately the discharge of contaminants to Commencement Bay. The remedial alternatives involving active groundwater treatment would further lower groundwater contaminant concentrations and, therefore, have the lowest residual risk. However, this benefit is not permanent, as it would occur only as long as the treatment systems were operating. Since most of the onsite slag will not be removed by any of the upland cleanup activities, the slag will continue to contribute contaminants to groundwater indefinitely. Therefore, reduction of surface water infiltration and groundwater flow to Commencement Bay is critical to making the Selected Remedy effective as a long-term protection of human health and environment. The *in situ* groundwater treatment and seawater injection alternatives may be less reliable than the pump and treat alternative because these treatment technologies are generally less proven. These latter treatment methods may not be necessary if effectiveness can be achieved with groundwater and surface water flow reductions combined with selected contaminant source removals.

10.3.2 Sediment

Removing contaminated sediment and consolidating it upland is considered more reliable than capping in place because removal and placement results in a smaller and more controlled area of contaminated sediments. In addition, an engineered *upland* disposal facility is easier to inspect, monitor, and maintain than a larger aquatic capped area or aquatic disposal site. Therefore, the greatest degree of long-term effectiveness is provided by dredging the contaminated sediments (assuming all contamination can be removed) and placing them on the upland Facility. In those areas where all contaminated material cannot be removed (i.e., the Nearshore area), *in situ* capping is best. In these areas, a cap can be designed with appropriately sized material such that it provides long-term isolation of the contamination (i.e., it remains in place and does not wash away with wave action or ship traffic and does not become recontaminated), while providing acceptable aquatic habitat. The cap would also be monitored regularly to ensure it is being effective.

10.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

10.4.1 Groundwater

All of the groundwater alternatives, including GW-B, would reduce the toxicity, mobility, and volume of contaminants through treatment. Groundwater intercepted at the On-Site Containment Facility and Stack Hill will be routed through the surface water treatment system, as required, before being discharged to Commencement Bay. The *in situ* treatment and seawater injection treatment alternatives would promote chemical precipitation of arsenic from groundwater, thereby reducing the arsenic load reaching Commencement Bay. Because all alternatives include capping, groundwater interception, and replacement of leaking subsurface water lines, the mobility of the contaminants and volume discharged to Commencement Bay is expected to be reduced by an estimated 75 to 95 percent.

10.4.2 Sediment

None of the alternatives involve treatment of the sediments. Treatment is not proposed for the sediments for several reasons. First, in order to treat the sediments, they must be removed. This is difficult in the Nearshore/Offshore area of OU 06 since the contaminated sediments are located in waters up to approximately 150 feet deep. Therefore, the chance of leaving contamination behind is very high. Second, since slag was poured to create the shoreline in portions of the Nearshore area, dredging in this area would be difficult due to slope stability issues. Third, the net benefit of treating the sediments is questionable as slag particles within the sediment matrix are already in a relatively immobile form (e.g., the slag does not tend to be bioavailable). Fourth, costs associated with treatment of the Yacht Basin sediments prior to upland containment above the groundwater table and under a low-permeability cap would be disproportionate to the incremental benefit that may be achieved if the sediments were contained under an upland cap without treatment.

10.5 Short-Term Effectiveness

10.5.1 Groundwater

All of the alternatives present minimal risks to the community and workers during cleanup. Similarly, all of the alternatives have minimal short-term environmental impacts. Best Management Practices (BMPs) would need to be implemented during construction for all alternatives. To limit the short-term impacts, implementation of any of the groundwater alternatives must be coordinated with the other upland cleanup actions. All of the alternatives therefore would require several years to construct, and several years are expected for there to be a noticeable improvement in groundwater quality.

10.5.2 Sediment

Short-term environmental impacts include water quality impacts, exposure of marine life to contaminants, and habitat loss (i.e., fisheries impacts) during the implementation of the remedial alternative. Remedial alternatives that involve dredging contaminated sediments would result in a potential for deleterious water quality and fisheries impacts (due to disturbance of contaminated sediment), human exposure to contaminants, and possible worker injury/exposure resulting from the use of dredging equipment. Remedial alternatives that involve capping contaminated sediments and constructing a confined aquatic disposal area would result in short-term loss of aquatic habitat due to covering the currently existing benthic community. These alternatives also have a potential to suspend contaminated sediment. Overall, capping has the greatest short-term effectiveness (e.g., the least short-term impact) because it requires the least amount of in-water work, and the contaminated material is not significantly disturbed. Dredging and construction of a nearshore facility would have the greatest short-term impacts due to the extensive in-water work required.

Although all these alternatives have short-term impacts, much of the short-term risk associated with both dredging and capping can be significantly reduced by carefully choosing methodology and BMPs (e.g., controlling the dredge depth and speed of dredging, controlling the rate of placement of cap material).

10.6 Implementability

10.6.1 Groundwater

Compared to the others, the Alternative GW-B is most easily implemented. The pump and treat alternative would be the most difficult to construct and operate since very large quantities of groundwater would require pumping and treatment (i.e., it is estimated that hundreds of gallons per minute would be required due to the incidental capture of seawater by the extraction system). However, pump and treat technology is reliable and available. The remedial alternatives involving *in situ* groundwater treatment would be easier to construct and operate but are less proven and reliable technologies than pump and treat. The *in situ* treatment alternatives would require pilot testing to confirm their efficacy at the Site. All of the alternatives would require long-term operation, maintenance, and monitoring.

10.6.2 Sediment

Capping and dredging are feasible actions depending on site-specific conditions. Construction of a sediment cap in the Nearshore/Offshore area would occur in relatively shallow water with modest subtidal slopes. The results of the pilot cap study (Parametrix, February 2000) indicate that capping in this area can be accomplished without unusual difficulty. Similar conditions exist in the Northshore area and placement of a sediment cap in that area is also considered feasible.

Dredging is infeasible in the Nearshore/Offshore area for several reasons. First, when the slag was poured, it solidified vertically in some areas, such that sediment removal in these areas could destabilize the bank (i.e., undercut some upland portions of the Facility). Second, if all slag were removed, a cutback of 60 to 120 feet of material would be required, making removal of the entire Breakwater Peninsula necessary. Due to the slag depth of the Breakwater Peninsula (up to 125 feet), removal of this entire peninsula is not considered a viable option. The Yacht Club facilities and parking lot located on the Breakwater Peninsula also prohibit dredging of the Nearshore/Offshore area. Placement of a sediment cap in the area offshore of the Breakwater Peninsula is also impracticable for reasons discussed in Section 9.2.3.

The Yacht Basin has relatively shallow water and gentle subtidal slopes such that dredging in this area can be accomplished. However, the presence of piers and pilings may slow the work and require the use of hand operated suction dredge equipment. A nearshore confined aquatic disposal (CAD) facility is also feasible but would require more engineering controls. Confined upland disposal of sediment at OU 02 would be more easily implemented than the nearshore confinement alternative because the upland work is already underway and space has been made available under the OU 02 low-permeability soil cap.

10.7 Cost

Cost estimates presented in this ROD are intended to be accurate within a range of +50 to -30 percent. Cost estimates are provided in Tables 9-1 through 9-4.

10.7.1 Groundwater

Aside from the no action alternative (GW-A), Alternative GW-B is the least costly ($1.8 million). The *in situ* groundwater treatment alternatives (GW-D and GW-E) are similar in cost ($4.3 million and $4.4 million, respectively). The pump and treat alternative (GW-C) is most expensive ($37.8 million).

Note that additional groundwater interception at the upgradient end of the Facility (southeast of Cooling Pond and Southeast Plant Area, see Figure 5-1) is technically possible under Alternative GW-B. However, Asarco has demonstrated that intercepting additional groundwater at the southwest (uphill) side of the Facility could only be done at a cost that is disproportionately high compared to the limited incremental environmental benefit expected.

10.7.2 Sediment

Nearshore/Offshore Area. For the Nearshore/Offshore area, dredging with upland disposal (Alternative S-1E) is the most expensive alternative at $26.2 million. Capping (Alternative S-1C, $11.6 million) is slightly less costly than dredging with nearshore confinement in a CAD (Alternative S-1D, $12.8 million).

Northshore Area. For the Northshore area, dredging with nearshore confinement in a CAD (Alternative S-3D) is the most expensive alternative at $0.86 million. Dredging with upland disposal (Alternative S-3E, $0.70 million) is slightly less costly than capping (Alternative S-3C, $0.74 million).

Yacht Basin. For the Yacht Basin, dredging with upland disposal (Alternative S-2D, $3.6 million) is less costly than dredging with nearshore confinement in a CAD (Alternative S-2C, $5.1 million).

10.8 State/Tribal Acceptance

Ecology staff have reviewed this ROD with respect to governing state statutes and regulations administered by Ecology. Ecology concurs with the Selected Remedy as identified in this ROD.

The Native American tribes have participated in the review of certain major Site documents. No tribal comments were received on the Proposed Plan. It is EPA's assumption that tribal representatives are in general agreement with the Preferred Remedy identified in the Proposed Plan.

10.9 Community Acceptance

EPA received written or verbal comments on the Proposed Plan from a few individuals and from Citizens for a Healthy Bay (see Part 3, Responsiveness Summary). The comments did not identify any issues causing EPA to change the core elements of the Preferred Remedy as presented in the Proposed Plan. Other comments were received from state and federal agencies. All comments, with EPA responses, are presented in Part 3 of this ROD. Based on the number and nature of comments received, EPA believes that the Preferred Remedy as identified in the Proposed Plan is acceptable to the public.

11 Principal Threat Waste

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430(a)(1)(iii)(A)). Principal threat wastes include wastes with high concentrations of toxic compounds or wastes that are highly mobile and generally cannot be contained in a reliable manner or would present a significant risk to human health and the environment should exposure occur (EPA, July 1999).

For groundwater and marine sediment at OU 06, the principal threat wastes are the contaminated materials in the six OU 02 source areas, which are identified in Section 5 and Figure 5-1 (the groundwater and sediment themselves are not considered principal threat wastes). The OU 02 source areas are:

- Stack Hill
- Copper Refinery
- Cooling Pond
- Fine Ore Bins Building
- Arsenic Kitchen
- Southeast Plant Area

The principal threat wastes at the Site are addressed by the OU 02 ROD (EPA, March 1995). These materials are being excavated and removed from the subsurface where practicable and placed in the On-site Contaminant Facility as part of the ongoing remedial action for OU 02.

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12 Selected Remedy

The Selected Remedy for OU 06 includes the implementation of the following four alternatives:

- **Groundwater Alternative GW-B**. Source removal, soil capping and surface water controls, groundwater interception/treatment, replacement of leaking subsurface water lines, and institutional controls and monitoring (see Table 9-1). Note that the majority of the remedy elements associated with Alternative GW-B are being addressed by the requirements of the OU 02 ROD (EPA, March 1995). With the exception of stipulating institutional controls and long-term monitoring related to groundwater, this ROD is not requiring additional groundwater remedies over and above those already being implemented under the OU 02 remedial action (see Section 4 for additional information on the relationship between OUs 02 and 06). This ROD also establishes the groundwater RAOs, and identifies the cleanup levels, point of compliance, and long-term monitoring requirements for groundwater.
- **Sediments Remedy S-1C for Nearshore/Offshore Area.** Sediment capping (Table 9-2).
- **Sediments Remedy S-2D for Yacht Basin.** Dredging and upland disposal (Table 9-3).
- **Sediments Remedy S-3C for Northshore Area.** Sediment capping (Table 9-4). Although capping is currently the **Selected Remedy**, dredging will be reevaluated for the Northshore area during the remedial design as described in Section 12.2.

The estimated cost of the **Selected Remedy** is $19.2 million. The estimated $19.2 million cost is divided between groundwater and marine sediment remedies as follows:

Institutional Controls and Long-Term Monitoring Components of Groundwater Remedy (Alternative GW-B)	$1.8 million
Sediments Remedy, Nearshore/Offshore Area (Alternative S-1C)	$11.6 million
Sediments Remedy, Yacht Basin (Alternative S-2D)	$5.1 million
Sediments Remedy, Northshore Area (Alternative S-3C)	$0.7 million
Total	$19.2 million

The details of the selected remedies are described below for groundwater (Section 12.1) and marine sediments (Section 12.2).

12.1 Groundwater

EPA's Selected Remedy for groundwater is Alternative GW-B. Alternative GW-B includes elements currently being implemented under the OU 02 ROD (EPA, March 1995) plus long-term monitoring and institutional control requirements addressed in this ROD. Together, these remedy elements comprise EPA's Selected Remedy for OU 06. This remedy is being selected because evaluations conducted by the Asarco Sediment/Groundwater Task Force indicate that marine sediments and the waters of Commencement Bay will be protected by the remedial actions being implemented under the OU 02 cleanup. Combined with long-term monitoring and institutional controls being added by this ROD, the groundwater remedy is expected to be permanent and to meet the RAOs.

12.1.1 OU 02 Groundwater Remedy Elements

The OU 02 remedy is in progress with substantial completion scheduled for 2003 and final completion expected in 2005. The OU 02 remedy elements applicable to groundwater and included in Alternative GW-B are source excavation and placement in the On-site Containment Facility, site capping and surface water controls, groundwater interception/ treatment, and removal of leaking underground piping. Source control measures will reduce the volume of contaminants that are transferred to the groundwater. Capping, surface water controls, groundwater interception, and removal of leaking pipes is expected to reduce groundwater discharge to Commencement Bay by approximately 75 to 95 percent (Hydrometrics, June 2000).

Source Removal. Excavation of principal threat wastes and contaminated soils from the OU 02 Site and permanent disposal of these materials in an On-site Containment Facility. Source control also includes stabilization of the shoreline to reduce slag erosion and its transport to the waters and sediments of Commencement Bay.

Site Capping and Surface Water Controls. The OU 02 Site (including the Breakwater Peninsula) will be capped with a low-permeability soil cover system to inhibit infiltration of surface water and precipitation. Run-off from precipitation falling on the cap will be captured in onsite surface water drainage systems and discharged to Commencement Bay. The cap surface will include controls to capture and direct surface water to Commencement Bay. Currently, a large percentage of groundwater discharging to Commencement Bay originates from onsite recharge of precipitation and surface water run-on. As part of the remedial action for OU 02, surface water controls will be constructed to capture surface water that would otherwise run onto the Facility from uphill locations and infiltrate into the shallow aquifer system. The captured surface water will be treated as necessary to meet the requirements of the OU 02 ROD (EPA, March 1995), and discharged to Commencement Bay.

Groundwater Interception/Treatment. Subsurface trenches or drains will be installed upgradient of the proposed On-site Containment Facility and railroad tunnel. These subsurface drainage systems will intercept and capture groundwater that would otherwise enter Facility aquifers. By reducing the recharge of Site groundwater, the overall contaminant load transported to Commencement Bay will be reduced. Groundwater captured by the interception trenches and drains will be directed to the Facility's surface water collection system and treated in conjunction with surface water collected as part of operations and maintenance requirements for OU 02. Treatment of the captured groundwater will be subject to the water quality requirements for OU 02 waters being discharged to Commencement Bay.[1]

Removal of Leaking Underground Piping. Leakage from underground stormwater, sewer, water, and fire protection lines is believed to contribute a significant volume of recharge to the shallow aquifer system. These underground lines will be either abandoned (sealed) or removed and replaced with new piping as needed. Some of this work has already been

[1] The design of this OU 02 water treatment system is in progress. Both polymer- and filtration-based systems designed to remove suspended metals from water are being evaluated. The post-treatment quality of the stormwater will not be determined until ongoing engineering studies are complete. However, design criteria call for the water to meet water quality criteria at the boundary of a defined mixing zone in Commencement Bay.

completed. Reduction of groundwater recharge from leaking pipes will reduce the overall contaminant load associated with groundwater discharging to Commencement Bay.

12.1.2 Additional Groundwater Remedy Elements

The Selected Remedy includes two elements not previously addressed in the OU 02 ROD (EPA, March 1995). These remedies are institutional controls and long-term, post-remedial action monitoring.

Institutional Controls. Institutional controls for groundwater will include restrictions on groundwater use for domestic or industrial purposes. The objective of the prohibition is to prevent human exposure to contaminated groundwater. This will be achieved by prohibiting the drilling of water wells (other than for environmental monitoring or treatment) and prohibiting the use of groundwater as a drinking water source. Specifically, no water wells will be permitted in the shallow and deep aquifer systems. The prohibition on groundwater use is expected to be in force into perpetuity for shallow groundwater (slag, marine sand, and intermediate aquifers) because source materials (e.g., slag) will remain in place and in contact with shallow groundwater, under the terms of the OU 02 ROD (EPA, March 1995). Therefore, these source materials will continue to be in direct contact with groundwater. A prohibition on use of deep aquifer groundwater will also be implemented by this ROD until such time groundwater quality complies with applicable health-based criteria (e.g., maximum contaminant levels). Prohibitions on groundwater use would only be rescinded or relaxed if groundwater contaminants no longer exceed acceptable levels as determined by EPA. The prohibition on groundwater use may be implemented through a combination of governmental controls (e.g., zoning restrictions or ordinances) and enforceable use restrictions that run with the land (e.g., a servitude or an easement that includes use restrictions and is properly recorded).

Long-Term Post-Remedial Action Monitoring. Long-term groundwater monitoring will occur on a regular basis after the remedial action is complete. The objective of the monitoring program will be to assess the performance of the Selected Remedy over time and to verify that the remedy continues to be protective of human health and the environment. At a minimum, monitoring wells at the downgradient perimeter of the Site (along the Commencement Bay and Yacht Basin shorelines) will be monitored. Monitoring wells upgradient of the Site and near key source areas (or former source areas) will also be required. Monitoring nearshore surface water in Commencement Bay will be required to assess impacts that discharging groundwater may have on the bay water.

Details of the groundwater monitoring program will be presented in the OMMP. At a minimum, post-remedial action groundwater monitoring will include measurement of the following:

- Static groundwater level
- General water quality parameters (temperature, pH, conductivity, salinity, total dissolved solids, total suspended solids, turbidity, dissolved oxygen, chloride, and sulfate)
- Metals (arsenic, cadmium, copper, iron, manganese, nickel, lead, zinc)

- Organics (DMA area only; aniline, 4-chloroaniline, N-methylaniline, and N,N-dimethylaniline)

The OMMP will also address the expectations for groundwater quality improvements at the point of compliance (see Section 12.1.4) and identify trigger points at which additional groundwater controls would be considered.

The groundwater monitoring approach will be designed to complement the sediment monitoring program and monitoring required for OU 02 (e.g., monitoring of the On-site Containment Facility will be required under OU 02). The monitoring program will be subject to refinement by EPA based on results of the data collected. Additional details on the anticipated groundwater monitoring requirements are summarized in Section 12.1.5.

No further active remediation beyond those elements listed above are believed necessary at this time to address groundwater in OU 06.

12.1.3 Groundwater Cleanup Levels

Cleanup Levels for Shallow Groundwater. The cleanup levels identified for groundwater discharging from the Site are 3.1 µg/L for copper and 6 µg/L for arsenic (Table 12-1). These cleanup levels are being set to protect marine organisms in Commencement Bay (copper) and human health via the fish consumption pathway (arsenic). The established regional background (uncontaminated) concentrations for arsenic and copper in groundwater are 6 µg/L and 40 µg/L, respectively (EPA, April 1993).

The arsenic cleanup level of 6 µg/L is higher than the federal National Toxics Rule (NTR) standard of 0.14 µg/L for protection of human health based on a fish consumption pathway (40 C.F.R. Part 131.36). The NTR standard for arsenic (0.14 µg/L) is a relevant and appropriate requirement for groundwater but is being waived by EPA for groundwater at OU 06. The natural background concentration of arsenic in groundwater in the Tacoma vicinity is 6 µg/L (EPA, April 1993). Further, the practical quantitation limit (PQL) for arsenic in site groundwater has historically been approximately 2 µg/L. As such, the federal NTR standard (0.14 µg/L) is not an achievable or measurable cleanup level for groundwater at OU 06.

EPA is deferring to the State of Washington's MTCA regulation as the basis for the arsenic cleanup level (6 µg/L). Within the MTCA framework for determining an arsenic cleanup level for this site, Ecology has determined that the federal NTR standard of 0.14 µg/L and MTCA marine surface water criteria of 0.0982 µg/L are both considered applicable. However, MTCA mandates that where a risk-based cleanup value is below a natural background concentration, the cleanup value will be adjusted to equal the natural background concentration (WAC 173-340-700 (4)(d)). Therefore, even though the NTR and MTCA marine surface water standards for arsenic are applicable under MTCA, MTCA supports a 6 µg/L cleanup level for arsenic without a need to waive any MTCA requirement.

The cleanup level of 3.1 µg/L for copper is protective of human health and marine life in Commencement Bay. The background concentration for copper in the vicinity of the Site is significantly higher at 40 µg/L. However, it is believed that the copper cleanup level of

3.1 µg/L is achievable because concentrations are significantly diluted as groundwater mixes with seawater in the nearshore portions of the Site aquifers.

MCLs are not considered applicable to shallow groundwater at the Site because (1) most of the groundwater is categorized as Class III (non-potable due to high TDS levels) and (2) the Facility is considered a waste management area such that MCLs do not apply inside this area.

Cleanup Levels for Deep Groundwater. The cleanup levels applicable to the deep groundwater system are MCLs for metals (Table 12-1). It should be noted that this ROD imposes an institutional control on use of groundwater from the deep aquifer (see Section 12.1.2).

12.1.4 Groundwater Point of Compliance

Shallow Groundwater. In accordance with MTCA (WAC 173-340-720(6)(c) and (d)), compliance with the above-referenced cleanup levels for arsenic and copper in groundwater discharging from the Site will be determined at a conditional point of compliance. Normally, MTCA requires that a point of compliance be "established throughout the site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the site" (WAC 173-340-720(6)(b)). Achieving groundwater cleanup levels "throughout the site," however, is not a reasonable expectation because hazardous substances (e.g., slag and other source materials) will remain on the upland portion of the Facility based on the OU 02 ROD. In such cases, MTCA allows a conditional point of compliance "as close as practicable to the source of hazardous substances, not to exceed the property boundary" (WAC 173-340-720(6)(c)). Further, at such sites where groundwater discharges into nearby surface water, WAC 173-340-720(6)(d) indicates that (1) the cleanup levels may be based on protection of surface water and (2) "the department may approve a conditional point of compliance" that is located within the surface water as close as technically possible to the point or points where groundwater flows into the surface water.

WAC 173-340-720(6)(d) further indicates that a conditional point of compliance may be approved when the following four requirements are met:

- **Prohibition on use of a dilution zone to demonstrate compliance (WAC 173-340-720(6)(d)(i))**. Use of a dilution zone to demonstrate compliance with surface water cleanup levels shall not be allowed.
- **Requirement for all known available and reasonable methods of treatment (AKART) (WAC 173-340-720(6)(d)(ii))**. The demonstration of AKART relative to possible groundwater treatment has been met (see Appendix A, "Analysis of Cost and Benefits of Groundwater Controls in Addition to the Upland Remedy," to the *Historical Summary of the Evaluation of Groundwater Remedial Alternatives* [Hydrometrics, June 2000]).
- **Requirement that groundwater discharges not cause violations of sediment quality standards (WAC 173-340-720(6)(d) (iii)).** Technical evaluations completed by the Task Force demonstrate that Site groundwater discharges are not expected to cause violations of sediment quality standards (see Group 5 Technical Memorandum, Asarco Sediment/Groundwater Task Force [Hydrometrics, April 1999]). Furthermore, long-

term sediment monitoring will be required to verify that acceptable sediment quality conditions are maintained after the remedial action is complete.

- **Requirement to estimate contaminant flux rates and to address potential bioaccumulation in marine life resulting from groundwater discharging to surface water at constituent concentrations below method detection limits (WAC 173-340-720(6)(d)(iv))**. Post-remedial action monitoring conducted under the OMMP will require estimation of contaminant flux rates and assessment of potential bioaccumulation of metals in marine life resulting from groundwater discharge.

The above-referenced conditions are met at the Site (including the last requirement to address potential bioaccumulation in marine life, since associated monitoring and evaluations will be required by the OMMP). Based on MTCA regulations cited above, and consultation with Ecology, EPA is setting a conditional point of compliance for groundwater at the interface of the surface water and the shoreline of Commencement Bay and the Yacht Basin. Specifically, the conditional point of compliance for the slag aquifer will be at the interface between the slag (or any overlying shoreline armoring materials) and the surface water.

Deep Groundwater. The point of compliance for the deep groundwater system will be throughout the deep aquifer.

12.1.5 Sampling and Analytical Methods for Demonstrating Compliance

Sampling and analytical methods appropriate for demonstrating compliance with groundwater cleanup levels will be established in the OMMP and in cooperation with Ecology. It is envisioned that compliance monitoring will require periodic sampling.

Surface Water Samples. Samples will be collected from Commencement Bay and the Yacht Basin, as close as technically possible to the point where groundwater flows into these surface water bodies. The exact location, method, and timing of such sampling will be documented in the OMMP and subject to EPA review and approval.

Groundwater Samples. Groundwater will be collected from a series of monitoring wells located near the shoreline. Groundwater quality results from these wells will be compared to surface water quality data collected from adjacent (immediately downgradient) surface water sampling locations described above. Considering the difference between groundwater and surface water sampling results from adjacent locations, a factor will be developed to estimate the degree of dilution/attenuation occurring for each contaminant between the near-shore monitoring wells and the surface water at the conditional point of compliance. The compliance concentration at each nearshore well will be established by adjusting upward the cleanup levels for the protection of the surface water to reflect the dilution and attenuation expected to occur as groundwater flows from a monitoring well to the shoreline. These adjusted cleanup levels will be compared to the monitoring well data for compliance purposes. Appropriate evaluations will be required to determine a technically defensible dilution/attenuation factor for each monitoring well location.

12.2 Sediment

EPA's Selected Remedy is a combination of capping in the Nearshore/Offshore and Northshore areas and dredging of the Yacht Basin with onsite upland disposal of the dredged sediments.[2] The affected areas are shown in Figure 12-1. The rationale for the Selected Remedy is provided below. In addition, upland source control activities being conducted under the OU 02 remedial action need to occur prior to sediment remediation so that the possibility of sediment recontamination is minimized.

12.2.1 Sediment Remedy Elements

The Selected Remedy for sediments includes five elements: capping, dredging, no action, institutional controls, and long-term monitoring.

Capping. Capping is the Selected Remedy for the Nearshore/Offshore (Alternative S-1C) and Northshore (Alternative S-3C) areas. Capping is the Selected Remedy because it will isolate contaminated materials from the benthic organisms. Capping is the most practicable solution given the constraints associated with the depth of sediment contamination and the character of the subtidal slopes. Approximately 88,000 square yards (18 acres) of existing contaminated sediments within the severely impacted portion of the Nearshore/Offshore area (including the sediment under and adjacent to the existing piers) will be capped with a minimum of 3 feet of clean sediment. Approximately 7,000 square yards (1.5 acres) of the severely impacted portion of the Northshore area will also be capped with a minimum of 3 feet of clean sediment.[3]

The borrow source(s) for the cap material will be determined during remedial design and will originate from either a marine (in-water) or upland source. The cap will be designed such that it provides chemical isolation, is physically stable, and provides a cap surface that allows recolonization of benthic communities. In order to achieve this, the design will assess the geotechnical aspects of the area, as well as the erosional nature of the cap materials used, depth of bioturbation, future use of the area, and other design considerations. The results of the pilot cap study (Parametrix, February 2000) will be considered during the remedial design process. Placement of the cap is expected to be relatively easy to implement. Similar caps have been successfully completed elsewhere in the Puget Sound area.

Dredging. The Selected Remedy for the Yacht Basin is Alternative 2D, dredging and upland disposal. Dredging is the Selected Remedy for the Yacht Basin because it would remove the contaminated material, and removal tends to be a more controlled remedy than in-water containment. Furthermore, without prior dredging, capping in the marina is not possible because the cap would interfere with and be damaged by navigation.

An area approximately 75,000 square yards (15.5 acres) will be dredged in the Yacht Basin because it was determined to be a severely impacted area. It is estimated that approximately 1 to 2 feet of material (up to 50,000 cubic yards) will require removal. The exact depth of dredging will be based upon information obtained from core samples that are collected during the summer of 2000. Post-dredging confirmatory sampling will also be required to

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[2] Current plans call for capping in the Northshore area, however, depending on remedial design considerations, this small area may be dredged.

[3] See footnote 2.

verify that contaminated sediments have been adequately removed. If all of the contaminated sediments in the Yacht Basin cannot be practicably dredged or if slag is encountered, then the remaining contaminated sediment areas will be capped in place to the extent practicable.

The dredged material will be contained upland in OU 02 (Figure 1-2). OU 02 redevelopment activities have reserved capacity for these dredged spoils. The precise location will be detailed in the construction phasing schedule for OU 02. Redevelopment includes site grading and the installation of a low-permeability soil cap that will contain the sediments dredged from the Yacht Basin.

Material dredged from the Yacht Basin will be contained temporarily on the upland portion of the Facility and dewatered. Dewatered sediments will be permanently contained in an upland location in the central part of the Facility. Sediments contained in the upland location will be permanently covered with the low-permeability cap being installed across the Facility under the OU 02 remedial action. Effluent derived from the dewatering of dredged material will be discharged into the Yacht Basin or into Commencement Bay in accordance with BMPs and applicable water quality requirements. The specific sediment dewatering methods and requirements for management of discharges from dewatering effluent will be defined during remedial design and implemented during construction.

The dewatered sediments are currently scheduled to be placed beneath the upland low-permeability cap no later than November 30, 2004 as stipulated by "Amendment Number One" to the Asarco Smelter Consent Decree (Lodged in the District Court of Washington, June 2000) and a "Modification Agreement" signed by EPA and Asarco (EPA, November 1999). If either the OU 02 or OU 06 remediation schedules are such that the marine sediments cannot be placed under the cap by this date, the sediments may need to be permanently disposed of at an appropriate offsite location approved by EPA. Assuming the sediments are permanently contained onsite as planned, the mobility of the contaminants would be minimized as the dredged sediments will not be in contact with water as they will be placed at an elevation above the highest anticipated groundwater level. The operations and monitoring requirements for the OU 02 remedial action will include appropriate monitoring of the upland cap to verify its long-term effectiveness. Further, there will be a plan prepared under the OU 02 operations and monitoring program to address any failure or potential failure of the cap covering the dredged sediments.

No Action. No remedial action is planned for sediments offshore of the Breakwater Peninsula area (approximately 85,000 square yards or 17.5 acres). Sediments within this area (Figure 12-1) are within the Contaminant Effects Area. However, no remedial action is planned because of inherent engineering/construction impracticability associated with this area. The presence of steep slopes (as much as 50 percent slope) make capping or dredging infeasible. Further, the stability of a cap on such a steep slope is questionable. In addition, dredging is not possible because the entire Breakwater Peninsula would need to be removed since it is constructed entirely of slag (up to 125 feet thick).

Institutional Controls. All offshore capped areas will be designated as "no anchor" zones. This remedy is being selected because it will ensure long-term protection of capped areas. The no anchor designation will apply to commercial vessels using "whale-tail" type anchor, which have the capacity to break through the cap material and expose contaminated sediment. This institutional control will be implemented though federal rule-making by the U.S. Coast Guard and the U.S. Army Corps of Engineers in consultation with the Washington Department of Natural Resources. The rule-making will be subject to public comment.

Long-Term Post-Remedial Action Monitoring. Monitoring will occur on a long-term, regular basis after the remedial action is complete to verify the performance of each remediation area and the adjacent areas. This remedy is being selected because long-term monitoring of the offshore sediment cap will be necessary to confirm that the cap is isolating the contaminated sediments from marine life. Long-term monitoring is planned over a period of decades.

Long-term monitoring will occur off the Breakwater Peninsula since it cannot be remediated due to technical impracticability.

Long-term monitoring will also occur in those areas adjacent to the active remediation areas (the Moderate Impacts Area and the Contaminant Effects Area), where RI findings indicate exceedances of the SMS biological criteria. Monitoring is necessary to evaluate if long-term biological change is occurring in these areas, to monitor the long-term effectiveness of the sediment remedy, and to ensure the RAOs are being met. These evaluations will be conducted in accordance with the SMS and the preponderance-of-evidence approach, as discussed in Section 7.2.2. These areas will be monitored over a long duration so trends can be identified and responded to as necessary.

An Operation, Maintenance, and Monitoring Plan (OMMP) will be prepared as part of the remedial design and implemented as part of the remedial action. The OMPP will identify inspection and monitoring procedures to verify that the elements of the remedy are performing as intended or, if they are not, to identify needed repairs on a timely basis. The cap's physical integrity, particularly its thickness, will be verified on a regular basis. Inspections will be also conducted following major storm or earthquake events that could potentially affect the cap. Chemical analysis of cap materials will be conducted to verify that contaminants are not accumulating in the upper part of the cap, where the marine organisms live. Biological data will also be collected including abundance evaluations, bioassays, and tissue analyses.

The OMMP will identify monitoring requirements and conditions applicable to the moderate impact areas to see that RAOs are achieved in those areas not capped or dredged. For example, if long-term monitoring indicates contamination of marine sediments that is inconsistent with RAOs, or that the cap is eroding, action will be taken as appropriate. Likely responses to cap erosion may be the placement of additional cap material or armoring materials to reduce erosion. Specific actions and associated "trigger" conditions will be identified in the OMMP. In addition, more source control measures could be instituted upland to reduce the rate of cap recontamination (i.e., additional groundwater diversion measures). If EPA determines through long-term monitoring that the selected remedies are not protective, EPA can amend this ROD or issue an Explanation of Significant Difference (ESD) to modify the remedy as necessary.

12.2.2 Sediment Cleanup Levels

Remediation cleanup levels identified for the marine sediments at OU 06 are based upon the characteristics of each specific area and the type of remedy selected for that area. The sediment cleanup levels will also be used to measure compliance under the long-term monitoring program . The State of Washington's SMS (WAC 173-340), including the Sediment Quality Standards (SQS), the Cleanup Screening Levels (CSL), and the biological impact conditions determined by the preponderance-of-evidence approach (Section 7.2.2) will be used as cleanup levels for sediment. The specific remedy units (Figure 9-2) and their corresponding cleanup levels are summarized in Table 12-2 and are described below:

- **Capping for the Nearshore/Offshore and Northshore Areas.** The cleanup levels for these areas have been derived from the results of the preponderance-of-evidence approach, which has also been used to define the extent of active remediation (capping). For long-term monitoring, the SQS will be applied to ensure that the cap is supporting a healthy and diverse biological community.
- **Dredging for the Yacht Basin.** The cleanup levels selected for the Yacht Basin will be the SMS. These will be used to determine the vertical and horizontal extent of the active remediation (dredging). RI data suggest that fine-grained sediments like those present in the Yacht Basin do not typically exhibit biological effects when arsenic and copper concentrations are below the CSL. Therefore, the CSL criteria for these metals will be used as their cleanup levels. RI data also suggest that biological effects in fine-grained sediments may be more sensitive to sediments with zinc and lead contaminants. Therefore, the SQS have been selected as cleanup levels for these two metals. The above-referenced cleanup levels for arsenic, copper, lead, and zinc will also be used during long-term monitoring to ensure that the RAOs are met in the Yacht Basin.
- **Moderate Impact and Contaminant Effects Areas.** Long-term monitoring will be required for marine sediments at OU 06 that will not undergo active remediation. Monitoring is required to ensure that sediment conditions continue to meet RAOs. The preponderance-of-evidence approach will continue to be applied to these areas in order to evaluate the long-term biological conditions, monitor the long-term effectiveness of the overall remedy to these portions of the Site, and to ensure the RAOs are being met.

12.3 Expected Outcomes of the Selected Remedy

It is expected that the Selected Remedy will protect human health and the environment consistent with the RAOs outlined in Section 8.

Source control measures will reduce the leaching of contaminants to groundwater. Installation of a low-permeability cap, surface and groundwater water controls, and abandonment or replacement leaking underground piping is expected to reduce groundwater flow recharge. The expected effect is an estimated 75 to 95 percent reduction in the contaminant loading to Commencement Bay from groundwater discharge. It is expected that groundwater cleanup levels for arsenic (6 μg/L) and copper (3.1 μg/L) will eventually be reached at the conditional point of compliance after the remedial action is completed and groundwater conditions have stabilized.

Although achievement of groundwater cleanup levels is expected near the shoreline due to dilution effects of adjacent marine waters, the quality of shallow groundwater over most of the Site is not expected to change significantly. Significant improvements in groundwater quality are not expected because source materials (e.g., slag) will remain in place permanently as part of the OU 02 ROD (EPA, March 1995).

As anticipated by the remedial design for OU 02, the upland part of the Facility will be developed for commercial and recreational use. Public access will be provided to the waterfront and intertidal areas in selected locations. The underlying shallow groundwater included in OU 06 will not be available as a drinking water source. Deep groundwater included in OU 06 will not be available as a drinking water source until such time groundwater quality complies with applicable health-based criteria (e.g., maximum contaminant levels).

It is expected that the remedial measures employed to address sediment contamination will result in attainment of cleanup levels for arsenic, copper, lead, and zinc consistent with SMS (Table 12-2). For areas subjected to active remedial measures (e.g. the Yacht Basin from dredging and the Nearshore/Offshore area and Northshore area from capping), concentrations of COCs will be reduced immediately upon the removal and capping of contaminated sediments. Recolonization of these areas is expected to occur rapidly as demonstrated in the Cap Pilot Study (Parametrix, February 2000). An overall improvement in marine sediments and benthic community structure is expected to occur in all impact areas over several years. The Yacht Basin will continue to be suitable for use by recreational watercraft; however, this use will continue to limit the suitability of this habitat for some organisms.

Long-term monitoring as defined in the OMMP will identify inspections and monitoring procedures to verify that the elements of the remedy are performing as intended.

12.4 Summary

The Selected Remedy for OU 06 is composed of four alternatives to address groundwater and marine sediments (Alternatives GW-B, S-1C, S-2D, and S-3C). The Selected Remedy complies with statutory requirements under CERCLA, meets the CERCLA threshold criteria, and provides the best balance with respect to CERCLA's balancing and modifying criteria. EPA believes the Selected Remedy will protect human health and the environment, comply with ARARs (except as waived by this ROD), be cost-effective, and utilize permanent solutions to the maximum extent practicable.

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13 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy does or does not meet these statutory requirements.

13.1 Protection of Human Health and the Environment

The Selected Remedy (Alternative GW-B for groundwater and Alternatives S-1C, S-2D, and S-3C for sediments) will protect human health and the environment by minimizing the discharge of contaminants to Commencement Bay via groundwater and removing or isolating contaminated sediments in Commencement Bay and the Yacht Basin. When combined with the remedy being implemented for OU 02 under the 1995 ROD (EPA, March 1995), the remedy will reduce the threat of exposure to the chemicals of concern to both humans and marine organisms. Cleanup levels for sediment are expected to be met immediately upon completion of the remedial-action activities. However, the biological community will require time to recolonize the areas where sediment is covered by cap material or is impacted by dredging. Contaminant concentrations in groundwater are expected to decrease gradually with time. Cleanup levels for groundwater will not likely be met until several years after the remedial action is complete.

13.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The Selected Remedy is expected to comply with federal and state ARARs with the exception of arsenic in groundwater discharging to Commencement Bay, which is not expected to comply with the federal NTR marine water standard of 0.14 μg/L (40 C.F.R. Part 131.36). A list of ARARs for OU 06, including the justification for the NTR waiver for arsenic, are provided below.

State of Washington Model Toxics Control Act (MTCA) (WAC 173-340)

Key sections of MTCA applicable requirements are listed below:

- *WAC 173-340-360(4)*—Identifies the order of preference of cleanup technologies, including treatment as the highest preference.
- *WAC 173-340-360(6)*—Addresses selection of a cleanup that provides for a reasonable restoration time frame and identifies factors to be considered when establishing that time frame.

- *WAC 173-340-440*—Requires institutional controls where active cleanup measures (e.g., treatment) will not attain MTCA cleanup levels or where a cap is used to contain contaminants above MTCA cleanup levels.
- *WAC 173-340-720*—Sets groundwater cleanup standards and guides selection of the point of compliance.
- *WAC 173-340-730*—Sets surface water cleanup standards and guides selection of the point of compliance. Applicable as both sediments and groundwater may impact surface water quality of Commencement Bay.

Minimum Standards for Construction and Maintenance of Water Wells (R.C.W. § 18.104, WAC 173-160)

Well construction regulations establish minimum standards for water well construction. This regulation will be applicable to wells constructed for groundwater monitoring purposes. This regulation is also applicable to the decommissioning of existing or future wells.

Regulation and Licensing of Well Contractors and Operators (R.C.W. § 18.104, WAC 173-162)

These regulations apply to all water well contractors and operators who are providing well installation, maintenance, or abandonment services within the State of Washington.

General Regulations for Air Contaminant Sources (WAC 173-400)

This regulation requires Best Management Practices to be employed, including covering stockpiles, cleaning trucks prior to leaving the Site, and monitoring air emissions. As an example, these regulations will be applicable to handling and dewatering dredged sediments.

U.S. Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)

Commencement Bay provides potential habitat for certain endangered species and is used as a salmonid migratory route. This Act prohibits water pollution with any substance deleterious to fish, plant life, or bird life, and requires consultation with the U.S. Fish and Wildlife Service and appropriate state agencies prior to construction of the remedy. Criteria are established regarding site selection, navigational impacts, and habitat remediation. This statute is applicable to capping and dredging to be performed in Commencement Bay.

Safe Drinking Water Act (42 U.S.C. § 300)/National Primary Drinking Water Regulations (40 C.F.R. Part 141 Subpart B)/Water Quality Standards for Ground Waters of the State of Washington (WAC 173-200-040)

The federal primary drinking water standards adopted by the State of Washington set maximum contaminant levels (MCLs). MCLs are the maximum permissible levels of contaminants allowed in drinking water based on the prevention of adverse health effects. Class III groundwater (non-potable due to total dissolved solids greater than 10,000 mg/L) prevail in the shallow aquifer system and are not subject to MCLs. However, MCLs are applicable for those portions of the deep aquifer where Class II (potable) groundwater is present.

Federal Water Pollution Control Act/Clean Water Act (33 U.S.C. §§ 1251-1376; 40 C.F.R. Parts 100-149)

Acute marine criteria are relevant and appropriate requirements to control discharges to marine surface water during cap placement and sediment dredging.

Federal Clean Water Act (33 U.S.C. § 1251 et. seq.)/Washington State Water Quality Standards for Surface Waters (WAC 173-201A)

Surface water quality standards for protection of human health and the aquatic life will be applicable to discharges to surface water during cap placement and sediment dredging. The water quality standards also guide the quality of groundwater that will discharge to Commencement Bay for purposes of protecting marine organisms.

National Toxics Rule (40 C.F.R. Part 131.36)

The federal NTR standard for arsenic of 0.14 µg/L (40 C.F.R. Part 131.36) is a relevant and appropriate requirement for groundwater. EPA is waiving the NTR for arsenic because compliance with the requirement is technically impracticable from an engineering standpoint because the NTR level is neither achievable nor measurable at this site (40 C.F.R. Part 3000.430 (f)(ii)(C)(3)). Specifically, the NTR standard is being waived because the natural background concentration of arsenic in groundwater in the Tacoma vicinity is 6 µg/L (EPA, April 1993). Further, the PQL for arsenic in site groundwater has historically been approximately 2 µg/L. See Section 12.1.3 for additional discussion addressing the basis for this ARAR waiver.

Washington Sediment Management Standards (WAC 173-204)

Chemical concentration and biological effects criteria are established for Washington State, including Puget Sound sediments, and are applicable to sediment remediation.

State Water Pollution Control Act (R.C.W. § 90.48)/Water Resources Act (R.C.W. § 90.54)

Requirements for the use of all known, available, and reasonable technologies for treating wastewater prior to discharge to state waters are applicable to any dewatering of marine sediment prior to upland disposal. Section 401 requires certification for activities conducted under Section 404 authorities. The substantive requirements of a certification determination are applicable.

Construction in State Waters, Hydraulic Code Rules (R.C.W. § 75.20; WAC 220-110)

Hydraulic project approval and associated requirements for construction projects in state waters have been established for the protection of fish and shellfish. Substantive permit requirements are applicable to cap placement. The technical provisions and timing restrictions of the Hydraulic Code Rules are applicable to cap placement and dredging.

State Discharge Permit Program/NPDES Program (WAC 173-216 and -220)

The Washington State NPDES program provides conditions for authorizing direct discharges to surface waters and specifies point source standards for such discharges. As an example, these standards are applicable to discharges to surface waters resulting from sediment dewatering operations during dredging and disposal work.

Whole Effluent Toxicity Testing and Limits (WAC 173-205)

Establishes whole effluent toxicity limits in accordance with R.C.W. § 90.48.520, 40 C.F.R. Part 122.44(d), and 40 C.F.R. Part 122.44(e) for inclusion into National Pollutant Discharge Elimination System (NPDES) permits to protect aquatic life through the implementation of all known, available, and reasonable methods of prevention, control and treatment of toxicants and through the attainment of state water quality standards. The requirements are applicable if it is determined that the substantive requirements of a NPDES permit must be met for diversion of contaminated and treated water from sediment dewatering.

Federal Clean Water Act Dredge and Fill Requirements; Sections 401 and 404 (33 U.S.C. § 401 et seq., 33 U.S.C. §§ 1251-1316; 33 U.S.C. § 1413; 40 C.F.R. Parts 230 and 231; 33 C.F.R. Parts 320-330)

These regulations provide requirements for the discharge of dredged or fill material to waters of the U.S. and are applicable to any in-water work. The sediment dredging and capping elements of the Selected Remedy are subject to the requirements of Section 404(b)(1). Mitigation requirements associated with the remedy selected for OU 06 will be addressed as part of the 404 process. A Biological Assessment (BA) is currently being prepared by EPA to meet the substantive requirements of the Section 404 Permit. Mitigation is also required to compensate for the loss of approximately 0.2 acre of intertidal habitat in the Yacht Basin.

Federal Endangered Species Act of 1973 (16 U.S.C. § 1531 et seq., 50 C.F.R. Parts 200 and 402)/Marine Mammal Protection Act (16 U.S.C. § 1361 et. seq.)

This regulation is applicable to any remedial actions performed at the Site, as this area is potential habitat for threatened and/or endangered species. Best Management Practices (BMPs) required to ensure full compliance with ESA requirements will be addressed and implemented. EPA is currently preparing a BA to meet the substantive requirements of the Section 404 Permit. At this time EPA is informally consulting with the National Marine Fisheries and the U.S. Fish and Wildlife Service on the remedial actions.

Rivers and Harbors Appropriations Act (33 U.S.C. § 403, 33 C.F.R. Part 322)

Section 10 of this Act establishes permit requirements for activities that may obstruct or alter a navigable waterway; activities that could impede navigation and commerce are prohibited. These substantive permit requirements are applicable to dredging and capping.

Shoreline Management Act (R.C.W. § 90.58, WAC 173-14 through 173-28); Coastal Zone Management Act (16 U.S.C. § 1451 et seq., 15 C.F.R. Part 923)

These statutes and regulations are applicable to capping activities in the shoreline area.

State Aquatic Lands Management Laws (R.C.W. § 79.90-79.96, WAC 332-30)

The State Aquatic Lands Management Laws are applicable. The final remedy must be consistent with state laws that promote environmental protection, public access, water dependent uses, and uses of renewable resources that generate revenue to the state in a manner consistent with these management goals.

Resource Conservation and Recovery Act (40 C.F.R. Part 261.4(g))

This regulation is applicable and provides an exemption in determining that contaminated sediments dredged under the requirements of Section 404 of the Clean Water Act are not classified as RCRA hazardous waste.

Native American Land Claims Acts Including Washington Indian (Puyallup) Land Claims Settlement Act (25 U.S.C. § 1773)/Puyallup Tribe of Indians Settlement Act of 1989

The Puyallup Tribe of Indians Settlement Act of 1989 is relevant and appropriate in that the Puyallup Tribe maintains certain rights pertaining to fisheries resources and associated habitat.

Archeological and Historical Preservation Act (16 U.S.C. § 4699)

This statute is applicable and requires that significant scientific, pre-historical, or archeological data be preserved if present on the Site.

Federal Clean Air Act (42 U.S.C. § 7401 et. seq., 40 C.F.R. Part 50)/Washington Clean Air Act (R.C.W. § 70.94, WAC 173-400 and -460)

Air quality statutes and regulations would be applicable if dust is generated as part of sediment dewatering/handling or if emissions are created by facilities used to treat water produced during sediment dewatering.

To Be Considered (TBCs)

TBC items are state and local ordinances, advisories, guidance documents or other requirements that, although not ARARs, may be used in determining the appropriate extent and manner of cleanup. Generally, TBC requirements are used when no federal or state requirements exist for a particular situation. A list of TBCs for the Site include:

- **Puget Sound Water Quality Management Plan**. Defines objectives for standards regarding the confined disposal of contaminated sediment. Although the Selected Remedy does not include a CAD, the standards presented in the *Puget Sound Water Quality Management Plan* may be useful with respect to the design and construction of a sediment cap (e.g., selection of import cap material).

- **Standards for Confined Disposal of Contaminated Sediments, Washington Department of Ecology (January 1990)**. Guidelines for assessing the suitability of dredged material for unconfined disposal relevant to cap material specifications.

- **Area of Contamination Interprogram Policy, Washington Department of Ecology**. Guidelines for management of dredged sediment meeting the criteria as a state dangerous waste.

- **Sediment Cleanup Standards Users Manual, Washington Department of Ecology**. Guidance for implementing the sediment cleanup decision process for contaminated sediments.

- **Sediment Source Control Standards Users Manual, Washington Department of Ecology (June 1993)**. Guidance for implementing the Sediment Source Control Standards.

- **Local Shoreline Master Program**. Guidelines for managing development of shorelines to preserve natural resources while protecting public access and navigation.
- **Development of Sediment Quality Criteria for the Protection of Human Health: Tier I Report, Washington State Office of Toxic Substances (1995)**. Proposes draft sediment quality standards based on risks to humans.

13.3 Cost-Effectiveness

The estimated present worth cost for the Selected Remedy is $19.2 million and is considered cost-effective. The $19.2 million estimated cost is divided between groundwater and marine sediment remedies as follows:

Institutional Controls and Long-Term Monitoring Components of Groundwater Remedy (Alternative GW-B)	$1.8 million
Sediments Remedy, Nearshore/Offshore Area (Alternative S-1C)	$11.6 million
Sediments Remedy, Yacht Basin (Alternative S-2D)	$5.1 million
Sediments Remedy, Northshore Area (Alternative S-3C)	$0.7 million
Total	$19.2 million

This estimate does not include the cost for any OU 02 remedy element that may benefit groundwater.

In making a determination regarding cost-effectiveness, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP, Section 300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering, the statutory preference for treatment as a principal element. EPA also considered the bias against offsite treatment and disposal, and considered state and community acceptance when selecting the preferred remedy.

13.5 Preference for Treatment as a Principal Element

Treatment of contaminated sediment to reduce toxicity or mobility of contaminants is not considered feasible. As stated previously, treatment was evaluated for sediment cleanup, however it was not considered further for the following reasons: First, in order to treat the sediments, they must be removed. This is difficult in the Nearshore/Offshore area of OU 06 because the contamination is very deep. Therefore, the chance of leaving contamination behind is very high. Second, since slag was poured to create the shoreline in portions of the Nearshore area, dredging in this area would be difficult due to slope stability issues. Third, the net benefit of treating the sediments is in question as the slag pieces within the sediment matrix are already in a relatively immobile form (e.g., the slag does not tend to be bioavailable; see discussion in Section 5.2). Fourth, costs associated with treatment of the Yacht Basin sediments would be disproportionate to the costs associated with the current upland disposal plan.

13.6 Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Additional groundwater interception or other controls may be required in the future if it is determined that groundwater cleanup levels are not being met and additional groundwater capture is practicable considering the expected reduction in risk to human health and the environment. This issue will be assessed as part of the Five-Year Review process.

13.7 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan for the Asarco Sediments/Groundwater OU 06 was released for public comment in January 2000. A public meeting was held on February 10, 2000, to present the preferred remedy and solicit comments from the public. The Proposed Plan identified the Preferred Remedy for OU 06 as comprising Alternative GW-B (groundwater) and Alternatives S-1C, S-2D, and S-3C (sediments). EPA carefully reviewed all written and oral comments provided during the comment period. Based on the comments received, two minor changes have been incorporated into the Selected Remedy:

- **Reduction of Sediment Cap Thickness from 1 Meter to 3 Feet**. The Preferred Remedy identified in the Proposed Plan called for a 1-meter (39-inch) cap in the Nearshore/ Offshore Area (18 acres). The Selected Remedy identified in this ROD calls for this area to be capped with 3 feet (36 inches) of clean material. This change is based on a re-evaluation of the depths to which burrowing organisms are reported to penetrate the cap. This re-evaluation determined that a 36-inch cap will effectively isolate the contaminated sediments from the biota and overlying water as well as a 39-inch cap. Therefore, the Selected Remedy will be protective of human health and the environment.

- **Possible Dredging of the Northshore Area**. The Preferred Remedy identified in the Proposed Plan called for capping contaminated sediments in the Northshore area (1.5 acres). The Selected Remedy calls for this area to be capped but acknowledges that dredging may be determined to be appropriate depending on engineering considerations assessed during the remedial design. As such, dredging will be re-evaluated as part of the remedial design process. Either capping or dredging would be protective of human health and the environment.

The above-referenced remedy modifications could have been reasonably anticipated based on the information in the Proposed Plan. Therefore, additional public comment on these changes is not required.

PART III

Responsiveness Summary

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Introduction

This Responsiveness Summary provides EPA's responses to comments on the Proposed Plan for the Asarco Sediments/Groundwater Operable Unit 06 (EPA, January 2000a). Comments were received from citizens, corporate and community organizations, and government agencies. The Responsiveness Summary includes responses to both written and oral comments received during the 60-day comment period (January 26 to March 25, 2000). Copies of the written comments received are provided in Appendix D. Oral comments were received during the public meeting on February 10, 2000. The transcript from this meeting is available in EPA's Administrative Record for the Asarco Sediments/Groundwater Operable Unit 06.

EPA has grouped the comments and corresponding responses into 15 topics:

- Site Risks
- Sediment Impact/Remediation Area
- Alternatives to Sediment Capping
- Protectiveness and Effectiveness of Sediment Capping Remedy
- Sediment Cap Thickness
- Sediment Dredging
- Institutional Concerns Regarding Sediment Capping
- Groundwater Extraction and Treatment
- Remediation Goals/Levels (Groundwater)
- Remediation Goals/Levels (Sediment)
- Remedy Costs
- Endangered Species Act and Biological Assessment Issues
- Natural Resource Mitigation
- Long-Term Monitoring
- Other Comments

The Responsiveness Summary addresses each comment received. The comments are numbered for convenience and cross-referencing purposes. They are reproduced as received by EPA (written comments) or as cited in the transcript of the February 10, 2000 public meeting (oral comments). Exceptions are EPA annotations in the comments; these are noted as italicized text within brackets (e.g., [*EPA annotation…*]). Comment letters or oral comments addressing more than one issue have been divided and presented under the above-referenced topic headings. Each comment is presented in non-italicized font. EPA responses are italicized. Also note that references to page and section numbers in the comments refer to the Proposed Plan.

Site Risks

Comment No. 1

Comment: Pg. 9, 3rd full para. This paragraph compares site tissue concentrations to reference tissue concentrations and ignored the sections of the Phase 1 Data Report that showed "...the site station tissue chemistry was found to be indistinguishable from the reference station tissue chemistry in all cases (see Table 8-3)." In other words, the differences were not statistically significant. Further, it is not appropriate to state that tissue concentrations are elevated without providing any risk context. Anyone that only gets this far reading the document may not learn that these tissue concentrations are acceptable using EPA's risk criteria, as stated later in the Proposed Plan.

Response: *EPA acknowledges that extensive details regarding site risk are not provided in the Proposed Plan. However, the text in the Proposed Plan is accurate as written, and the reader is referred to the Phase 1 report for additional details regarding site risk.*

Comment No. 2

Comment: 5.1 Human Health Screening Risk Assessment

Sediments: In determining human health risks associated with eating fish caught within the site, the low end range (1 gram per day of fish) was selected to represent the consumption of an infrequent sports fisherperson who might eat fish from the waters off the facility a few times each year. The greater Commencement Bay area hosts a number of ethnic communities who routinely fish for subsistence. Because of easy access, the waters along Ruston Way/Asarco/Point Defiance are a popular fishing spot for members of these communities. We believe that the assumption of 1 gram per day of fish does not consider the subsistence harvest practiced by members of these communities and needs to be increased accordingly.

Response: *EPA concurs. The risk associated with recreational and subsistence users was addressed in the risk assessment. In this risk assessment, EPA assumed 290 grams per day of fish consumption for the subsistence user. This risk is discussed in the third paragraph on page 12 of the Proposed Plan and Section 7 of this ROD.*

Comment No. 3

Comment: (Section 8.1) Do you understand why fish tissue remained below risk thresholds even though groundwater exceeds human health risk based levels for fish consumption? If not, how can you be sure that the environmental conditions which allow this to happen will remain constant?

Response: *The human health risk values were calculated from fish tissue collected at the Site. In other words, the fish collected were exposed to site groundwater and the waters and marine sediments of Commencement Bay. The fish collected were not just exposed to groundwater. Therefore, collection of site-specific tissue data is the most representative of actual site conditions. The groundwater risk numbers referenced above assume that the organisms will be exposed to contaminated groundwater only, and not to surface water and sediment as well. Therefore, the data collected as part of the site investigations are most applicable to the actual site conditions.*

As for future site conditions, EPA believes that the conditions at the Site will, at least, remain the same, or improve due to the remedial actions planned for the Site.

Sediment Impact/Remediation Area

Comment No. 4

Comment: As Asarco understands the Expanded RI/FS data and the Proposed Plan, all impacted areas that require remediation and can practicably be remediated will be remediated. However, the use of the terms "moderately impacted" and "minimally impacted" in the Proposed Plan are potentially misleading and may imply that some impacted areas will not be remediated. These terms also seem to ignore the sophisticated approach that EPA and Asarco have taken to identify and characterize areas with contaminant effects. Asarco would prefer that areas simply be identified as "impacted" and "non-impacted" as determined by the preponderance of evidence approach and the extensive sediment effects data.

The approach to identification of impacted areas presented by Asarco in Phase 1 of the Expanded RI/FS was substantially more complex and complete than the approach described in the Proposed Plan. In comparison to the Phase 1 approach, it is extremely simplistic to use "benthic results to identify the most highly impacted areas...." Asarco prefers to base impact determinations on all of the detailed sampling and data analysis work that Asarco and EPA have conducted rather than the highly simplistic approach described in the Proposed Plan, which is only a slight modification of the Sediment Management Standards (SMS).

In Phase 1, Asarco evaluated measures of chemistry, bioassays, benthic community results and other types of sampling (e.g., pore water chemistry, pore water bioassays, tissue chemistry, sequential extraction analyses of slag) to determine those measures that appeared to be most highly correlated. The benthic results were evaluated in many ways including relatively simplistic SMS measures and much more powerful data analysis tools (e.g., proportional similarity index and principal coordinates analysis). All of these measures were evaluated and chemistry, sediment bioassays, and numerous measures of benthic abundance and diversity were used in the final preponderance-of-evidence approach. In this approach, some benthic community measures were given greater weighting than other benthic measures, sediment bioassays, and chemistry. Bulk sediment chemistry results were given the least weight in the preponderance-of-evidence approach. Some other evidence was judged to be inappropriate for use in cleanup decisions.

The purpose of the preponderance-of-evidence approach was to define those areas exhibiting contaminant effects. No "moderate impact areas" were defined in the Phase 1 Report. The preponderance-of-evidence either "tipped the scale" into contaminant effects designation or it did not. Thus, one significantly different bioassay result or a particularly high chemistry result does not indicate a "moderately impacted" area. In such cases, the preponderance of other evidence (mainly various measures of the benthic community) indicates that this area is not impacted. Defining stations that have one significantly different bioassay and/or chemistry result as "moderately impacted" ignores all of the evidence presented in the Phase 1 and 2 Reports that clearly indicate the effects of slag may confound typical SMS interpretations of bioassay and particularly bulk sediment chemistry results. The preponderance-of-evidence approach was not designed to define "in between" or "moderately impacted" areas (see Responses to comments on Phase 1 Report). Consequently, Asarco has never agreed to the proposed definitions of moderately impacted areas.

In the Proposed Plan, the only areas that receive the designation "non-impacted" are those that do not exceed the bulk sediment chemistry Sediment Quality Standard (SQS). Asarco has collected and reported a vast amount of information indicating that where slag particles are present, bulk sediment chemistry is often irrelevant to the actual toxicity of the sediments. Some sediment stations at the Asarco site were well above the SQS and showed no other evidence by any measure of contaminant effects, yet in Section 5.2 of the Proposed Plan these stations are defined as "minimally impacted." Because there is no evidence of contaminant effects, it is inappropriate to define these stations as impacted in anyway.

The reason described for the minimal impact designation is that the sediments "may have impacts in the future" However, EPA provides no scientific evidence to clarify what action or event might reasonably be expected to cause these sediments to have impacts in the future. There is no evidence available from any of the numerous studies completed to support this supposition of potential future impacts. All available information, particularly regarding slag metals availability (e.g., the sequential extraction analysis) and the present healthy state of the benthic community, do not support this supposition. Because there is no evidence that these sediments would reasonably pose future impacts, these sediments should be designated as "non-impacted."

Similarly, Asarco does not agree that stations with "minor biological CSL exceedances" should be designated as "minimally impacted." As stated in the previous comment, Asarco believes this simplistic approach ignores the preponderance of evidence for these stations (all the other benthic and/or bioassay measures) that indicate these stations are not impacted in any way. These stations should also be designated as "non-impacted."

Finally, consistent with the above comments, the remediation area should be defined simply as "impacted stations" not "severely impacted stations."

Response: *A range of biological effects were identified at the various sampling locations. There are many areas that show some impact, but not sufficient impact to warrant active remediation. It is incorrect to ignore these "gray" areas, and only use the terms "impacted" and "non-impacted." Therefore, EPA will continue to use the terms "moderately" and "minimally" impacted when discussing the site sediments. The fact that the Phase 1 report did not use these terms is irrelevant, since one of the main goals of that report was to identify areas requiring active remediation.*

The goal of the preponderance of evidence approach was to assess each station using all possible data. The goal was not to assess all stations from the "black and white" perspective as either "in" or "out" of the cleanup area (e.g., EPA never determined that this approach would only result in two categories of stations: impacted and non-impacted). EPA has used the information from the preponderance of evidence approach, and has assigned a category to the range of results received from that approach. EPA will therefore continue to use the terms "moderately impacted" and "minimally impacted."

Comment No. 5

Comment: 7.2 Sediment
In addition to the remedial alternatives presented in the proposed cleanup plan, additional actions are required in the Non-Impacted/Minimally Impacted Stations and Moderately Impacted Stations to ensure that these stations are remediated to meet all State of Washington Criteria. (see 5.2 above)

Response: *Based on the preponderance of evidence approach, the stations in the minimally impacted and moderately impacted areas will be monitored to ensure they meet RAOs. Based on this approach, these stations indicate some impact, but do not warrant active cleanup.*

Comment No. 6

Comment: 5.2 Ecological Risk Assessment
Sediment:

Non-Impacted/Minimally Impacted Stations

Stations that have chemical concentrations greater than the state standards must be cleaned up to meet Washington State standards. Additionally, those areas with minor biological CSL exceedances must be remediated as well.

Moderately Impacted Stations

Stations falling within this category need to be remediated to meet Washington State cleanup standards.

Response: *As discussed above, based on the preponderance of evidence approach, the stations in the minimally impacted and moderately impacted areas will be monitored to ensure they meet RAOs. Based on this approach, these stations indicate some impact, but do not warrant active cleanup. As stated in our previous responses, EPA has determined that active cleanup in these areas would have a net negative environmental impact.*

Alternatives to Sediment Capping

Comment No. 7

Comment: The proposed plan does not define the design life for the remedy. It is uncertain how long monitoring will occur, under what conditions monitoring will be enhanced or curtailed, and what will trigger contingency actions now and in the future. These and other concerns lead to uncertainty regarding the permanence of the remedy and to questions regarding how exhaustively more permanent solutions were explored.

For example, the proposal to cap the north nearshore unit is not supported by the information and analysis. The costs shown demonstrate that dredging and upland disposal, a more permanent remedy, is less expensive. Costs associated with mitigation for habitat impacts due to cap design, as well as a number of additional costs – including potential compensation for use of public aquatic lands – not included in the existing analysis, will increase the costs associated with the capping alternative. We therefore do not support capping of this unit.

We also believe that permanent solutions such as treatment are viable. Vendors are providing treatment rates of around $29 per cubic yard. We encourage EPA to further evaluate treatment as part of the decision-making process.

Response: *The caps will be designed to cover the contaminated sediments into perpetuity. Monitoring and assessment of the caps will occur regularly as required by the Operation, Maintenance, and Monitoring Plan (OMMP). The OMMP will be developed by Asarco as part of the remedial design process. The OMMP will identify thresholds where new or revised monitoring, maintenance, or remedial actions will be triggered.*

DNR is correct that dredging with upland disposal (assuming it is placed onsite) is slightly less expensive than capping. EPA will require that dredging be considered for this area during remedial design. The ROD acknowledges that dredging of the Northshore area may occur in lieu of capping depending on the outcome of remedial design evaluations.

Mitigation is not included in the cost for any alternative, because it has not been determined what mitigation is required.

Potential treatment of marine sediments was evaluated by EPA as part of the Feasibility Study process. Several technologies groups were evaluated including thermal destruction, thermal desorption, chemical separation, sediment washing, and in-place solidification/stabilization. As part of this evaluation, EPA did not identify any established treatment options for sediments that are reliable and cost-effective.

Comment No. 8

Comment: The proposal for the sediments unit does not adequately provide for long-term isolation of materials. For example, the porous slag slopes and incomplete armoring will result in continued release of fine-grained slag particulates to the nearshore sediments. More innovative alternatives to reduce the slopes to allow more effective armoring or to isolate the peninsula in some other way need to be more thoroughly analyzed. The benefits and total costs (including on-going source control, long-term operation and maintenance, and contingency actions) associated with all potential alternatives need to be fully evaluated in order to make well-informed decisions.

Response: *The comment appears to be focused on the possibility of slag particles being eroded from the slag face and deposited on the cap material or other sediments. Armoring of the slag slopes at the shoreline was specifically addressed by the 1995 ROD for Operable Unit 02 (i.e., Asarco Tacoma Smelter and Breakwater Peninsula ROD, which addressed upland conditions). At present, the remedial design for the shoreline armoring system is nearly complete. The design incorporates engineering features to minimize erosion of the slag face.*

Protectiveness and Effectiveness of Sediment Capping Remedy

Comment No. 9

Comment: (Section 9.2.1) The likely static and dynamic slope stability risks indicate the need for a more permanent solution.

Response: *The stability of the sediment cap and associated perimeter side slopes will be addressed during remedial design.*

Comment No. 10

Comment: (Section 9.2.4) What is the contingency for heavy erosion of the cap?

Response: *The responsible parties will be responsible for maintaining an isolating cap at the Site. The Operations, Maintenance, and Monitoring Plan (OMMP) will address contingency actions for erosion of the cap (e.g., placement of additional material should a significant amount of material erode from the cap).*

Comment No. 11

Comment: Pg. 22, Sec. 8.1 Overall Protection of Human Health and the Environment, Groundwater: There isn't any discussion of how the range of alternatives will protect the environment of Commencement Bay, which receives the discharging groundwater. The marine habitat of Commencement Bay is composed of the waters of Commencement Bay as well as the sediments.

Response: *Comment noted. Section 10 of the ROD addresses how the remedy for groundwater is protective of the marine environment of Commencement Bay.*

Comment No. 12

Comment: Pg. 25, Sec. 8.3, Long-Term Effectiveness and Permanence, Sediment: NOAA agrees with the analysis in the Proposed Plan and supports the preferred approach which is to dispose dredged contaminated sediments in the upland containment facility with other contaminated materials. The consolidation of contaminated site materials into a few engineered upland facilities is expected to make long-term operation, maintenance and monitoring of these disposal facilities more efficient and reliable than would disposal into near-shore or sub-aquatic disposal facilities.

Response: *Comment noted.*

Sediment Cap Thickness

Comment No. 13

Comment: EPA's Proposed Plan for the Asarco Sediments/Groundwater Operable Unit provides for sediments to "be capped with a minimum of 1 meter of clean sediment from an upland source." None of the information Asarco has developed during the sediment investigations justifies the "minimum of 1 meter" thickness. Asarco is concerned that EPA has specified a considerably thicker cap than is necessary for protection of the environment of Commencement Bay and human health.

EPA proposes a minimum cap thickness rather than a nominal cap thickness as well as an increase from the 0.6 m (60 cm or 2 ft) cap proposed in the Refinement of Remedy (Parametrix, 2000) to the thicker 1 m cap. These increases represent almost twice as much cap material as originally considered by Asarco and evaluated in the pilot cap tests. Thus, the EPA proposal would be considerably more expensive than the Asarco proposal of a nominal cap thickness of 0.6 m.

No evidence has been provided by EPA that the considerably thicker cap will provide greater protection of the environment in Commencement Bay. Requiring the minimum cap thickness of 1 m requires technical or scientific justification that this increase would provide a substantial increase in protection. No such justification has been provided by EPA or any other entity in the Asarco Sediments evaluations. It appears then, that EPA's requirement for a minimum 1 meter cap is arbitrary, capricious and beyond the scope of the agency's authority given the persuasive evidence for a nominal 0.6 meter cap in the pilot study. Also, under the National Contingency Plan, selected remedies are required to be cost- effective. If a remedy is both protective of human health and the environment, and meets ARARs, it must also be cost-effective. 40 CFR § 300.430(f)(1)(ii)(D). Under the regulation, cost-effectiveness is determined by evaluating three criteria – long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, and short-term effectiveness. One then compares overall effectiveness with cost to see whether the cost is proportional to effectiveness. Both a nominal 0.6 meter cap and a minimum 1 meter cap are protective of human health and the environment and meet ARARs. However, the cost increase attributable to the minimum 1 meter cap is disproportionate to its effectiveness given that the nominal 0.6 meter cap is equally effective. If the remedy is not cost-effective, EPA can't select it.

The rationale for requirement of a minimum cap thickness of 1 m appears to have its origins in the Navy Homeport deliberations of the 1980's. At that time, deepwater disposal and capping of Everett Harbor sediments dredged from the Homeport site was proposed. Opponents to this action maintained that a minimum cap thickness of 1 m should be required to eliminate any potential that the contaminated harbor sediments would be exposed if ghost shrimp should burrow into the cap. This was based on the theory that ghost shrimp can burrow up to nearly 1 m deep, and that their burrowing would move sufficient quantities of contaminated sediments to the surface to incur a risk to the marine environment.

Asarco has searched, but been unable to find factual information that supports this concern. There appears to be a misconception that the burrowing shrimps (ghost shrimp and/or blue mud shrimp) are a demonstrated threat to a sediment cap in Puget Sound. The potential threat of these shrimp is that their burrowing activities will lead to sufficient contaminated sediment redistributed to the surface layers of the cap to raise contaminant levels above biological effects concentrations. This would require the shrimp to:

- Burrow to depths that would penetrate well into the existing sediments or
- Actively burrow within the contaminated sediments moving large volumes of the contaminated sediment to the surface, or
- Pump large amounts of water through the contaminated sediments extracting substantial concentrations of metals.

None of these actions are probable.

It is valuable to review what is known about the local species of burrowing shrimp. There are two species of subtidal burrowing shrimp in Puget Sound, ghost shrimp (Neotrypaea californiensis formerly Callianassa californiensis) and the blue mud shrimp (Upogebia pugettensis). Neotrypaea lives primarily at middle intertidal levels, commonly decreasing in abundance at lower intertidal elevations due to predation (Posey 1985, Posey 1986, Swinbanks and Luternauer 1987). Upogebia also tends to be intertidal but is found commonly at lower elevations. Both species are also found in subtidal areas. Neotrypaea is a deposit feeder that actively burrows in the top 10 cm of the sediments where it also constructs a single less active extension of its burrow generally about 30 cm deep, but sometimes as deep 40-50 cm (Swinbanks and Murray 1981). Upogebia is a filter feeder that forms a lined burrow that remains constant over time. Its burrow is Y shaped with the lower extension reaching as deep as 50-60 cm. Upogebia appears to actively pump water through the U shaped upper portion of its burrow to obtain food.

To our knowledge there have been no investigations demonstrating that sufficient numbers of ghost shrimp are likely to burrow to sufficient depths and move sufficient material to represent any demonstrated risk to the marine environment. We believe it is more likely that small numbers of ghost shrimp might burrow as deep as 60 cm in a cap, and that if they did the quantity of material they would move would not raise surface concentrations of metals to near the sediment quality standards. Upogebia does pump water through the upper portions of its burrows to provide food and oxygen. Because its burrows are lined and the active pumping is likely restricted to the upper U shaped portion of their burrows, there is little reason to expect that this water flow would extract measurable levels of contaminants even if the bottom of the burrow did extend into contaminated sediments.

Asarco has been unable to find any reports of burrowing shrimp actually changing the contaminant concentrations of sediments within a cap, or at the surface of a cap. The concern for contaminant redistribution appears to be theoretical rather than demonstrated.

Asarco also believes there is little risk in providing a 60-cm cap. Additional cap material can be added at a later date if monitoring determines there is actual evidence that ghost shrimp or other means are moving contaminants to the upper layer of the cap. The Proposed Plan (page 31) provides for the addition of material if monitoring indicates additional material is warranted.

Response: *Based on the depth of burrowing organisms known to be present at the Asarco facility, EPA supports the placement of a 3-foot cap at the Site. This cap thickness (3 feet or approximately 90 centimeters) is slightly different from the thickness proposed in the Proposed Plan (1 meter or 100 centimeters). As supported by the information below, EPA believes a 3-foot cap is necessary to protect human health and the environment and to ensure long-term effectiveness and permanence, but yet still be cost-effective. The EPA's preferred alternative is not "arbitrary and capricious and beyond the scope of EPA's authority," as stated in the above comment. For the reasons described below, EPA does not believe that the 0.6-meter (2-foot) cap proposed by Asarco is protective of the environment or effective in the long term.*

EPA's rationale for placing a 3-foot cap at the Site is based on the fact that bioturbation at this Site may extend to depths of approximately 30 inches (0.75 meter). The depth of bioturbation, which is based on the type of organisms that may inhabit the cap after cleanup, may be significant at the Site due to the presence of Neotrypaea californiensis (formerly Callianassa californiensis). This shrimp has been documented at the pilot cap, and tends to build extensive burrows with multiple entrances. Burrowing activities are significant in the upper 50 centimeters (20 inches) of sediment (Hornig et al 1989, Griffis 1991, Swinbanks et al 1987, Posey 1986, and Ott et al 1976), and some research states that burrows can extend to depths of approximately 30 inches (or 0.75 meters) (Kaestner 1980, Hornig et al 1989). Further, both the depth of potential burrowing activity and the impact of the *burrowing activities on sediment characteristics need to be taken into account when selecting a cap thickness for the Site. Even if a shrimp does not penetrate the entire cap, the burrows alter the characteristics of the sediment (higher water content, finer grained) such that the sediment may become more prone to erosion and transport from the Site.*

In addition, Callianassa are capable of redistributing a significant volume of subsurface sediment to the surface if they colonize a cap. At the Denny Way cap in Elliott Bay, Callianassa were found at densities of 8-10/m2 at six months after capping, and between 38 - 66/m2 at 18 months after capping. At the latter density at the Denny Way Cap, Callianassa was estimated to be redistributing 1.2 to 5.4 kg/m2/day of subsurface sediment to the cap surface. Further, as indicated by the results of the pilot cap study conducted at the Site, a few inches of mixing occurs within the bottom of the clean cap material during cap placement. To insure an effective cap, these local data (regarding the volume of sediment moved by organisms and the amount of mixing that occurs during cap placement) indicate that a minimum cap thickness of 3 feet is appropriate to minimize disturbance and recycling of the contaminated sediments to the surface.

In conclusion, since the presence of these burrowing organisms has been documented at the Site, and there is evidence to indicate these organisms burrow to approximately 30 inches, EPA supports a minimum 3-foot (36 inch) cap. A cap of this thickness would provide the long-term isolation that is necessary for this remedial action.

Further, the Refinement of Remedy Report (Hydrometrics, January 2000) proposed a minimum cap thickness of 2 feet, not a nominal thickness of 0.6 meter (or approximately 2 feet), as stated in the comment. EPA is currently proposing a cap with a minimum thickness of 3 feet. This difference in cap thickness does not represent twice the volume of material as stated in the comment.

Comment No. 14

Comment: (Section 8.1) Were the full range of potential organisms considered when determining the thickness of cap necessary to prevent recontamination due to bioturbation?

Response*: Yes. See the response (above) to Comment No. 13.*

Comment No. 15

Comment: Pg. 29, Sec. 9.2.1 In Situ Sediment Capping: [*As stated in the Proposed Plan*] "In situ capping is the Preferred Alternative for the Nearshore/Offshore area and Northshore area. Approximately 88,000 sq. yd. (18 acres) of existing contaminated sediments in the Nearshore/Offshore area will be capped with a minimum of 1 meter of clean sediment from an upland source and approximately 7,000 sq. yd. (1.5 acres) of existing contaminated sediments in the Northshore area will be capped with a minimum of 1 meter of clean sediment. The cap thickness will be designed such that it provides chemical isolation, is stable, and provides a cap surface that will allow recolonization of benthic communities."

While NOAA was originally pessimistic about the feasibility of capping the contaminated sediments in the remaining Nearshore and Offshore Units, the initial results of the Pilot Project supports this approach. Obviously, a fairly coarse material (sand and gravel) will be needed; such materials are often low in organic content (usually in the silt and clay fractions). However, it would be desirable if there is some way that increased organic content could be incorporated into the capping material to enhance biological repopulation. This is a challenge since the organics are usually associated with the finer components which can be swept away by the currents during emplacement. EPA should keep the goal of benthic recolonization in mind during design.

NOAA believes that nothing less than a 1-meter cap will effectively isolate contaminated sediment at the ASARCO site. One of the objectives for the sediment component of the remedy is "Restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above Washington State Sediment Management Standards (SMS, WAC 173-204)" (See bottom of pg. 16). In order to accomplish this goal, the habitat value of the sediments must be restored. It is likely that burrowing organisms will recolonize the cap material soon after it is placed, as occurred in the pilot study cap at the site (see the monitoring reports prepared for Asarco by Parametrix, Inc.). One organism thought to inhabit the sediment offshore of the Asarco facility is a ghost shrimp (also called mud shrimp). This organism is known to construct burrows 2 feet deep (Garman, personal communication). Other researchers report that ghost shrimp burrow to a depth of three feet (Ricketts and Calvin, 1962). Based on this information, we conclude that one meter is the minimum cap thickness that would be effective. It is necessary to isolate contaminated sediment from ghost shrimp and other burrowing organisms to prevent the biota from facilitating transfer of the contaminants to the sediment surface, the water column, and to higher trophic level organisms (G. F. Riedel et. al., 1989).

Response: *EPA concurs with NOAA's comment. Benthic recolonization will be considered during design of the cap, and EPA continues to support a 3-foot-thick cap for the Site.*

Sediment Dredging

Comment No. 16

Comment: The Proposed Plan describes dredging to a depth of approximately 2 feet. This is an acceptable depth to use to develop a conservative estimate of dredging volume. However, it needs to be made clear that actual dredging depth will depend on the actual depth of contamination that is verified to be present during Remedial Design and during actual dredging. There is no evidence of sediments exceeding cleanup screening levels (CSLs) below a depth of 1 ft in the marina.

As part of the Phase 2 Expanded RI/FS, subsurface sediment chemistry core samples were collected by divers at stations 5-0 and 5.5-0 in the yacht basin (Parametrix 1996). The upper layer of sediment that contains metals higher than CSLs was visually distinctive from the deeper sediments that did not exceed CSLs. Cores were observed to contain black sand in the upper 0.4 ft and gray sand from 0.4 to 1.9 ft. Core samples from the upper 1.0 ft exceeded CSLs for arsenic, copper, and zinc. Samples from 1.0 to 1.9 ft were below CSLs.

Divers collected two additional core samples from the shallow, shoreward side of the basin in 1997. Rather than dividing the cores into 1-ft segments, these cores were sectioned according to visually distinctive changes in sediment type. The core from station 5-0.9 was described as a dark olive colored sandy gravel in the upper 17 cm (0.6 ft). The 17 to 18 cm section was gravel with shell debris. Copper exceeded the CSL in the upper section and all metals tested were below CSLs in the 17 to 18 cm section. The other core sample contained olive colored fine sand in the upper 21 cm (0.7 ft). The 21 to 37.5 cm section (0.7 to 1.2 ft) was silty sand with gravel and cobbles. The upper section exceeded CSLs for copper and mercury and the lower section was less than the CSLs for all metals analyzed.

Additional core samples will be collected in the spring of 2000 as part of the preliminary design analyses for yacht basin dredging. These analyses will help determine whether metals exceeding CSLs are limited to the upper 1 ft of sediments, or if deeper sediments exceed CSLs in any areas of the yacht basin.

Response: *EPA acknowledges Asarco's comment. The exact depth of dredging will depend on the existing core information, as well as the core information that will be collected in the spring of 2000. Post-dredging confirmatory sampling will also be required to confirm adequate removal of contaminated sediments.*

Comment No. 17

Comment: Page 20, Table 7-3. The note for alternative S-2D states: "As a contingency, if all the contaminated material cannot be removed from the Yacht Basin, dredging in the Basin followed by placement of clean material may occur." EPA should acknowledge that slag will remain in the Yacht Basin following dredging and that this material, though it may exceed CSLs, has been shown to not exhibit contaminant effects at other areas of the Site. It would not be possible to remove all the slag exceeding CSLs from the basin without removing the entire breakwater peninsula, and dredging at the base of the peninsula will need to be designed so that it does not destabilize steep slopes. Placement of clean material over the slag will not be necessary because the metals in slag are bound in a rock-like form and are not necessarily available to the benthic community.

Response: *EPA will depend on a tiered sampling approach for determining if additional action in the Yacht Basin is necessary after initial dredging is complete. As discussed in Asarco's comment above, it is anticipated that the sediment below 1 to 2 feet in the Yacht Basin does not contain chemical concentrations above state Sediment Quality Standards (however, an exception may be immediately next to the Breakwater Peninsula). Should conditions warrant, however, EPA may require placement of a cap over a dredged surface as one possible option for remediating parts of the Yacht Basin. Contingencies for addressing these types of situations will be developed during the remedial design.*

Comment No. 18

Comment: EPA + Asarco should consider deeper dredging between the road and a dock to remove contaminants and to facilitate passage of deeper draught Boats – contaminated sediments have accumulate from Asarco property to fill this area in to a disadvantageous degree.

Response: *EPA's goal is to dredge the sediment where samples indicate adverse biological effects. The exact depth of dredging will be further refined in late 2000, after additional sampling has occurred in the Yacht Basin. As for dredging to accommodate passage of deeper draught boats, Asarco has committed to work directly with Tacoma Yacht Club members on this issue. This collaborative effort will ensure the needs of boat owners are being addressed.*

Comment No. 19

Comment: Make sure any Dredging Plan for the Yacht Basin includes indemnification for damage to Boats + houses and dockage. Make sure provision for temporary moorage for displaced boats is made available.

Response: *It is EPA's understanding that Asarco will work directly with the Yacht Basin owners on indemnification and temporary moorage issues.*

Comment No. 20

Comment: Pg. 30, Sec. 9.2.2 Yacht Basin: [*As stated in the Proposed Plan*] "For the dredging alternative, the material would be dewatered, and then placed in a controlled, upland location (known as Crescent Park, in the central part of the upland Facility), that will be monitored for many years. This allows for the long-term effectiveness of the remedy to be monitored. Further, the mobility of the contaminants would be reduced, as the sediment would be in a location that does not have contact with water. There will also be contingency plans should the upland cap begin to fail (i.e., get cracks in it)."

Comment: NOAA supports the preferred alternative because it permanently removes contamination from a site area that is perturbed by marina activities and only dredging to remove the contamination will allow the marina to continue operations in the future without restrictions on dredging. In addition, isolating the contaminated materials in an upland facility with contingencies for any incipient failure of the containment structure should be easy to monitor and implement because these upland site areas also will be used for isolation of contaminated soils and/or debris.

Response: *EPA acknowledges NOAA's support for the proposed remedies.*

Comment No. 21

Comment: (Oral comment provided at the February 10, 2000 public meeting)
Well, I have a voice that doesn't need a microphone. I would like to once again address the materials that have come down on the site close to the shore both inside of the breakwater and along our A dock, the part down there.

Those sediments have come down and the glacial till has come down with sediments because it's been blessed with those for decades as well. It has caused us a problem that will be a problem with our agreement with the park board. We lease this property from the park board.

And when this project as totally dreamed up comes to pass that there is a walkway, a pedestrian walkway along there, we have unattractive boathouses on that side so that you can see them from that walkway. And the reason for that is that it is shallow there.

This land that has come down has made the water shallow so larger boats, larger sailboats cannot come in there. Only small boats, inexpensive boats, can go in there because they're capable of backing out and turning around in a normal tide, where a larger boat can't do it because it's too shallow there.

So we have, one, the problem that, I think, that the sediments must be deeper there because it's been built up over a period of time and not sluiced away. But we also have the problem of that material coming down in a way that makes it so that we need that dredged out, that material removed for other reasons, and material that we had nothing to do with depositing there as well as however much arsenic there is.

And we would like to see what kind of help we could get in looking deeper into that particular problem when you consider the depth of the dredging or the amount of the dredging that you are going to do. Thank you.

Response: *Comment noted. EPA will take steps to see that Asarco coordinates with the Tacoma Yacht Club to address the coordination of dredging required for environmental protection and possible additional dredging that may be advantageous for navigation or other purposes.*

Comment No. 22

Comment: (Oral comment provided at the February 10, 2000 public meeting)

Thank you.

Again, as chairman 9f the board of trustees of Tacoma Yacht Club, I would like to officially put in the record that we want to be included as members of the team that work on planning and designing the way that we would go about dredging. At least being included because of the 300-plus boats our membership has moored here plus the portion of the basin that we lease to a private operator for public moorings. There's another 200-plus boats.

We have a lot of responsibility there, and we don't want to turn that responsibility over without having a say in just exactly how it's going to take place. So we want to officially go on the record as making that request.

We will make the people available. We will make professional people available, and I think probably will be an asset to the team. Bottom line is, we'd like you to leave it alone but I got a hunch you're probably not interested in that so we would want to be involved.

Response: *Comment noted. EPA will take steps to see that the responsible parties coordinate with the Tacoma Yacht Club regarding the dredging and associated work that will occur in the Yacht Basin.*

Comment No. 23

Comment: (Oral comment provided at the February 10, 2000 public meeting)

Thank you. I'm Chuck Prowse of the Tacoma Yacht Club, and Roy Brooks pretty well summed up everything that I wanted to say. I have some concerns about details and that was primarily the closure of the basin and its impact on our use of boats, being able to move them out of the basin when we want to use them.

Also I'd like to make a comment on a subject that was mentioned earlier and that was controlling sediments generated during the dredging operation and the proximity of this basin to the Metro Parks aquarium. There is a tidal current that runs parallel to the shoreline here and it runs up to two knots. It runs right past our clubhouse and goes right on down to the aquarium. It would take any sediment that escaped out of the basin right down to 5 the aquarium intake.

Response: *Comment noted. Suspended sediment caused by dredging will be controlled. The details will be addressed during the remedial design.*

Institutional Concerns Regarding Sediment Capping

Comment No. 24

Comment: The current proposal includes the permanent capping of contaminated sediments in place. Siting such permanent caps within the City of Tacoma Harbor Area - as the proposal currently does - is problematic in that the caps may be inconsistent with constitutional, statutory and regulatory directives.

The main issues are:

- Capping as a mechanism for contaminated sediment storage is a non water-dependent use. Non water-dependent uses in harbor areas are considered interim uses and can only be allowed if defined criteria are met (e.g., compatibility and exceptional circumstance analyses and other factors, Washington Administrative Code (WAC) 332-30-137);
- Institutional controls (i.e., Regulated Navigation Area) likely necessary to maintain the integrity of the capped areas will limit commerce and navigation in a Harbor Area. However, Harbor Areas are reserved for commerce and navigation in the Washington State Constitution; and
- Caps displace navigation and increase present navigational hazards.

In addition, some of the proposed cap appears to extend beyond the outer harbor line. This is especially problematic because Article XV Section 1 of the Washington State Constitution establishes that "the state shall never give, sell, or lease to any private person, corporation, or association any rights whatever in the waters beyond such harbor lines."

If the proposed caps are authorized, the City of Tacoma's Harbor Area will have to be adjusted, a time-consuming process subject to rules detailed in WAC 332-30-116. A Harbor Area relocation should maintain or enhance the type and amount of harbor area needed to meet long-term needs of water dependent commerce. The relocation should also maintain adequate space for navigation beyond the outer harbor line. After these findings are made, there are other issues to be considered (see WAC 332-30-116(2)).

We have identified to EPA the value of the Asarco area as an important functional component to the overall Harbor Area in Commencement Bay. We continue to encourage EPA to define a plan that recognizes this important land use role and that allows a balance between commerce/navigation and habitat functional needs. The cleanup plan should not impact the existing deep draft capability at the site or lessen the current and future capacity for structures associated with navigation and commerce.

Response: *EPA offers a six part response:*

1. *Capping as a Mechanism for Contaminated Sediment Storage is a Non Water-Dependent Use* **-** *EPA does not intend capping as a temporary or interim remedy. EPA is mandated by CERCLA to select the remedies that are permanent to the maximum extend practicable. EPA must also perform five-year reviews to ensure that the cap stays in place and remains protective. EPA will*

require the cap to be monitored to ensure that it is continuing to protect human health and the environment. If EPA determines that the cap is no longer protective, EPA can amend its ROD or issue an Explanation of Significant Difference (ESD) and modify the remedy if necessary.

EPA also disagrees that capping is a nonwater-dependent use. The regulations define "nonwater-dependent use" as a "use that can operate in a location other than on the waterfront." WAC 332-30-106(42). First, if EPA selects capping as the appropriate remedy then it must take place in the water; that is, it cannot logically exist in any location but on the water, thereby making it waterdependent as defined by the regulations. WAC 332-30-106(71). Second, Washington's regulations also define the policy for "nonwater-dependent use" as a "low priority use providing minimum public benefits." WAC 332-30-137. Capping the sediments to prevent harm to human health and the environment does provide "public benefits" and therefore does not fall under the regulatory policy.

2. *Institutional Controls – Although EPA must implement institutional controls to maintain the integrity of the cap, EPA does not believe that capping will impede reasonably foreseeable uses of navigation and commerce.*
3. *Caps Displace Navigation and Increase Present Navigational Hazards – See response to #2, above.*
4. *The Proposed Cap Appears to Extend Beyond the Outer Harbor Line – EPA is not seeking to buy, lease, or receive rights to property. By choosing capping as a remedy, EPA is trying to prevent further contamination of the sediments. EPA, or the party performing the work, will need access to the waters to perform the remediation and subsequent monitoring, but the property shall remain with DNR.*
5. *Adjustment of the City of Tacoma's Harbor Area – EPA expects that DNR will cooperate in making any necessary and appropriate changes to legal designations and in developing institutional controls to maintain the protectiveness of the remedy so that human health and the environment can be protected.*
6. *Deep Draft Capability of the Site and Future Capacity for Structures Associated With Navigation and Commerce – See response to #2, above.*

Comment No. 25

Comment: For public aquatic lands, the state laws, the state Constitution, and the existing policies, strategies, and guidance for implementing these laws do not support the use of public aquatic lands for permanent storage of contaminated material. If contamination is to be temporarily stored on public aquatic lands, the worst of the contamination must be removed for treatment or upland disposal, and the remaining storage site must be designed to allow future removal for treatment or upland disposal once technology makes it feasible to do so. Neither the alternatives analysis nor the resulting proposal to cap recognizes or incorporates these standards for use of public aquatic lands.

Response: *The laws and policies cited by DNR do not clearly address cleanup issues, including the suitability of capping as a remedy. EPA intends for capping to be a permanent solution for the sediments. EPA will require monitoring of the cap to ensure its stability and effectiveness. If EPA later determines that the cap is not protecting human health and the environment, EPA can amend its ROD or issue an Explanation of Significant Difference (ESD) to modify the remedy.*

Groundwater Extraction and Treatment

Comment No. 26

Comment: We strongly support alternatives to actively remove and treat contaminated groundwater, and we encourage a commitment to long-term, intensive monitoring to determine effectiveness of the remedy.

Response: *Alternative GW-C (Pump/Treat and Discharge to Outfalls) was evaluated as part of the Feasibility Study. The pump/treat system would need to be operated into perpetuity because the primary source material (slag) can not be removed and will continue to contribute contaminants to groundwater indefinitely. A pump/treat system such as Alternative GW-C would therefore not provide any permanent environmental solution. In addition to being cost-effective, the preferred alternative (GW-B) has the benefit of reducing groundwater discharge to Commencement Bay by an estimated 75 to 95 percent, thus resulting in a significant reduction in contaminant loading to the marine environment.*

Comment No. 27

(Section 8.6) Since the following sentence claims that pump and treat is reliable and available, by "difficult" do you mean costly?

Response: *The pump and treat alternative would be "difficult" to construct and operate in the sense that the layout of the overall system would be extensive and the physical plant facilities large compared to similar systems at other sites. From a hydraulic perspective, a pump and treat system would be inefficient due to the proximity of Commencement Bay (i.e., an extraction system would pump a significant volume of water originating from the bay). From a logistical standpoint, the size and extent of the system would be relatively difficult to operate given the presence of the other remedy elements (low-permeability cap, drainage systems, onsite containment facility, etc.) and the other site uses anticipated for the future. The system would also be costly to build and operate compared to the other alternatives evaluated.*

Remediation Goals/Levels (Groundwater)

Comment No. 28

Comment: Asarco strongly prefers that the Preferred Alternative and Proposed Plan result in attainment of Remedial Action Objectives and Remediation Goals (RGs). Asarco's primary concerns regarding the attainment of RAOs and RGs are:

1. The Remedial Action Objectives for groundwater do not match the RAOs of the Asarco Tacoma Smelter Facility Record of Decision ("Upland") ROD. Since the remedial action is being, and will continue to be, implemented as part of the Upland ROD, it appears that the remedial action must "serve two masters."
2. RAOs are overly broad and ignore site-specific information about the risk from arsenic.
3. The compliance point for attainment of RGs is not specified. Depending on location of groundwater compliance points the RGs may not be attainable.

To remedy these concerns, Asarco proposes that:

- The RAOs for groundwater in the Proposed Plan should complement the RAOs for groundwater in the Upland ROD;
- The RG for arsenic should be based on EPA's Site-specific risk assessment that indicates existing groundwater discharges to Commencement Bay do not cause unacceptable risks to human health and the environment; and
- the compliance point for groundwater discharges should be identified as the point of discharge (i.e., post-remedial action groundwater/seawater interface).

Specifically, Asarco proposes the following groundwater RAOs:

1. Prevent ingestion of potable groundwater containing concentrations above Federal MCLs and direct contact with groundwater containing contaminants in concentrations above risk-based goals.
2. Reduce discharge to Commencement Bay of groundwater that exceeds applicable marine surface water quality standards, <u>risk-based levels protective of human health</u>, or background concentrations (if background concentrations are higher than the standards).

Asarco proposes an arsenic remediation goal of 0.012 mg/L based on maintenance or improvement of groundwater arsenic concentration at the slag shoreline.

Asarco proposes a compliance point of surface water along the face of the post-RA slag shoreline.

<u>Remedial Action Objectives</u>

The Proposed Plan modifies the earlier RAOs in the Upland ROD for the Site making them overly broad and inappropriate. EPA's remedial action objectives (RAOs) for groundwater in the Proposed Plan are as follows:

1. Prevent ingestion of or direct contact with groundwater containing contaminants.
2. Prevent discharge (to Commencement Bay) of groundwater that exceeds applicable marine surface water quality standards or background concentrations (if background concentrations are higher than the standards).

For comparison, the Upland ROD RAOs are:

1. Prevent ingestion of potable (Class IIB) groundwater containing contaminants in concentrations above ARARs or above risk-based goals when ARARs are not protective or not available.
2. Reduce discharge to Commencement Bay of contaminated waters containing contaminants in concentrations above ARARs or risk-based goals when ARARs are not protective or not available.

As written, Proposed Plan RAO #1 is neither achievable nor necessary. EPA has substituted "groundwater" for "potable groundwater" and "groundwater containing contaminants" for "groundwater containing concentrations above ARARs" All groundwater, everywhere, contains "contaminants" but that is not a problem for human health or aquatic life unless concentrations are too high (i.e., above ARARs or risk-based goals). As written the RAO is so broad that it is nearly meaningless and gives no direction to the goals that are to be achieved.

Compared to the Upland ROD RAOs, Proposed Plan RAO #2:

- Substitutes "prevent discharge to Commencement Bay of groundwater" for "reduce discharge of contaminated water"; and
- Substitutes "background concentrations" for the phrase "risk-based goals when ARARs are not protective or not available."

Prevention of discharge of groundwater from the Site is not technically possible. However, the Preferred Alternative will reduce the discharge of groundwater from the Site to the extent practicable and will reduce the discharge of contaminants to levels that are clearly protective of human health and the environment.

Background concentrations are not appropriate substitutes for risk-based goals for arsenic since Site-specific risk information and protective risk-based goals are available. The Proposed Plan correctly points out that

> "Neither the Maximum Contaminant Limits (MCLs) promulgated under the Federal Clean Water Act nor the State of Washington Model Toxics Cleanup Act (MTCA) groundwater cleanup levels are considered Applicable or Relevant and Appropriate Requirements (ARARs) for the shallow groundwater system at the Facility." page 15, Proposed Plan

In this case, it is appropriate to use risk-based levels and EPA correctly notes that:

> "Currently, the groundwater discharging to Commencement Bay will exceed human health risk based levels for fish consumption (0.14 µg/L for arsenic) (National Toxics Rule; CFR 40, § 131.36). However, past fish tissue sampling indicates low risk from Facility contaminants even to people consuming large quantities of fish from the Facility." page 15, Proposed Plan

However, the RAO and RG for arsenic fail to acknowledge EPA's uncertainty in the National Toxics Rule (NTR) fish consumption limit and fails to acknowledge EPA's Site-specific data and risk assessment. The NTR does not reflect the current understanding of arsenic health risks. EPA has been reviewing the NTR arsenic criteria for several years with the intent to revise the criteria. EPA's risk assessment indicates that existing risk from fish consumption is acceptable and will be lowered further by implementation of the Preferred alternative.

CERCLA Section 121(d)(2)(B)(i) provides a standard for determining whether or not any water quality criteria under the Clean Water Act is relevant and appropriate. In making this determination, Section 121 directs that the Agency:

"shall consider the designated or potential use of the surface or groundwater, the environmental media affected, the purposes for which such criteria were developed, and the latest information available."

The existing human health criteria for arsenic in the NTR does not reflect the latest information available and does not consider Commencement Bay, the environmental media affected. EPA is currently in the process of revising the human health criteria for arsenic in the NTR. Recent information on arsenic risks in Commencement Bay are available in EPA's risk assessment entitled "EPA Ecological Risk Assessment and Seafood Consumption Screening Risk Assessment Asarco Sediment Site – October 1996." Given the uncertainty in the NTR arsenic level and the existence of more recent Site-specific data, Asarco believes that the NTR arsenic level should not be an ARAR for the Site in accordance with CERCLA Section 121(d)(2)(B)(i). In establishing the RAO for arsenic in groundwater, EPA should consider the latest information on the environmental media affected. The latest information available is EPA's risk assessment on Commencement Bay. Asarco proposes that the RAO be revised to include the use of risk-based limits for arsenic.

Remediation Goal for Arsenic in Groundwater

For current arsenic risks EPA's risk assessment (USEPA, October 1996) concluded:

The potential for adverse non-cancer health effects associated with ingestion of fish caught near the site is low (i.e. at or below the hazard quotient benchmark value of 1.0).

For the reasonable maximally exposed individual, inorganic cancer risk estimates are close to but not greater than the upper end of the risk management range recommended in the NCP (1 x 10-6 to 1 x 10-4) at fish ingestion rates greater than approximately 150 grams per day.

For the average case individual, inorganic cancer risk estimates are within or below the NCP risk management range at all fish ingestion rates considered.

Or as summarized by EPA in the Proposed Plan:

> "…past fish tissue sampling indicates low risk from Facility contaminants even to people consuming large quantities of fish from the Facility." Page 15, Proposed Plan

In light of Site-specific data regarding the low arsenic risk from seafood ingestion, Asarco proposes that an appropriate RG for arsenic would be based on maintaining existing arsenic concentrations in groundwater discharging to Commencement Bay. Since the Preferred Alternative will result in a substantial decrease (to the extent practicable) in the amount of groundwater flow to Commencement Bay, maintaining groundwater arsenic concentrations would result in substantial decreases in the load (or mass) of arsenic discharged to Commencement Bay. Therefore, the Proposed Remedy with Asarco's proposed RG would result in further reduction to the maximum extent practicable of the already acceptable arsenic risk.

Groundwater Compliance Point

The Proposed Plan does not specify a compliance point for groundwater discharging to Commencement Bay. Asarco proposes that the compliance point for groundwater discharges should be in the surface water as close as technically possible to the point or points where ground water flows into the surface water. After remediation, the point on the Site that is "as close as technically possible to the point or points where the ground water flows into the surface water" will be surface water along the face of the stabilized and protected slag shoreline. This compliance point of surface water along the face of the post-RA slag shoreline would protect the water resource at the point of possible human or aquatic life exposure and would comply with MTCA.

Under Washington's Model Toxics Control Act (MTCA), groundwater compliance monitoring points should be selected to be "as close as technically possible to the point or points where the ground water flows into the surface water." (WAC 173-340-720(3)(b)(v)). Furthermore, "At these sites [where the affected ground water flows into nearby surface water], the department may approve a conditional point of compliance that is located within the surface water as." (WAC 173-340-720(6)(d)). Presently, the point where groundwater flows into surface water on the Site is the face of the slag shoreline. During Upland remediation, the face of the slag shoreline will be armored to prevent erosion. After Upland remediation is completed, the point where groundwater flows into surface water on the Site will be the face of the armored shoreline. Therefore, the proposed groundwater compliance point is surface water at the face of the post-RA shoreline.

Response: *The response to the above comment is been divided into three parts:*

- *Remedial Action Objectives for Groundwater*
- *Cleanup (Remediation) Goal for Arsenic in Groundwater*
- *Point of Compliance for Groundwater*

1) <u>Remedial Action Objectives for Groundwater</u>

The comment suggests that the RAOs for groundwater must replicate the RAOs cited in the 1995 ROD for OU 02 (i.e., the "serve two masters" argument). The 1995 ROD specifically defers a cleanup decision for Facility groundwater. Because the remedy selection for groundwater was deferred for 5 years, it is appropriate to reassess the RAOs in context of new information that has become available.

EPA agrees with Asarco's comment indicating that the RAO as presented in the Proposed Plan may be vague with respect to the use of the term "contaminated" without qualification. Therefore, the RAO as stated in Section 8 of this ROD has been revised to read:

> *"Prevent ingestion of groundwater containing contaminant concentrations above federal maximum contaminant levels (MCLs) or above risk-based goals for those substances for which MCLs have not been established and prevent direct contact with groundwater containing contaminant concentrations above applicable risk-based goals."*

Regarding the second RAO ("Prevent discharge [to Commencement Bay] of groundwater that exceeds applicable marine surface water quality standards or background concentrations [if background concentrations are higher than the standards]."): The RAO is not meant to suggest that discharge of all groundwater to Commencement Bay can be prevented. Instead, the intended objective is to prevent discharge of groundwater <u>containing contaminants at concentrations in excess of applicable standards or background concentrations</u>. We agree with Asarco's proposed revision of the RAO that recognizes the need to incorporate wording acknowledging the need to protect human health in addition to the marine environment. Therefore, the RAO as stated in the ROD has been revised to read:

"Prevent discharge to Commencement Bay of groundwater containing contaminants at concentrations exceeding applicable marine surface water quality standards, risk-based levels protective of human health, or background concentrations (if background concentrations are higher than the applicable standards)."

2) <u>Cleanup (Remediation) Level for Arsenic in Groundwater</u>

EPA acknowledges that human health criteria for arsenic is under review. At this writing, however, the National Toxics Rule (NTR) standard of 0.14 µg/L has not been revised and remains an ARAR for the Site. However, the ROD waives the NTR standard for groundwater and defers to MTCA for determining the cleanup level. Application of MTCA results in a cleanup level of 6 µg/L for arsenic (see Section 12.1.3 of the ROD).

3) <u>Point of Compliance for Groundwater</u>

The point of compliance for groundwater was recently determined by EPA in cooperation with the Washington State Department of Ecology. The point of compliance will be at the interface of the surface water and the shoreline of Commencement Bay and the Yacht Basin. Specifically, the point of compliance for the slag aquifer will be at the interface between the slag (or any overlying shoreline armoring materials) and the surface water. This is technically a "conditional" point of compliance as addressed by WAC 173-340-720 (6)(c) and (d). Compliance will be based on a comparison of groundwater data from nearshore monitoring wells with cleanup levels adjusted to reflect a location-specific dilution/attenuation factor. See Section 12.1.4 of the ROD for more information.

Comment No. 29

Comment: Page 15, Remediation Goals. At a minimum it would seem appropriate for EPA to acknowledge that the NTR arsenic criteria is under revision. It might also be appropriate to establish that if the arsenic RG can not be met, then the revised arsenic criteria would be considered in determining the need for additional groundwater controls/remediation.

Response: *See the response to Comment No. 28. The ROD acknowledges the on-going review of risk information for arsenic. Improvements in groundwater quality are not expected to occur immediately after remediation is complete. Instead, such improvements are likely to occur over a period of years. To that end, EPA expects that remedy success or failure with respect to meeting cleanup levels can only be determined after collecting post-remediation data for several years. If the cleanup level for arsenic is not being met, the need for supplementary cleanup actions will be assessed as part of the five year review processes. Such actions could include, but are not limited to, relaxation of the cleanup level (if supported by new risk-based standards) or additional remedial actions if they are deemed effective and practicable. EPA expects that the Operation, Maintenance, and Monitoring Plan (OMMP) will identify an evaluation and decision process for assessing the long-term monitoring data and determining if the cleanup levels are being achieved.*

Comment No. 30

Comment: 6.1 Groundwater Cleanup Objectives

Background contamination levels for copper in the remedial area are held to be 40 ug/L and a question is raised as to whether groundwater cleanup levels of 3.1 ug/L can be met. However, no mention is made as to what the background levels for copper in groundwater are for the Commencement Bay area outside of the Asarco site. Presumably, the higher copper background contaminant level is directly attributable to past smelter operations, and therefore subject to remedial action to correct the problem.

Response: *The 40 µg/L concentration cited for copper is the established "natural" background level. It represents the copper concentration in groundwater in the greater Tacoma area, not just in the vicinity of the Site (for further information on how background levels were determined see Remedial Action Objectives and Preliminary Remediation Goals for the Asarco Tacoma Site, Appendix F, [EPA, April 1993]).*

Comment No. 31

Comment: (Section 6.1) What happens in the future if and when background concentrations and laboratory detection limits drop? Will cleanup goals track these drops, if they occur, until it reaches the National Toxics Rule standard of 0.14 µg/l for arsenic. Likewise for copper.

Response: *The five-year review process will assess if the remedy is performing as designed and is still protective of human health and the environment. Cleanup levels could be modified to reflect new risk-based or regulatory criteria.*

Comment No. 32

Comment: Pg. 15, Sec 6.1, Groundwater Cleanup Objectives: [*As stated in the Proposed Plan*]

- "Prevent discharge (to Commencement Bay) of groundwater that exceeds applicable marine surface water quality standards or background concentrations (if background concentrations are higher than the standards)."

AND: "The cleanup goal of 3.1 ug/L for copper is protective of human health and marine life in Commencement Bay. It is acknowledged, however, that the background concentration for copper in the vicinity of the Facility is 40 ug/L , and it may not be possible to achieve the 3.1 ug/L cleanup goal. If not, copper in groundwater will be managed to the 40 ug/L background concentration."

These statements are ambiguous. The information provided above documents that the (upgradient groundwater) background concentration for copper is higher than the acute and chronic ambient water quality criteria. On the basis of the wording of the Groundwater Cleanup Objective, this would indicate that for copper in groundwater the cleanup objective is 40 ug/L. However, the ecologic receptors and the applicable criterion apply to waters of Commencement Bay. It is questionable whether a remedy that does not lead to compliance with the water quality criteria is ecologically protective, and it is possible that even if the groundwater copper concentration is controlled to 40 ug/L, that the shoreline waters of Commencement Bay will not meet the water standard. There are other sources of copper (and other metals and metalloids) contamination along the shoreline such as contaminated surface water runoff and the large deposits of slag, but these sources also are affected by former actions of Asarco.

It is the position of NOAA, as the federal Natural Resource Trustee for marine organisms and habitats, that a goal of the overall remedy should be the attainment of water quality criteria for the protection of marine life in all areas of Commencement Bay affected by former site smelting, manufacturing, and/or disposal activities.

Response: *Comment noted. EPA shares the Natural Resource Trustee's goal to attain water quality criteria for the protection of marine life in Commencement Bay. This is reflected in the stated cleanup level of 3.1 µg/L for copper (equal to the marine chronic criteria for copper). EPA believes that the 3.1 µg/L cleanup level for copper may be achieved before groundwater discharges to Commencement Bay. EPA expects copper concentrations to decline with time due to the benefits of upland contaminant source removal actions, site capping and surface water controls (limiting groundwater recharge), and the ongoing seawater intrusion that occurs in the nearshore portions of the site aquifers (resulting in dilution of copper before groundwater is discharged to Commencement Bay). "Ultra clean" sampling data collected by Asarco in 1999 show that current (pre-RA) copper concentrations in Commencement Bay water immediately adjacent to the slag shoreline face are below the 3.1 µg/L cleanup level in most locations sampled. The significant exception is the Yacht Basin where samples exceed the copper cleanup level as far as 200 feet from shore (8.38 µg/L, average of high and low tide samples collected in September 1999). This is not unexpected given the proximity of the Yacht Basin to the previously existing "Copper Refinery Area," a significant upland source of copper contamination. Source materials are being removed from the Copper Refinery Area as part of the OU 02 remedial action. Further, Yacht Basin sediments containing copper above sediment cleanup levels will be removed by dredging as part of the remedial action for OU 06. With time, these source removal efforts and other upland remedial actions are expected to result in decreased copper concentrations in the Yacht Basin water.*

Remediation Goals/Levels (Sediment)

Comment No. 33

Comment: The Proposed Plan describes the sediment clean up objectives for remediation as the State Sediment Management Standards (SMS). Asarco agrees that the SMS may be a useful relatively simple initial measure that can be used as a guideline of the success of the remediation. However, it should not be the sole determination of whether the remediation is successful as defined in Section 6.2 of the Proposed Plan.

As discussed above, the SMS uses bulk sediment chemistry, bioassays, and relatively simplistic measures of benthic abundance. Both the data analysis presented in the Phase 1 Report and EPA's own methodology for determining contaminant effects areas presented in the draft Proposed Plan go beyond the simple SMS approach. It is therefore unreasonable to go back to the SMS approach when evaluating the success of remediation.

If the physical and chemical properties of the sediments (e.g., particularly slag particles) can confound the determination of cleanup areas, they can certainly confound the determination of cleanup success. To be consistent with all of the knowledge gained on Asarco sediments over the years, an achievable reasonable sediment cleanup objective must allow for these potentially confounding effects and go beyond a simple SMS type approach.

Asarco recommends that a preponderance of evidence approach as presented in the Phase 1 Report be used to determine the cleanup success. Because this approach may require extensive sampling and data analysis, cleanup success could be determined through a tiered process. The tiered process would use progressively more complex and accurate analyses to determine whether the sediments have indeed been cleaned up similar to PSDDA and the SMS itself. One possible approach would be as follows:

Tier 1. Compare bulk sediment chemistry to SQS values. If sediment chemistry is below SQS, then cleanup objective has been met. If sediment chemistry is above SQS, proceed to Tier 2.

Tier 2. Conduct bioassays (suite to be determined) and compare results to reference sediments (similar to SMS). If bioassays not significantly different (exact criteria to be determined) from reference, then the cleanup objective has been met. If bioassays are significantly different, then proceed to Tier 3.

Tier 3. Conduct benthic community analysis and analyze various measures (to be determined but similar to Phase 1 Report) of abundance and diversity. (In this case the simple SMS benthic measures might be used but some other more complex data analysis must also be included).

Immediately after cap construction, only Tiers 1 and 2 could be used, because no benthic community would be present. However, recourse to Tier 3 would be available several years after construction.

In addition, the use of the word "prevent" in the cleanup objective definition appears to be inappropriate. Asarco agrees that the exposure of receptors to contaminant effects can be "limited" or "minimized." However, cleanup success should not be measured in terms of absolute prevention of all exposure to contaminants to all potential receptors. It is possible that minor exposures might take place, but in overall terms the remediation would still be successful. The success of the remediation should be measure in terms of whether the entire cleanup meets the overall goals of protection of human health and the environment.

Response: *EPA agrees with the concept that a tiered approach is applicable to determining the success of the remedy. The exact details of this approach will be determined as part of the Operation, Maintenance, and Monitoring Plan (OMMP).*

Asarco's concern regarding the use of the word "prevent" in the cleanup objective is noted by EPA, however EPA believes that as a goal, the word "prevent" is still appropriate. EPA will keep the wording of the cleanup objective as is.

Comment No. 34

Comment: Of greatest concern is that EPA defer to and enforce all Washington State cleanup standards for groundwater and sediments. As was recently proved in the findings for Asarco at the Asarco Everett facility, failure to enforce Washington State standards on one site can have adverse impacts to another site cleanup. As Asarco is a PRP for another Commencement Bay Superfund sediment cleanup action in the Hylebos Waterway, it is imperative that uniform cleanup standards be employed throughout the entire Commencement Bay cleanup area.

Response: *Comment noted. The cleanup levels selected for this Site are consistent with ARARs (including Washington State cleanup standards for groundwater and sediments) and have been developed based on site-specific conditions and information. Further, the Washington Department of Ecology concurs with the cleanup levels selected for the Site.*

Comment No. 35

Comment: 6.2 Sediment Cleanup Objectives

EPA's stated cleanup objective for sediments is to restore and preserve aquatic habitats by limiting or preventing the exposure of environmental receptors to sediments with contaminant above Washington State Sediment Management Standards.

Response: *The comment has correctly restated EPA's cleanup objective. EPA assumes that CHB concurs with EPA's objective.*

Remedy Costs

Comment No. 36

Comment: (Table 7.2 and 7.3) Alternative S-1E: Dredge and Upland Disposal has a present worth cost of $26.2 million for 88,000 cy. This is $298/cy. Alternative S-2D: Dredging and Upland Disposal has a present worth cost of $3.6 million for 55,000 cy of Yacht Basin sediment. This is $65/cy. Why is one over 4.5 times more than the other?

Response: *The difference in the costs for the Dredge and Upland Disposal alternatives for the Yacht Basin versus the Nearshore area is due to the fact that the material from the Yacht Basin can be accommodated under the onsite cap . If material was removed from the Nearshore area, it would need to go offsite, because there is not sufficient capacity onsite to handle all of the nearshore sediment. Offsite disposal is significantly more expensive than onsite disposal.*

Comment No. 37

Comment: (Section 8.7) The sentence "For all sediment areas, upland disposal is less costly than nearshore confinement" is not consistent with Table 7.2.

Response: *DNR is correct – the statement is incorrect as written. Instead, it should read: "upland disposal is less costly than nearshore confinement when the dredged material can be placed onsite."*

Endangered Species Act and Biological Assessment Issues

Comment No. 38

Comment: We anticipated that the extension to the comment period would provide the opportunity to review the Proposed Plan in the context of the Commencement Bay Biological Assessment (BA). We view the BA as critical to decision-making at all scales in the bay, including site-specific cleanup actions. Without consideration of the BA, we do not believe that our common goal of achieving cleanup in a broader ecosystem management context can be ensured. We also cannot evaluate the adequacy of the proposed site-specific remedial action in achieving ESA compliance without review by and discussion with EPA and National Marine Fisheries Service of the BA and the biological opinion. Until this information and analysis is available, we remain concerned that the effects of the proposed remedial action on critical habitats for chinook salmon are not resolved at either a site or baywide scale.

For example, we are concerned with the lack of information and guidance on the functional linkages between deep water (>-10 MLLW) epibenthic habitats and the foodweb for young-of-year and immature resident chinook salmon. Recent studies of the polychlorinated biphenyls body burdens for Puget Sound chinook and herring stocks indicate an exposure pathway link between the benthic community and the pelagic foodwebs of these species. This information argues for a very conservative approach to remediating chemicals of concern for bioaccumulation, such as arsenic and mercury.

We are also concerned that the proposal does not restore the healthy nearshore habitats, both as salmonid migration corridors and as intertidal feeding areas, that once existed at the site. In addition, we believe that decisions regarding cleanup objectives are based on incomplete information. We encourage incorporation of the latest information from the federal services – particularly results of current NMFS efforts - on cleanup standards that are protective of trust resources.

Available information suggests that numerous individuals from the White River chinook stock are expected to rear nearshore at the Asarco site for extended periods. The proposed plan does not provide sufficient information to determine the degree to which chinook salmon will be restored and protected. We encourage EPA to more actively integrate the numerous cleanup decisions necessary throughout Commencement Bay within the context of the Commencement Bay BA and biological opinion. We are interested in working with EPA on a management plan for the entire bay that defines both site-specific and baywide implementation actions, with net gain in habitat area and function being one of the primary plan objectives.

Response: *The Biological Assessment (BA) being performed for Commencement Bay does not address the Asarco sediment site (e.g., it covers the waterways within Commencement Bay only). Instead, DNR is referred to the BA and Endangered Species Act (ESA) assessments being performed specifically for the shoreline armoring being conducted under OU 02 and the sediment capping and dredging proposed for the offshore areas of the Asarco Facility (two separate BAs and ESAs) .*

As for concerns regarding bioaccumulation of chemicals at the Site, DNR is referred to the tissue sampling (benthic and fish tissue samples) and the benthic community analyses completed by Asarco as part of the Phase 1 sampling program. In addition, Asarco will analyze tissue samples after cleanup to verify that bioaccumulation is not occurring at an unacceptable level.

Comment No. 39

Comment: (Section 5.2) It is unclear how healthy biological communities are being defined. How was this determined? Diversity, abundance, both?

Response: Both.

Natural Resource Mitigation

Comment No. 40

Comment: Finally, we would like to discuss the potential reuse of the treated groundwater as a resource for restoration of a stream delta estuary. Such a delta existed on-site prior to development. The value of these small estuaries as nodes of productivity is becoming more widely recognized. Salmonid species such as chinook, chum, and cutthroat have been documented to preferentially target these areas in their utilization of nearshore corridors. The potential for creation of a stream delta estuary appears to exist on the southeast portion of the site. Integration of planning for such a project with the remedial and damage assessment actions may provide opportunities for an improved, less expensive, more comprehensive project.

Response: *EPA needs more information from DNR on the development of a stream delta estuary, especially in light of EPA's 1995 ROD for the Asarco Smelter and current plans for shoreline armoring and habitat restoration being conducted under this previous ROD. The shoreline armoring and habitat restoration plans are available in EPA's Administrative Record for this site..*

Comment No. 41

As we noted in our recent comments on the Nov. 1999 Explanation of Significant Differences (ESD) for the Commencement Bay Nearshore/Tideflats Superfund Site (2 Feb. 2000), NOAA has consistently based our evaluation of the Commencement Bay investigations and cleanup plans on five basic principles:

1. That cleanup(s) progress sooner rather than later to reduce continued exposure of trust resources to contaminants;
2. A preference for complete removal of contaminants from the aquatic environment (most contaminants originated from the uplands);
3. if the aquatic environment must continue to serve as the repository for the contaminated sediments, we prefer that contamination not be transferred from impacted waterways to otherwise clean areas for disposal;
4. Where remedial actions cause adverse impacts (during cleanup or disposal), mitigation for lost natural resources or their services is required; and
5. Cleanup and disposal decisions must be made under a baywide planning and evaluation effort, especially for threatened/endangered trust resources and their habitats.

This Proposed Plan appears to satisfy our principles 1, 2, 3, and 5. Where mitigation is required (principle 4) based on cleanup action details yet to be specified, we would strongly recommend the enhancement of the nearshore/intertidal area immediately south of the slag peninsula along Ruston Way. This could entail the removal of wood wastes from the bottom and re-contouring to allow eelgrass propagation from the existing bed further south. We look forward to reviewing a detailed Clean Water Act 404 analysis and/or mitigation plan.

Response: *Comment noted. Mitigation requirements associated with the remedy for OU 06 will be addressed as part of the Clean Water Act 404 (b)(1) evaluation that is currently being conducted.*

Comment No. 42

Comment: The facility's operations have filled and/or degraded a substantial acreage of aquatic lands. The values of the public aquatic lands for a broad range of functions and services are damaged. The proposed remedy does not restore those values, and Asarco has not proposed to compensate the State of Washington as a natural resource trustee for past and on-going losses. We will seek natural resource damages for functions and services that are not restored in order to compensate the citizens' natural resource trust values.

The extent of damages will be highly-dependent on the degree to which the functions of aquatic lands have been and will continue to be injured by slag deposition/deposits, groundwater, runoff, point discharges, and other releases of injurious contaminants. We encourage the resolution of natural resource damages claims in conjunction with the remedial action processes at the site.

Response: *After EPA selects the remedy for the sediments, EPA will begin discussions with the potentially responsible parties (PRPs) for cleanup of the Site. It is not clear how the federal and state natural resource trustees intend to proceed with their potential claims against the PRPs. EPA will cooperate with the trustees in the future to resolve natural resource damage claims.*

Long-Term Monitoring

Comment No. 43

Comment: Asarco agrees that monitoring of remediated areas is needed to verify cleanup success. However, Asarco does not believe that extensive long-term monitoring of other areas is necessary and believes the cost of this monitoring is substantial given the limited benefit of monitoring non-remediated areas. Asarco believes that EPA's proposed plan for this sampling implies that the RI/FS process was somehow incomplete and that contaminant effects area have not been adequately identified. This is not true. In fact, Asarco and EPA have come to a consistent and scientifically supported decision on areas exhibiting contaminant effects. Asarco also believes that monitoring constitutes a remedial action for these areas and that EPA does not have authority under CERCLA to require actions for these non-impacted areas.

The Proposed Plan indicates that monitoring of areas outside remediation units will be conducted to "confirm the assumptions and conditions" used to make clean up decisions. The Plan further indicates that based on this monitoring, some further action may be needed. Sediment sampling to "confirm assumptions and conditions" regarding areas and volumes of sediments that may exhibit contaminant effects was conducted during the RI and FS studies consistent with Superfund Guidance. The primary purpose of the Expanded RI/FS process was to determine those areas that exhibit contaminant effects, and therefore, require remediation. Prior to conducting the Phase 1 sampling, an extensive monitoring plan was developed with the full participation of EPA and its consultants including methods for evaluating the results of that sampling. It was agreed at that time that a "preponderance-of-evidence" approach would be used to evaluate the numerous types of sampling and data analysis that were conducted. This original concept is entirely consistent with the Superfund RI process, which should define the areas and volumes of contaminated materials to be remediated. It has been Asarco's position since completion of the Phase 1 Report that the sampling and analysis effort provided more than sufficient information to determine areas where action such as remediation is needed (with some exceptions in the marina and north shore areas, which were addressed in subsequent sampling).

Under CERCLA Section 104, EPA can take action when a hazardous substance is released into the environment or threatened to be released. EPA can also take action if a there is a release or threat of a release of a pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare. A "pollutant or contaminant" is anything that, when released into the environment and "upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains will or may reasonably be anticipated to cause death, disease " or problems with the organism or offspring. 42 USC § 9601(33).

The metals in the sediments outside the contaminant effects area have not been released (they are in the slag matrix), nor are they likely to be released. Moreover, the metals in sediments are not pollutants or contaminants because they are not causing effects. If there is neither a release nor a threatened release of hazardous substances, contaminants or pollutants, the agency cannot compel remedial or response action.

Response: *Under Section 104 of CERCLA, EPA can take action when a hazardous substance has been released into the environment or is threatened to be released. Arsenic, copper and other hazardous substances were released into the waters and sediments of the Site as a result of smelter activities beginning in the early 1900s. Hazardous substances continue to be released, or threatened to be released, from the slag, groundwater, surface water, and sediments. Accordingly, EPA intends to take action to protect human health and the environment from releases or threatened releases of hazardous substances.*

As discussed in the response to Comment No. 4, a "preponderance of evidence" approach was used to evaluate the overall health of the sediment at the Site. This approach resulted in stations which exhibited a wide range of effects. In other words, there were stations that showed no effects, stations that showed some effects, and other stations that showed many effects. The latter stations (those showing many effects) were selected as stations as requiring active remediation. That means, it was determined that the effects were significant enough that dredging or capping was warranted (e.g., destroying the current habitat and allowing new habitat to recolonize was determined to be appropriate). This area is called the "Contaminant Effects Area." As for those stations with minor biological effects, this area was determined to require monitoring. It was determined that active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated. This area is not "clean," as indicated by some biological effects, however, it was not impacted enough to warrant destruction of the existing habitat. This "gray" area, therefore, is determined to require some monitoring to ensure that RAOs are met. Those stations displaying no effects are not proposed for active cleanup or monitoring.

Comment No. 44

Comment: Page 3, 5th bullet. This bullet states that Asarco will monitor the dredged area "to ensure that it is not becoming recontaminated." Asarco is responsible for recontamination, if any that originates from the Site, but cannot ensure that the Yacht Basin will not become recontaminated from marina activities.

Response: *Comment noted. The Operation, Maintenance, and Monitoring Plan (OMMP) will address this issue. Monitoring strategies and procedures will be identified to produce data that will distinguish between contamination sources to the extent possible.*

Comment No. 45

Comment: 9.2.4 Long-Term Monitoring

Components of the long-term remedial monitoring plan must include action plans for earthquakes, high-intensity storm events, severe tide/wind storms, etc.

Response: *An Operation, Maintenance, and Monitoring Plan (OMMP) will be prepared as part of the remedial design. The OMPP will identify inspection and monitoring procedures to verify that the elements of the remedy are performing as intended or, if they are not, to identify needed repairs on a timely basis. The OMMP will call for special inspections following major storms or earthquake events.*

Comment No. 46

Comment: (Section 7) What is the term of the OMMP?

Response: *The Operations, Maintenance, and Monitoring Plan (OMMP) will have a duration of decades. The minimum duration of the monitoring period will be determined during development of the OMMP. Extension of the monitoring beyond the minimum period will be dependent on the monitoring results and associated decision rules will be determined by EPA.*

Comment No. 47

Comment: (Section 8.2) The plan should require that institutional controls, maintenance and monitoring results be shared and coordinated with DNR.

Response: *Discussions between EPA, DNR, and Asarco will address these concerns as the RD/RA process proceeds. All documents associated with institutional controls, maintenance, and monitoring will be available for public review. Therefore, these documents will be available to DNR.*

Comment No. 48

Comment: NOAA appreciates the efforts the two remedial project managers and ASARCO have made to incorporate previous NOAA technical comments and suggestions into the overall cleanup of the former ASARCO Smelter Facility. By combining parts of both operable units, it appears that the sediment remediation will be accomplished sooner than originally scheduled and the use of the upland disposal site for the Yacht Club sediments further streamlines the cleanup.

The natural resource agencies have expended considerable time and effort providing technical advice to EPA, Ecology, ASARCO, and their consultants - this Proposed Plan suggests that it was worth the effort since most of NOAA's previous concerns about the sediments have been addressed. We want to encourage EPA, Ecology, and ASARCO to continue to seamlessly integrate the sediment remediation with the shoreline stabilization. In this way, there should be no wasted efforts between the two operable units cleanups and the impacts to the natural resources will be minimized while the on-going exposures to contaminants will be curtailed sooner rather than later.

NOAA strongly supports EPA's requirement for long-term monitoring of the remedy. Our only concern with the proposed monitoring is that it does not include measuring contaminant concentrations in the waters of Commencement Bay adjacent to the facility shoreline. As explained in our section-specific comments below, we think that monitoring water quality in Commencement Bay is critical and we recommend that EPA include offshore monitoring in the final plan.

Response: *The Operation, Maintenance, and Monitoring Plan (OMMP) will include provisions for sampling Commencement Bay waters at the shoreline.*

Comment No. 49

Comment: Pg 2: Elements of the Preferred Alternative, Groundwater: The first item identifies limiting groundwater "loading" to Commencement Bay as a remedial objective. The second item identifies monitoring of groundwater as the method to document success or failure of the remedy. However, the Groundwater-Sediments Task Force determined that two processes at the site complicate calculations of contaminant loading to Commencement Bay from discharging groundwater:

(1) Tidal cycles in Commencement Bay cause significant fluctuations in the hydraulic gradient at the CB shoreline; these tidal waters intermittently enter the fractures in the slag along the shoreline and mix with discharging groundwater, altering the groundwater gradient, discharging water volumes and the concentration of conservative constituents, such as chloride (Cl); and

(2) The solubility of the metal and metalloid (e.g., arsenic) ions that are contaminants of concern at the site varies with changes in pH and/or redox conditions, both of which are altered as the groundwater mixes with saline, oxygenated seawater within the fractured slag before discharging into Commencement Bay. These processes are also described at the bottom of page 7 in the Proposed Plan.

Because measurements of groundwater gradients and contaminant concentrations in upland wells are an incomplete predictor of the contaminant loading to Commencement Bay (as explained above), and the dilution from tidal mixing at the shoreline is significant but not precisely quantified; the only way to determine if the shoreline water of Commencement Bay is not contaminated by the metal and metalloid contaminants from the site is to sample the shoreline waters of Commencement Bay and analyze for these constituents.

Response: *The Operation, Maintenance, and Monitoring Plan (OMMP) will include provisions for sampling Commencement Bay waters at the shoreline.*

Comment No. 50

Comment: Pg 5: State Sediment Management Standards - Sediment Cleanup Criteria:

BASIS: Numerous sediment samples at the site had extremely high concentrations of metals and metalloids, variable laboratory bioassay results, and benthic community analyses that did not show any statistically significant differences from reference. The apparent absence of the expected response (mortality leading to benthic community alterations) at these stations may result from the physical structure of the slag that contains most of the contamination. However, very high concentrations of contaminants remain at the site, and ecological indicators of an adverse response to these contaminants were varied. The toxicity of some of these contaminants can change with changing environmental conditions, e.g. temperature or oxygen availability, and toxicity can vary by organism lifestage. Therefore, it is important that areas where high concentrations of contaminants remain in contact with ecological receptors are monitored over the long-term to demonstrate continued ecological protectiveness.

NOAA supports the proposal not to require active remediation of these areas on the condition that EPA require long-term monitoring to demonstrate whether this decision continues to be protective. It is recommended that this monitoring be coordinated with the long-term monitoring of benthic communities in remediation areas that are dredged and/or capped to make efficient use of equipment and labor.

Response: *EPA concurs. Long-term monitoring will be performed in the "gray" areas that indicated some biological impacts (but not enough impacts to warrant active remediation). The timing of this monitoring will be addressed in the Operations, Maintenance, and Monitoring Plan (OMMP).*

Comment No. 51

Comment: Pg. 7, Sec. 3.1 Groundwater: [*As stated in the Proposed Plan*] "Groundwater at the Facility flows from the southwest to northeast and ultimately discharges to Commencement Bay."

Because Commencement Bay is the ultimate recipient of the contaminated groundwater, and because ecologic receptors along the Commencement Bay shoreline can be adversely affected by these contaminants, NOAA supports the preferred remedy on the condition that long-term monitoring of the site include collection of shoreline water samples for contaminant quantification.

Response: *Comment noted. The Operation, Maintenance, and Monitoring Plan (OMMP) will include provisions for sampling Commencement Bay waters at the shoreline.*

Comment No. 52

Comment: Pg. 8, Sec. 3.1 Groundwater: [*As stated in the Proposed Plan*] "DMA-related organic compounds are also present in the shallow groundwater system. However, the DMA, arsenic, and copper in the DMA area do not appear to result in any greater exceedances of surface water criteria in the adjacent Commencement Bay than observed elsewhere at the Facility. For this reason, no special groundwater remedial action is planned for the DMA area. However, groundwater monitoring in the DMA area will be part of the post-remedial action monitoring program."

NOAA can support a decision not to take action to reduce contaminants in groundwater at the DMA area, only if there will be long-term monitoring of the receiving water along the shoreline of Commencement Bay where NOAA trust resources are potentially affected by these contaminants, and with a commitment that if the monitoring data indicate this decision is not protective of the environment, other remedies will be evaluated for the DMA area.

Response: *Comment noted. The Operation, Maintenance, and Monitoring Plan (OMMP) will include provisions for sampling Commencement Bay waters downgradient of the DMA area.*

Comment No. 53

Comment: Pg. 10, Sec. 3.2, Sediment: [*As stated in the Proposed Plan*] "Some concentrations of metals and/or biological impacts (as measured with bioassays) exceeded the CSL outside of the Contaminant Effects Area in what is depicted as the "Moderate Impact Area" (Figure 5). The benthic communities in the Moderate Impact Area appear healthy. Because active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated, long-term monitoring is proposed in these areas to verify that the overall health of the ecosystem (after the upland and offshore cleanup activities are completed) is remaining the same or improving."

NOAA supports the proposal not to require active remediation of these areas on the basis that EPA will require long-term monitoring to demonstrate whether this decision continues to be protective. It is recommended that this monitoring be coordinated with the long-term monitoring of benthic communities in remediation areas that are dredged and/or capped to make efficient use of equipment and labor.

Response: *EPA concurs. Long-term monitoring will be performed in the "gray" areas that indicated some biological impacts (but not enough impacts to warrant active remediation). The timing of this monitoring will be addressed in the Operations, Maintenance, and Monitoring Plan (OMMP).*

Comment No. 54

Comment: Pg. 13, Sec. 5.2, Ecological Risk Assessment, Groundwater: [*As stated in the Proposed Plan*] "The findings of the Task Force regarding the impact of groundwater on the sediments and waters of Commencement Bay indicate the following:

- The amount of metals currently being discharged (pre-remediation conditions) by ground-water and surface water discharges to Commencement Bay results in the exceedance of applicable water standards for certain metals (e.g., arsenic and copper) within a few feet of the shoreline. The metals load discharged to Commencement Bay by groundwater is expected to decrease after remediation because the most highly contaminated source materials will have been removed and groundwater flow to Commencement Bay will be reduced."

NOAA agrees with EPA's assessment and strongly supports all efforts to reduce groundwater flows through the site which would continue to transport metals into the marine environment. Early interception of the groundwater upstream of the site should be maximized , the placement of an impervious cap over the site to eliminate surface water percolation downward then seaward is imperative, and co-precipitation treatment of collected runoff waters on site should be emphasized, if this technique removes significant levels of metals. However, we want to emphasize that the only means to ascertain whether the remedial actions have reduced the discharge of metals (and metalloids such as arsenic) along the shoreline of Commencement Bay to bring them into compliance with applicable water standards is to include sampling of the shoreline water of Commencement Bay in the post-remediation monitoring. Only a well-designed sampling plan can demonstrate to all parties that the selected remedy has caused shoreline areas to achieve the applicable water quality criteria.

Response: *Comment noted. The Operation, Maintenance, and Monitoring Plan (OMMP) will include provisions for sampling Commencement Bay waters at the shoreline.*

Comment No. 55

Comment: Pg. 16, Sec 6.1, Groundwater Cleanup Objectives: [*As stated in the Proposed Plan*]

- "Long-term monitoring"

NOAA recommends that this be amended to read; "Long-term monitoring of groundwater and (Commencement Bay) receiving water" in order to demonstrate that the water column used by marine organisms along the shoreline of Commencement Bay is protected by the remedy.

Response: *Comment noted. The ROD indicates that long-term post-remedial action monitoring will include provisions for sampling Commencement Bay waters at the shoreline.*

Comment No. 56

Comment: Pg. 23-24, Sec. 8.2 Compliance with Federal and State Environmental Standards, Groundwater: [*As stated in the Proposed Plan*] "Samples of Commencement Bay water collected at the shoreline confirm that current laws for marine water quality are not currently met at all locations and at all times. However, metals concentrations in groundwater flowing toward the shoreline are expected to decrease in future years in response to the site-wide changes (i.e., reduced groundwater discharge) affected by the cleanup. These changes are expected to allow state and federal laws to be met at the end of the remedy."

NOAA agrees with the preceding analysis and believes that monitoring of water quality along the shoreline, where contaminated slag will remain in place, is necessary to demonstrate that the remedy has resulted in compliance with Federal and State Environmental Standards for the waters (and habitats) of Commencement Bay. NOAA recommends that the Washington State Water Quality Criteria for protection of marine life be utilized as benchmarks for protection of the water column component of marine habitat.

Response: *EPA concurs. Arsenic and copper have been identified as the two constituents of concern for groundwater. The cleanup levels for these two metals are 6 μg/L and 3.1 μg/L, respectively. These levels meet or exceed the Washington State Water Quality Criteria for protection of marine life. Other metals data that may be collected during the long-term monitoring program will also be benchmarked against their respective Washington State Water Quality Criteria in accordance with procedures outlined in the final Operation, Maintenance, and Monitoring Plan (OMMP).*

Other Comments

Comment No. 57

Comment: (Section 9.1.1) What will be the final quality of treated groundwater?

Response: *At this time, it is expected that groundwater requiring treatment will be accommodated in the onsite stormwater treatment system to be constructed under the upland remedial action (governed by the 1995 ROD for OU 02). At this writing, the design of this system is in progress. Both polymer-*

and filtration-based systems designed to remove suspended metals from stormwater are being evaluated by Asarco. The post-treatment quality of the stormwater will not be determined until ongoing engineering studies are complete. However, design criteria call for the stormwater to meet design criteria applicable to OU 02.

Comment No. 58

Comment: As a long-time resident of North Tacoma, I would like to take this opportunity to comment on the EPA cleanup of the Asarco smelter. I would like to voice my concerns about the long-term effectiveness of the proposed disposal alternatives. I can not see how capping contaminated sediments on-site with 1 meter of clean material represents a safe and reliable solution. Humans have been burying garbage for thousands of years, surely we can do better than this by now? I would like to encourage the EPA to support the development and use of improved treatment methods. I believe the government has an obligation to the future health and well being of humans and the environment to forward progressive solutions. In addition, I am concerned about the storage of contaminated sediments so near the water. Earthquakes and slides could yield potentially disastrous results. Furthermore, there is the corrosive, erosive capacity of the salt air and water to consider. Hopefully, the EPA will continue to re-evaluate conditions at the Site and apply improved treatment measures as they become available.

Response: *The comment advocates removal (dredging) and treatment of contaminated sediments. Of the total area subject to sediment remediation, approximately 55 percent (Nearshore/Offshore and Northshore areas; 19.5 acres) will be capped and 45 percent (Yacht Basin; 15.5 acres) will be dredged. Capping of the Nearshore/Offshore and Northshore areas was selected as the preferred remedy based on application of the five balancing criteria required by the National Contingency Plan (see page 22 of the Proposed Plan). EPA agrees that treatment of the sediments, preferably in-place, to destroy contaminants of concern is the most desirable end point. Potential treatment of marine sediments was evaluated by EPA as part of the Feasibility Study process. Several technologies groups were evaluated including thermal destruction, thermal desorption, chemical separation, sediment washing, and in-place solidification/stabilization. As part of this evaluation, EPA did not identify any established sediment treatment options that are reliable and cost-effective. This decision was mostly due to the difficulty in removing these sediments, based on the nature of the sediments (some have large chunks of slag), the extensive depth of contamination, and the steep slopes off the Site. Further, the net benefit of treatment for some of the treatment technologies was limited (e.g., the end result after treatment was not much different than the slag presently on the Site).*

Comment No. 59

Comment: The Proposed Plan specifies an upland source of capping material. There is no justification for specifying that the cap material be derived “from an upland source” and nothing that should preclude an aquatic source of material. Cap material from an aquatic source would be as suitable or more suitable than material from an upland source for biological colonization. There should be no difference in the effectiveness of contaminant isolation with either an upland or an aquatic source. Appropriate material may be available at a lower cost from a marine source. Asarco believes the location and selection of capping material is a Remedial Design task and that the Proposed Plan should not preclude aquatic sources of capping material.

Response: *Comment noted. EPA agrees that the cap material could originate from either an upland or aquatic source as long as it meets the minimum specifications to be established during remedial design.*

Comment No. 60

Comment: The Proposed Plan delays a final decision on the need for additional groundwater controls pending additional remedial design analysis. Asarco believes that the existing information demonstrates that additional groundwater controls are not appropriate and that ongoing evaluations during Remedial Design are unnecessary.

The hydrologic analyses of the feasibility of additional upgradient groundwater controls have been completed and draft reports have been submitted to EPA. These analyses demonstrate that additional groundwater controls would capture negligible amounts of additional groundwater and contaminants. Capture and treatment would reduce some, but not all metal concentrations in the captured groundwater and would eliminate the current reduction in arsenic concentrations provided by natural attenuation on the Site. Therefore, little or no environmental benefits would be realized by the additional groundwater capture. Costs associated with constructing an interception system and the additional treatment costs would be substantially and disproportionately expensive relative to the environmental benefit received.

Response: *The Proposed Plan was written before the groundwater diversion issue had been fully explored by EPA and Asarco and prior to Asarco's submission of final reports addressing this issue. Since publication of the Proposed Plan, Asarco has demonstrated that inclusion of additional groundwater diversions at this time (specifically in the vicinity of the Cooling Pond, East Stack Hill drainages, and along Ruston Way) would be impracticable from a cost/benefit standpoint (see Appendix A of the report titled "Historical Summary of the Evaluation of Groundwater Remedial Alternatives, Asarco Tacoma Smelter Site," Hydrometrics, June 2000; this document is part of the Administrative Record).This impracticability demonstration was required to satisfy MTCA remedy selection requirements.*

Comment No. 61

Comment: The Proposed Plan presumes that treatment of groundwater will be necessary. The Proposed Plan should clearly state that treatment is not required unless treatment is necessary to meet Remediation Goals. Moreover, it is important to note that:

Design of the stormwater treatment system is an Upland Remedial Design task.

Design of the stormwater treatment system is based on treating stormwater, not groundwater.

Design of the stormwater treatment system is ongoing.

Therefore, the Proposed Plan needs to be flexible regarding treatment of groundwater by the yet to be designed stormwater treatment system. One area in which the Proposed Plan may unduly constrain design of the surface water treatment system regards the treatment of groundwater during baseflow (i.e. non-stormwater flow) periods. The Proposed Plan needs to allow the potential for bypass of captured groundwater from treatment during baseflow periods if such bypass is consistent with stormwater treatment.

Response: *EPA agrees that captured groundwater may need to be treated. The quality of groundwater captured in each of the primary diversion systems has not yet been estimated or otherwise measured. Once the quality of this groundwater is known with reasonable certainty, a decision can be made regarding the need for treatment. The Proposed Plan text concerning this issue was intended to mean that groundwater requiring treatment would be treated in the stormwater treatment system to be constructed as part of the remedy for Operable Unit 02. Based on commitments made by Asarco, this is the current approach for providing any required treatment of captured groundwater. Asarco also has the flexibility to process and treat groundwater separately from stormwater. The language previously included in the Proposed Plan has been modified in the ROD to clarify this issue.*

Comment No. 62

Comment: Page 4, 3rd bullet. The Refinement of the Proposed Remedy Report was revised and submitted to EPA on January 5, 1999. This document should be referenced instead of the August 1999 draft.

Response: *Comment noted. The correct citation has been provided in the ROD.*

Comment No. 63

Comment: Page 4, document list. The Copper in Nearshore Marine Water Technical Memorandum submitted to EPA on June 23, 1999 should be included in the list of documents providing additional detailed information.

Response: *Comment noted. This document has been included in a list of "key documents" presented in the ROD.*

Comment No. 64

Comment: Page 6, first para. Sentence states "The shallow aquifer system beneath the Facility is largely recharged by lateral flow of groundwater from the southwest (Ruston area) and infiltration of precipitation and surface water run-on."

It would be more accurate to say "The shallow aquifer system beneath the Facility is largely recharged by infiltration of precipitation and surface water run-on and to a minor extent by lateral flow of groundwater from the southwest (Ruston area)."

Response: *Comment noted. The language previously included in the Proposed Plan has been modified in the ROD to clarify this issue.*

Comment No. 65

Comment: Page 9, last full para. This paragraph seems to state that copper exceeds the marine chronic criteria (MCC) at all locations in Commencement Bay near the Site. This is not true. The best data available to Asarco and EPA indicates that copper concentrations currently exceed the MCC at about half of the sampling locations along the shoreline and only in very close proximity to the slag shoreline. At most locations, seawater a few feet away from the slag meets all aquatic life criteria for copper and all other metals.

In conjunction with the Asarco Sediment/Groundwater Task Force (ASGTF) Asarco conducted two rounds of special seawater monitoring in 1999 to determine copper concentrations in seawater near the Site. This seawater monitoring employed ultraclean sampling and analytical techniques and yielded analytical sensitivities and accuracies several orders of magnitude better than techniques previously available. Results of this monitoring were submitted to EPA in a June 1999 Draft Technical Memorandum and in a November 16, 1999 data transmittal. The ultraclean monitoring data demonstrates that copper concentrations do not exceed criteria in all samples; only samples collected near the shoreline in some areas.

Response: *Comment noted. The language previously included in the Proposed Plan has been modified in the ROD to clarify this issue.*

Comment No. 66

Comment: Page 13, The First Bullet is incorrect regarding Task Force findings related to arsenic. The Task Force found (see page 6-5 of the March 1999 ASGTF Group 5 Technical Memorandum) that groundwater discharges currently cause water column concentrations to exceed only the copper chronic aquatic life criterion. Current water column concentrations of arsenic and other metals are better than the chronic aquatic life criterion.

Response*: Comment noted. The language previously included in the Proposed Plan has been modified in the ROD to clarify this issue.*

Comment No. 67

Comment: Page 14, 1st para. What does “nonminimally impacted” mean?

Response: *The word “nonminimally” is a typographical error. It should read “non-impacted/minimally impacted station…”*

Comment No. 68

Comment: Page 16, 2nd para. Deep groundwater does not presently exceed MCLs or MTCA standards for any parameters except possibly arsenic (see Summary and Interpretation of 1994, 1995, 1996, 1997 and 1998 Post-RI Long-Term Monitoring Results (Hydrometrics, 1999) and Table 4-3 in Summary and Interpretation of Production Well Abandonment Action-Specific Monitoring Results (Hydrometrics, June 1997).

Response: *Comment noted. This language previously included in the Proposed Plan does not appear in the ROD.*

Comment No. 69

Comment: Page 23, last para. The Plan states “Modeling performed by the Task Force indicates that state and federal laws applicable to protection of marine water quality may not be currently achieved within a few feet of the shoreline for all metals.” Although model results did indicate some metal concentrations above marine chronic criteria, the Task Force placed more emphasis on empirical data rather than model predictions in concluding impacts from groundwater. The Task Force concluded that with the sole exception of copper, groundwater discharge currently does not cause metal concentrations to be higher than marine chronic criteria (see page 6-5 of the March 1999 ASGTF Group 5 Technical Memorandum).

Response: *Comment noted. The language previously included in the Proposed Plan has been modified in the ROD to clarify this issue.*

Comment No. 70

Comment: Page 25, 2nd para. States "The in situ treatment and seawater injection treatment alternatives would promote chemical precipitation (i.e., "settling out") of arsenic from groundwater, thereby reducing the arsenic load reaching Commencement Bay." Based on the Asarco Sediment/Groundwater Task Force evaluations, the effectiveness of in situ treatment is uncertain given that seawater already oxidizes and removes arsenic to the extent practical, with the exception of the Southeast Plant area.

Response: *Comment noted.*

Comment No. 71

Comment: Page 28, bottom of page. It states "Additional groundwater interception is being considered at the Facility, and may also be considered by EPA at a later date. The need for additional groundwater interception would be based on the results of ongoing groundwater sampling." Earlier in the Proposed Plan (3rd paragraph, pg. 27) it is stated that additional diversions are disproportionately expensive and would only be considered if cleanup goals could not be met. Asarco agrees that additional interception is disproportionately expensive and believes that additional interception should only be considered if cleanup goals are not met.

Response: *EPA acknowledges the inconsistency on this issue as presented in the Proposed Plan. Since publication of the Proposed Plan, Asarco has demonstrated that inclusion of additional groundwater diversions at this time (specifically in the vicinity of the Cooling Pond, East Stack Hill drainages, and along Ruston Way) would be impracticable from a cost/benefit standpoint. Additional groundwater interception in the future is possible if it is determined that groundwater cleanup levels are not being met and additional groundwater capture is practicable considering the expected reduction in risk to human health and the environment. EPA expects that this issue would be assessed as part of the Five-Year Review process.*

Comment No. 72

Comment: Page 29, 3rd para. It [*the proposed plan]* states "At a minimum, monitoring wells at the downgradient perimeter of the Facility (along the shoreline) will be monitored, including wells near source areas." Rather than "wells near source areas", it would be better to say, "wells near source areas if, and to the extent compatible with, protection and maintenance of the cap."

It further states "In addition, should the groundwater indicate high concentrations of metals, contingency actions, such as additional groundwater diversions, may be considered." What is meant by high metal concentrations? Above cleanup goals? Where? It is expected that concentrations will remain above cleanup goals in and near source areas but this occurrence alone should not trigger additional diversions. Given EPA's broad authority under the five year review provisions of the Upland ROD, this last sentence is unnecessary and should be deleted. If the sentence is retained, then EPA should specify the trigger criteria of "high concentrations of metals." Asarco believes appropriate trigger criteria would be remedial action objectives and remediation goals (including Asarco's proposed changes) at a compliance point located in surface water along the armored slag shoreline.

Response: *Monitoring wells will likely be required near primary source areas (or former source areas). Some of the existing wells may meet these monitoring needs but it is likely that new wells will also be needed in locations not previously monitored or to replace old monitor wells removed to accommodate remedial action construction activities. The technical objectives of the monitoring program will dictate the actual well locations. If installation of a new well (or maintenance of an existing well) is in conflict with protection and maintenance of the cap, the competing needs will be assessed to determine the most appropriate solution.*

The text addressing "high concentrations of metals" in groundwater and the possibility of "additional groundwater diversions" was intended to communicate that further groundwater capture may be necessary in the future if groundwater quality goals are not being met. The details of the thresholds and conditions that would trigger such an action (or an evaluation to determine if action is required) need to be determined during development of the Operation, Maintenance, and Monitoring Plan (OMMP). In general, EPA recognizes that groundwater cleanup levels may not be achieved in the slag matrix or immediately downgradient of other areas where source materials are present. The goal, however, is to manage the contaminant concentrations in groundwater such that applicable marine surface water quality standards and risk-based levels protective of human health are not exceeded in Commencement Bay waters at the shoreline.

Comment No. 73

Comment: On behalf of Citizens for a Healthy Bay (CHB), an organization representing 850 members of the Tacoma and Greater Commencement Bay community, thank you for the opportunity to comment on the proposed remedial plan for Asarco Smelter site groundwater and sediments. Except as discussed below, CHB generally agrees with the remedial actions proposed for site sediments and groundwater.

Response: *CHB's general and conditional agreement is noted.*

Comment No. 74

Comment: 7.1 Groundwater

We agree with the stated preferred alternative GW-B involving intercepting and treating site groundwater prior to discharging into Commencement Bay. We are concerned that the remedy be scaled to handle large magnitude storm events and associated increases to groundwater.

Also, use of an on-site cap to limit infiltration of precipitation into the soil will increase the amount of stormwater runoff and contaminants commonly associated with stormwater runoff. How will recontamination of the sediments by toxins such as PAHs, BEPs, fertilizers, herbicides, insecticides, etc. be avoided? We do not wish to see one set of problems exchanged for another.

Response: *The capacity of the groundwater diversion system will be engineered to accommodate a range of possible flows based on the expected fluctuations in seasonal groundwater conditions. The possible short-term impacts from large storm events will be considered in the engineering assessment.*

Stormwater conveyance and treatment systems are being designed under the 1995 ROD for Operable Unit 02. Future stormwater runoff from the Site will be subject to applicable laws and regulations. In addition, the long-term monitoring program will be designed to identify increases in contaminant loading to the sediments or waters of Commencement Bay such that preventive action can be taken if warranted. Further, the stormwater discharged to Commencement Bay is expected to meet marine chronic criteria with treatment and use of a mixing zone.

Comment No. 75

Comment: Citizens for a Healthy Bay urges you to consider that private citizens, aquatic communities and the improved health of Commencement Bay are the largest stakeholders in the cleanup and disposal of contaminated sediments and groundwater at the former Asarco Smelter site. As a citizen-based representative of that community, Citizens for a Healthy Bay is concerned about the decisions EPA will make regarding remediation at the Asarco site. We urge the Environmental Protection Agency to make decisions that will positively affect the primary stakeholders in the cleanup of Asarco sediments and groundwater.

Response: *EPA concurs.*

Comment No. 76

Comment: We also encourage removal of any leaking, unused and/or abandoned pipes and any other debris or unnecessary structures along the shoreline.

Response: *EPA concurs. The disposition of leaking, unused and/or abandoned pipes and other debris structures along the shoreline is being addressed as part of the ongoing remedial design for Operable Unit 02 (i.e., the Upland ROD).*

Comment No. 77

Comment: Going through the Fact Sheet on the Former Asarco Smelter cleanup from Jan. 2000, I wish to enter the following written comments on the clean up.

I am a boater and live and have lived in the Yacht Basin for the last 15 yrs. from just before the Smelter shut down. I have seen the Basin so dead and hot you could almost power a light bulb, to today, where electroylsis is almost gone and sea life has come back. Years back we never had much growth on boat bottoms, now we have barnacles and mussels and growth of seaweed. What are you doing, I have faith it is a good job and see nothing to change. I only want to push 2 points that relate to me.

Re: Yacht Basin Area. The bottom is deep mud gunk. In spite of the returned sea life, this life cannot be safe do [sic] to the bottom it lives over. And in some cases on and in.

I wish to strongly push for the dredging of the Basin to at least 2 ft. Absolutely no less and possibly more. I know what this stuff looks like and is.

My only other concern is the slow speed that all of the cleanup is going at. Please no more extensions. Lets just get it done!

Response: *Comment noted. Regarding the depth of dredging in the Yacht Basin: Asarco will collect additional sediment samples from the Yacht Basin this year. The data will be used to plan dredging* *depths. For the purpose of site cleanup, dredging will occur to the depth required to meet the cleanup criteria. As such, the final dredging depth is expected to vary by location.*

Comment No. 78

Comment: Tacoma Yacht Club should be formally designated as a stake holder in the design and implementation of the Remediation Plan for the Yacht Basin. The club will formally designate a committee to laison [sic] with E.P.A., Asarco and other active parties.

Response: *A project of this size and complexity requires coordination between all affected parties. To that end, Asarco has made a commitment to work directly with the Tacoma Yacht Club on Yacht Basin dredging issues. EPA will take steps to see that Asarco coordinates with the Yacht Club to the extent necessary.*

Comment No. 79

Comment: Pg. 21, Sec 7.1 Groundwater: [*As stated in the Proposed Plan*] "No remedial action is planned for the Slag Peninsula area (approximately 85,000 yd2 or 17.5 acres) because the water depths and steep slopes make capping or dredging technically impracticable."

NOAA supports EPA's position of not trying to actively remediate the steep portions of the Slag Peninsula Unit located in deep water. Conventional capping techniques do not appear to be productive because of the steep slopes and water depths. NOAA prefers intertidal and shallow subtidal capping to be placed only when equivalent (or more) fill is removed so that there is no net loss of aquatic habitat; for that approach to be used on the slag peninsula it would require the removal of too much of the peninsula before reaching gentle enough slopes for the capping material to repose in perpetuity. We are unaware of any other cost-effective and environmentally-sensitive remediation technology to solve these problems.

Response: *Comment noted.*

Comment No. 80

Comment: My standpoint, you must understand, comes from a metallurgical engineer who had an opportunity to tour the ASARCO smelter while a young college student. It is unfortunate to the community and the area as a whole that so much toxic substances were released into the environment in the name of progress and the almighty dollar. It should also be remembered that the plant offered employment to numerous workers during its lifetime. It was a monument to the ingenuity of metallurgists while now becoming a bane to those of us in the profession. It is demoralizing to think that the metals industry has had to cope with changes that sometimes make my training obsolete.

Just as a passing thought; there are plans to remove and store in a landfill, the contaminated soils around the Ruston plant. And the Seattle-Taocma [sic] airport is looking for fill for their third proposed runway. Abra-cadabra! Why not use this soil for their fill and kill two birds with one stone? I had heard some statistics about the amount of fill needed for the SEA-TAC airport and the time needed to complete their plans, much to the consternation of the local residents.

Another thought; why not sell, for refining, the waste products from the ASARCO plant? It used to be that tailings piles from older mines would be reprocessed again and again to remove the smallest traces of valuable metals. Arsenic still has used in rodenticides. Lead is used in storage batteries. Cadmium is used in low-melting point alloys. What other treasures could be gleaned from all the waste?

The EPA plan to cover the site with non-permeable material does not take into account one thing; water seeping UP through the covering layer. This is something that must be considered in our wet Washington weather.

Men have torn down mountains to get to precious metals for a long time. If the material at Ruston is offending, why not dig out a big hole and put it back into those torn-down mountains?

These are my thoughts and suggestions concerning the treatment of the wastesite at ASARCO's Ruston plant. I hope they are doing a better job of not polluting in their new location in the southwestern USA. It was a kick in the butt to see them leave town. That was one less place I could have sought gainful employment from.

Response: *EPA offers a four part response:*

1. *Disposal of contaminated soils and sediments at Seattle-Tacoma Airport –We assume that the phrase "contaminated soils around the Ruston plant" refers to both the contaminated terrestrial soils and marine sediments that are scheduled for onsite contaminant at the Site. Plans call for these materials to be disposed of in either the engineered On-Site Containment Facility (OCF) or under the proposed low permeability cap. Soils and waste materials from the upland portion of the Site and soils from the Ruston area were specifically addressed in the 1995 ROD addressing Operable Units 02 and 07 and in the 1993 ROD addressing Operable Unit 04 (OUs 02, 07, and 04 include cleanup of upland portion of the Site, demolition of Asarco facilities, Asarco Off-property soils, respectively). Per the 1995 ROD, EPA has determined that the soils and wastes from OUs 02, 04, and 07 are to be disposed of at the former Asarco facility. EPA did not evaluate the possibility of exporting dredged sediments to Seattle-Tacoma Airport as part of the RI/FS for OU 06 (Sediments/Groundwater). We believe that there are a number of significant difficulties with this approach that make it infeasible. These include the cost of transporting the material from Tacoma to the airport, environmental regulations that preclude disposal of contaminated material at facilities that are not designed for such purposes, and the cost and time associated with negotiating such a proposal with the Port of Seattle and nearby members of the community who may be affected, among others.*

2. *Recycling waste material – As discussed above, the 1993 and 1995 RODs address all of the terrestrial soils and waste materials associated with the Asarco facility. Remediation is either underway (OUs 04 and 07) or nearly underway (OU 02). A number of physical and chemical treatment processes, some of which included metals reclamation, were evaluated as part of the Feasibility Study for OU 02. It was determined that reliable cost-effective alternatives were not feasible or practicable due to the nature and volume of the waste materials.*

3. *Seepage through the site cap – The low permeability cap will be placed above the seasonal high groundwater table. In addition, the cap system will include a drainage layer to direct subsurface water to the surface water diversion system.*

4. *Disposal of contaminated material at former open pit mines – The comment suggests that contaminated soils, wastes, and sediments could be returned to former mine sites for final disposal. As discussed above, the 1993 and 1995 RODs address all of the terrestrial soils and*

waste materials associated with the Asarco facility. EPA did not evaluate the possibility of exporting dredged sediments to mine sites. Many of the same difficulties and costs addressed in the response to the Seattle-Tacoma Airport comment (above) apply to this alternative.

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Tables

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TABLE 5-1
Maximum Metal Concentration in Sediment

Contaminant	Max Concentration (mg/kg)	Percentage of Detections > CSLs
As	26,410	53
Cu	43,840	42
Pb	22,450	32
Zn	174,000	39

TABLE 9-1
Groundwater Alternatives

Alternative [1]	Description [2]	Estimated Cost (in millions $) [3]			
		Capital	Annual O&M	30-Year O&M	Total Present Worth
GW-A: No Action	No actions are taken.	$0	NA	$0	$0
GW-B: Source Control, Soil Capping and Surface Water Controls, Groundwater Interception/Treatment, Replacements of Leaking Subsurface Water Lines, Institutional Controls and Monitoring.	Reduce groundwater discharge to Commencement Bay by 1) limiting infiltration of precipitation and surface water, 2) intercepting groundwater at selected locations before it enters the Facility and treating* that groundwater as required prior to discharge to Commencement Bay, and 3) abandoning or replacing leaking underground sewer and water lines. Continued groundwater monitoring and implementation of institutional controls (e.g., restricting future use of Facility groundwater) will also occur. If groundwater cleanup goals are not achieved, contingency actions such as additional diversion, may be constructed. *Captured groundwater will be directed to the on-site stormwater treatment system being constructed as part of the upland, OU02 remedy. This treatment system includes particulates removal enhanced by the use of coagulants and flocculants.	$0	$0.1	$1.8	$1.8
GW-C: Pump/Treat and Discharge to Outfalls	Actively remove contaminated groundwater by a series of extraction wells. The groundwater would be treated and discharged to Commencement Bay. Candidate areas for the pump/treat alternative are downgradient of the Arsenic Kitchen, Southeast Plant (DMA) area, Copper Refinery, and Fine Ore Bins. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	$28.7	$0.6	$9.1	$37.8
GW-D: *In situ* Groundwater Treatment	*In situ* oxidation of groundwater by air injection to enhance chemical precipitation of arsenic. Nutrient injection would stimulate biological degradation of DMA-related compounds in the Southeast Plant Area. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	$2.0	$0.1	$2.3	$4.3

TABLE 9-1
Groundwater Alternatives

Alternative [1]	Description [2]	Estimated Cost (in millions $) [3]			
		Capital	Annual O&M	30-Year O&M	Total Present Worth
GW-E: *In situ* Treatment by Seawater Injection	Injection of seawater to raise pH and provide a more oxygenated subsurface environment conducive to chemical precipitation of arsenic. Candidate areas for seawater injection are the Arsenic Kitchen, Southeast Plant (DMA) area, and Fine Ore Bins. All elements of Alternative GW-B (above) would be included to reduce groundwater discharge to Commencement Bay, protect the deep aquifer, and provide institutional controls.	$2.2	$0.1	$2.2	$4.4

Notes:

1) Alternatives GW-1B and GW-3D from the 1993 FS are not addressed in this ROD because soil remedial actions selected previously by EPA have eliminated these alternatives as options. Alternative GW-A, "no action," is retained only for comparative analysis purposes.

2) Although not specifically listed, it is assumed that all alternatives listed this table would be implemented in addition to the selected remedy for OU 02 (i.e., source control, surface water and groundwater diversions, site capping and other OU 02 remedy elements are required in addition to the OU 06 groundwater alternatives listed in this table). The cost for the OU 02 remedy is excluded from the estimated cost shown in this table.

3) Present worth operation and maintenance (O&M) costs assume a 5 percent discount rate over 30-year period.

TABLE 9-2
Sediment Remedial Alternatives for the Nearshore/Offshore Area
(88,000 yd^2 or 18 acres)

Alternative	Description	Estimated Cost (in millions $)[1]		
		Capital	**O&M**	**Total Present Worth**
S-1A: No Action	No actions are taken.	$0	$0	$0
S-1B: Natural Recovery	Natural recovery does not involve any active work, but typically includes long-term monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	$0	$0.2	$0.2
S-1C: Capping	Cover 88,000 yd^2 (18 acres) of contaminated sediment with a minimum of 3 ft. of clean sand and gravel. In general, the purpose of a cap is to prevent the direct contact of people and marine organisms with contaminated sediment.	$10.3	$1.3	$11.6
S-1D: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore confined aquatic disposal (CAD) facility, which is an underwater cell that keeps the contaminated sediment covered with a cap and isolated from the overlying water. This alternative would require dredging of a minimum of 70,000 yd^3 of contaminated sediment with a dredge depth of approximately 1 yd (some of the 88,000 yd^2 or 18 acres of contaminated sediment would be covered by the nearshore facility), placement of the dredged sediment within a berm along the shoreline of the Facility, and placement of a clean sediment cap over the dredged material. The cap and containment berm of the nearshore CAD would be armored to minimize erosion.	$11.8	$1.0	$12.8
S-1E: Dredging and Upland Disposal	Dredge a minimum of 88,000 yd^3 of contaminated sediment with a dredge depth of approximately 1 yd; placement of the dredged sediment at an off-site location.	$26.0	$0.2	$26.2

Notes:

1) A discount rate has not been applied to the capital costs because the remedy will be implemented within a short period of time (5 years). Operations and maintenance (O&M) costs are for 20 years.

TABLE 9-3
Sediment Remedial Alternatives for the Yacht Basin (75,000 square yards; 15.5 acres)

		Estimated Cost (in millions $)[1]		
Alternative	**Description**	**Capital**	**O&M**	**Total Present Worth**
S-2A: No Action	No actions are taken.	$0	$0	$0
S-2B: Natural Recovery	Natural recovery does not involve any active work, but typically includes long-term monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	$0	$0.3	$0.3
S-2C: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore CAD. This alternative would require dredging of approximately 55,000 yd^3 of contaminated sediment, with a dredge depth of approximately 2 feet.	$4.9	$0.2	$5.1
S-2D: Dredging and Upland Disposal	Dredge an area of 75,000 yd^2 (15.5 acres) of contaminated sediment to a depth of 2 feet and place beneath the upland cap in the central portion of the upland part of the Facility. This alternative would require dredging of approximately 55,000 yd^3 of contaminated sediment. (Note: As a contingency, if all the contaminated material cannot be removed from the Yacht Basin, dredging in the Basin followed by placement of clean material may occur.)	$3.4	$0.2	$3.6

Notes:

1) A discount rate has not been applied to the capital costs because the remedy will be implemented within a short period of time (5 years). Operations and maintenance (O&M) costs are for 20 years.

TABLE 9-4
Sediment Remedial Alternatives for the Northshore Area (7,000 square yards; 1.5 acres)

		Estimated Cost (in millions $)[1]		
Alternative	**Description**	**Capital**	**O&M**	**Total Present Worth**
S-3A: No Action	No actions are taken.	$0	$0	$0
S-3B: Natural Recovery	Natural recovery would not involve any active work at the Facility, but would include monitoring to ensure that sediment quality is naturally improving over time (e.g., new clean sediment is covering up the contaminated sediment).	$0	$0.2	$0.2
S-3C: Capping	Cover 7,000 yd^2 (1.5 acres) of contaminated sediment with a minimum of 1.0 m of clean sand and gravel. In general, the purpose of a cap is to prevent the direct contact of people and marine organisms with contaminated sediment.	$0.5	$0.2	$0.7
S-3D: Dredging and Nearshore Confinement	Dredge contaminated sediment and place in nearshore CAD. This alternative would require dredging of approximately 4,500 yd^3 of contaminated sediment (7000 yd^2 dredged to a depth of 2 feet).	$0.7	$0.2	$0.9
S-3E: Dredging and Upland Disposal	Dredge contaminated sediment and place beneath the upland cap. This alternative would require dredging of approximately 4,500 yd^3 of contaminated sediment (7000 yd^2 dredged to a depth of 2 feet).	$0.5	$0.2	$0.7

Notes:

1) A discount rate has not been applied to the capital costs because the remedy will be implemented within a short period of time (5 years). Operations and maintenance (O&M) costs are for 20 years.

TABLE 12-1

Groundwater Cleanup Levels

Constituent	Cleanup Level (µg/L)	Basis
Shallow Aquifer System[1]		
Arsenic	6	Background concentration in regional groundwater
Copper	3.1	Marine chronic criteria; WAC 173-201A-040[2]
Deep Aquifer		
Metals	MCLs	Maximum contaminant levels; 40 C.F.R. Part 141.62

[1] Includes the slag, marine sand, and intermediate aquifers as referenced in various Site documents.

[2] The regional background concentration for copper in groundwater has been established at 40 µg/L; 3.1 µg/L will be the targeted cleanup level to be achieved through dilution within marine waters that mix with groundwater in the nearshore areas of the Facility aquifers.

TABLE 12-2

Sediment Cleanup Levels for Marine Sediments at OU 06

Remedy Unit	Type of Remedy	Remediation Cleanup Level	Monitoring Cleanup Level
Nearshore/Offshore and Northshore Areas	Capping	Preponderance-of-Evidence Approach[1]	Washington State Sediment Management Standards – SQS (WAC 173-340-320)
Yacht Basin	Dredging		
Arsenic[2]		93 mg/kg	93 mg/kg
Copper[2]		390 mg/kg	390 mg/kg
Lead[3]		450 mg/kg	450 mg/kg
Zinc[3]		410 mg/kg	410 mg/kg
Moderate Impact Zone and Contaminant Effects Areas	Monitoring	Preponderance-of-Evidence Approach[1]	Preponderance-of-Evidence Approach[1]

[1]See Section 7.2.2.

[2] CSL; (WAC 173-204-520)

[3] SQS; (WAC 173-204-320)

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Figures

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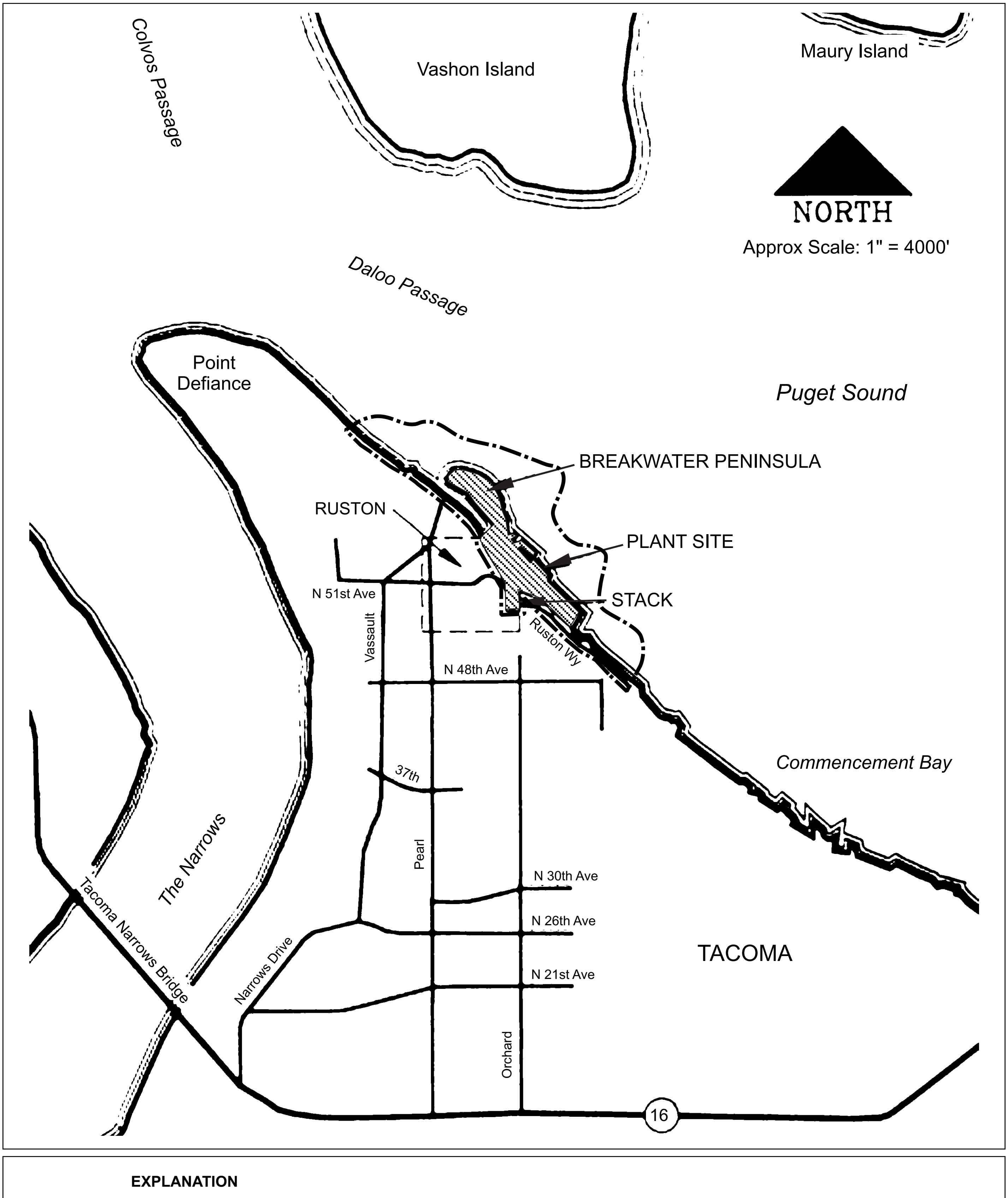


Figure 1-1
Asarco Facility Location Map
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 1-1 Asarco Facility Location Map . gr

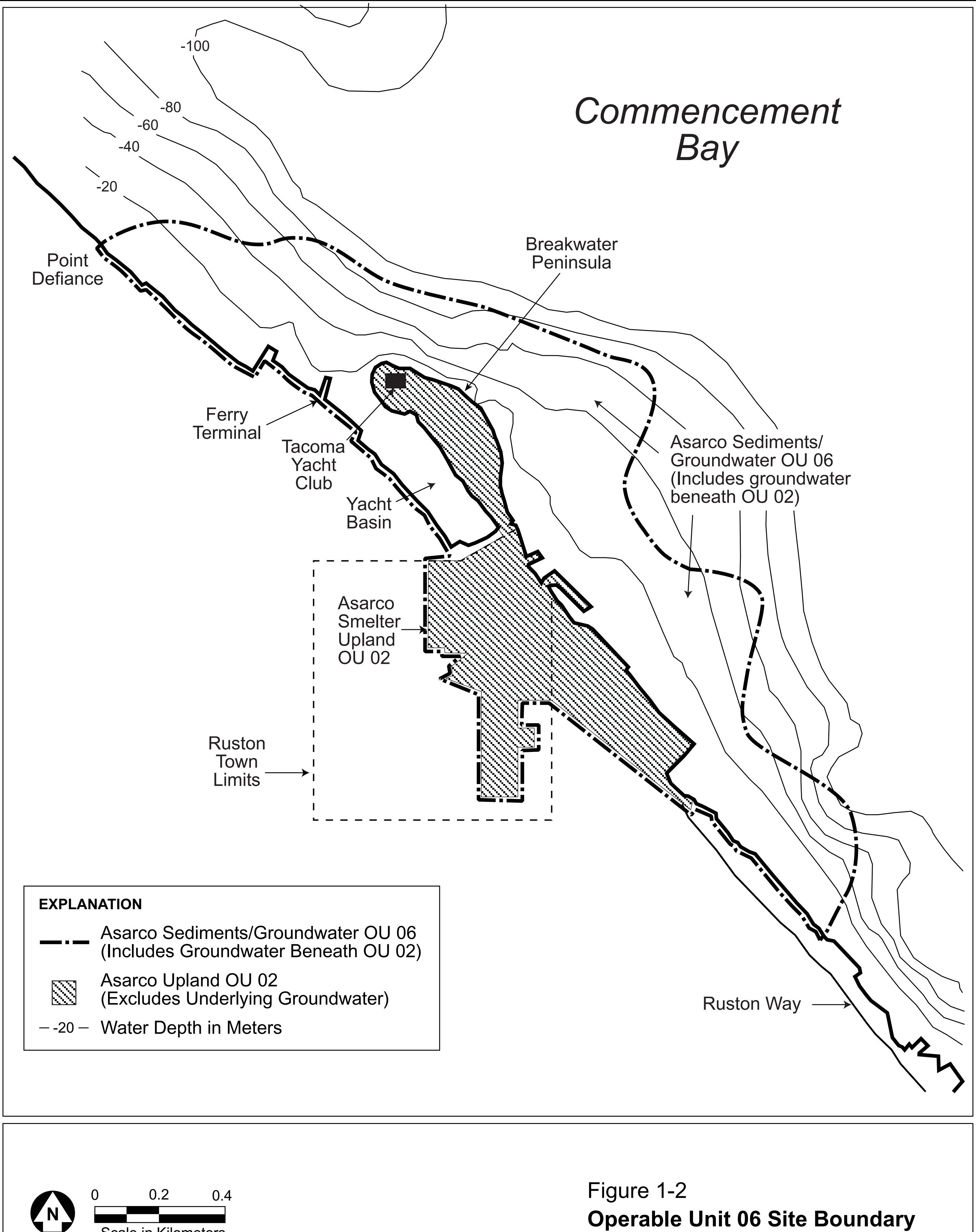


Figure 1-2
Operable Unit 06 Site Boundary
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 1-2 Site Location . 6-21-00 dk/gr

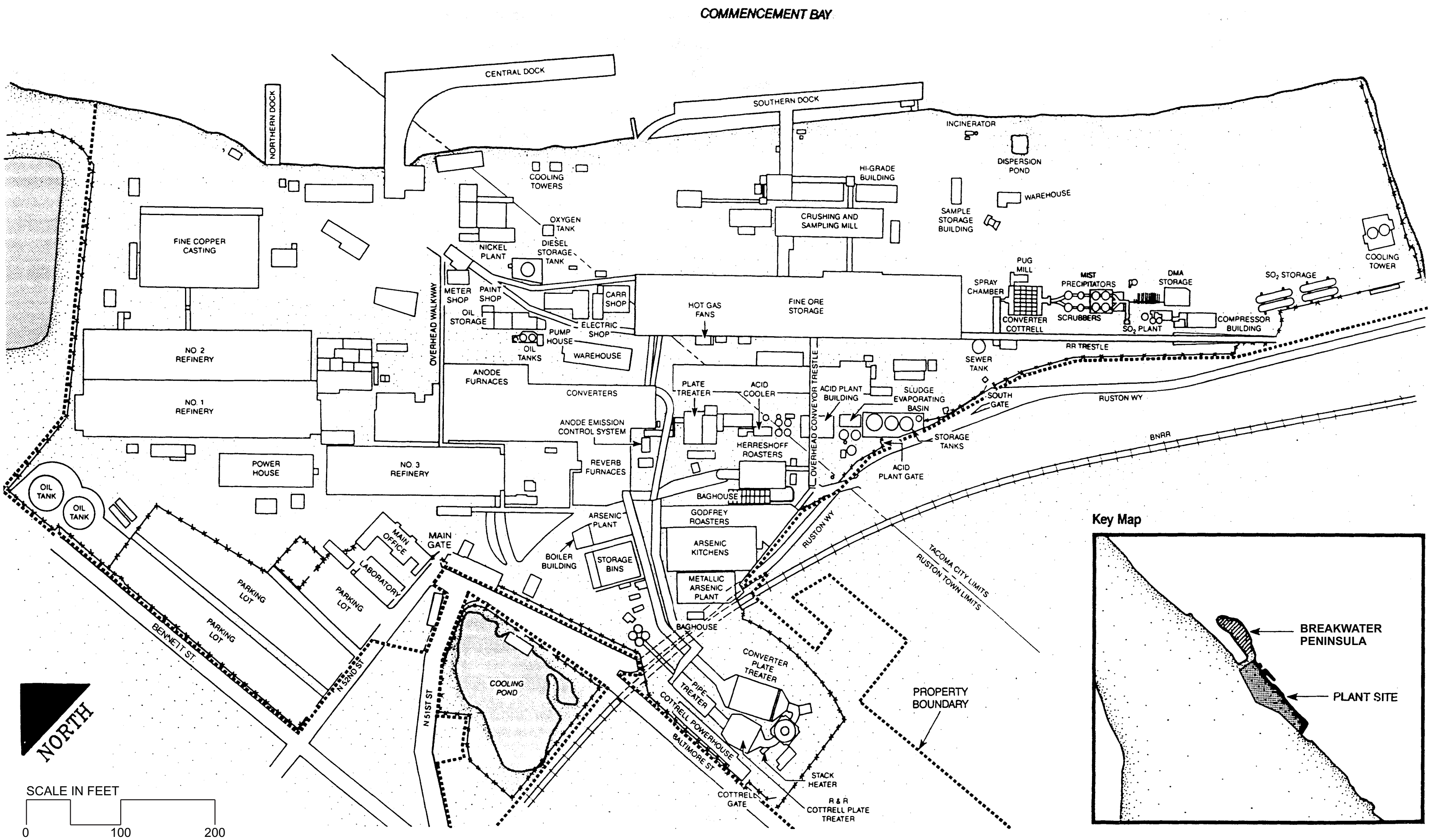
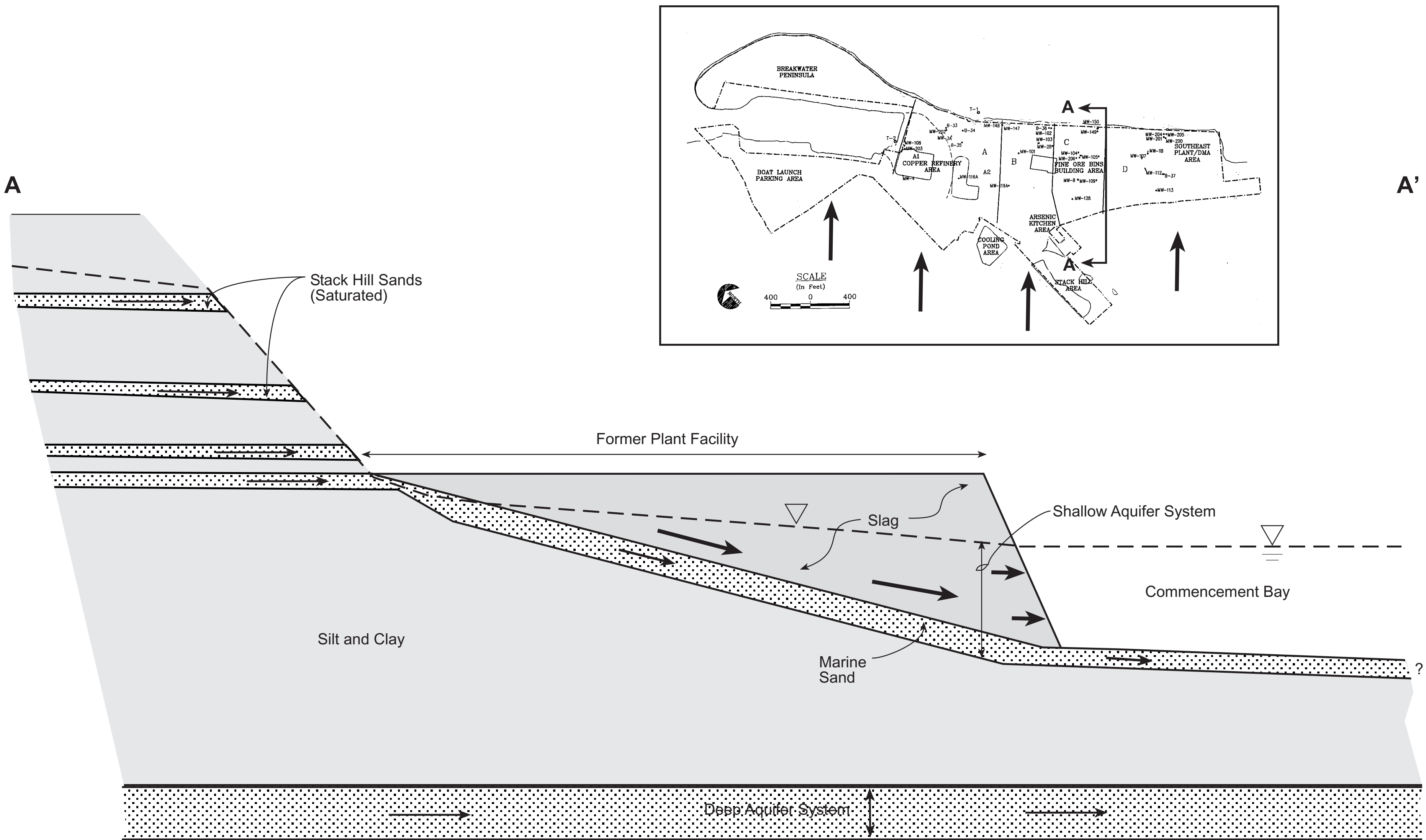


Figure 1-3
Former Facility Layout
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 1-3 Asarco Tacoma Smelter Site Former Facility Layout . 6-21-00 . gr



EXPLANATION

NOT TO SCALE

Water Level

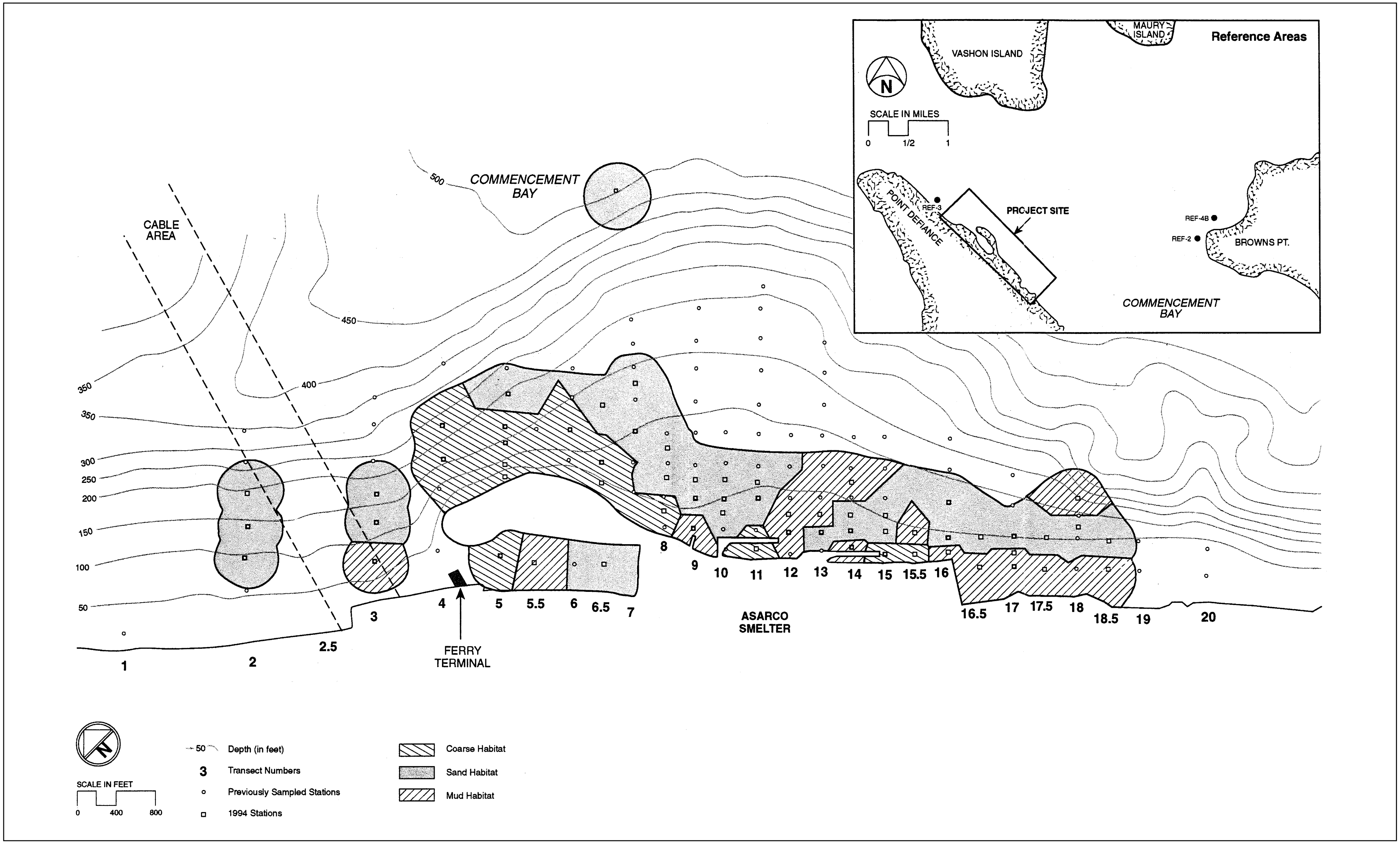
Groundwater Flow Direction

Figure 1-4

Conceptual Cross Section

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 1-4 Conceptual Cross Section . 6-21-00 . dk/gr



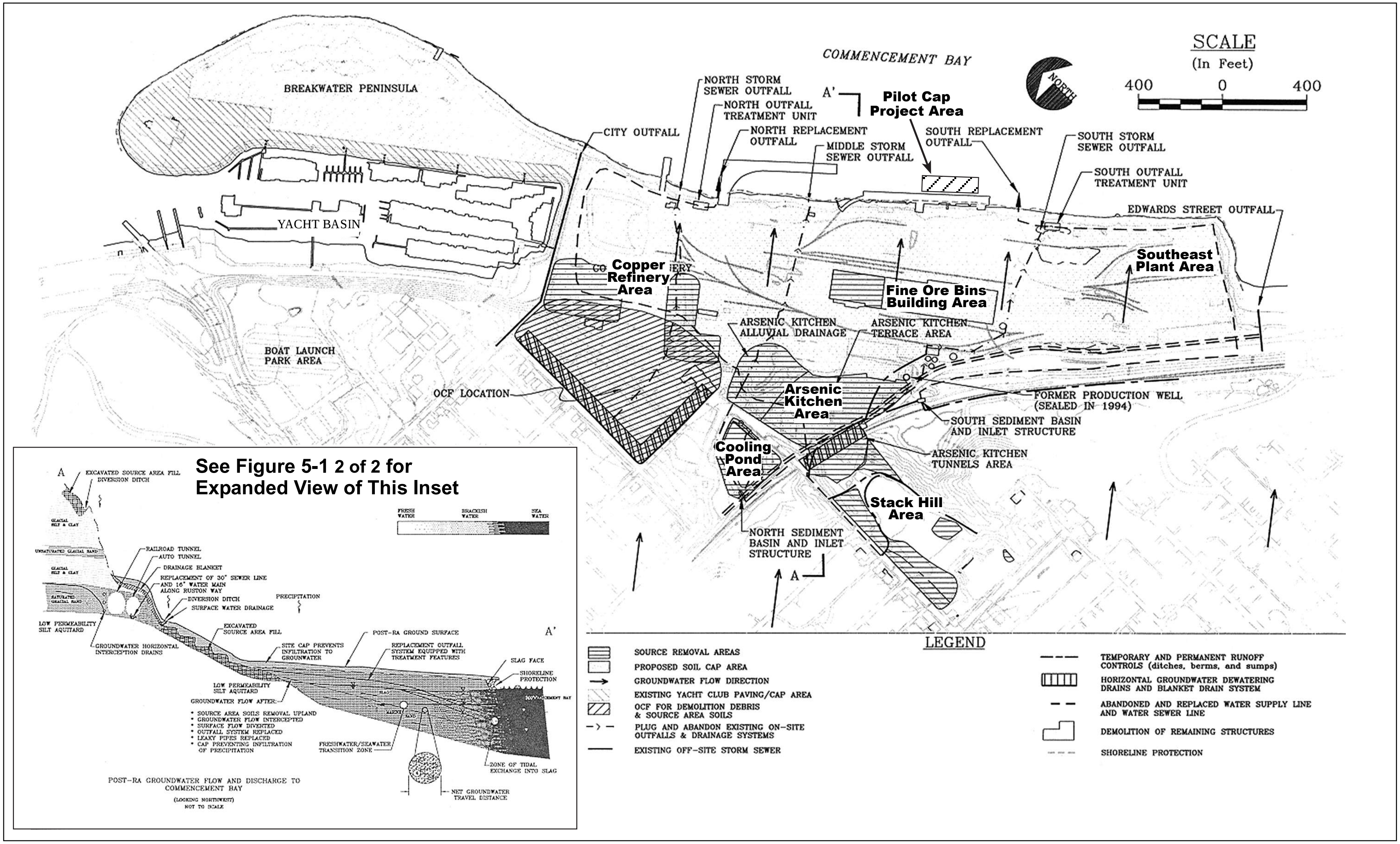
Source: Parametrix, Inc., April 1996.

Figure 1-5

Habitat Areas Defined by Benthic Infauna Sampling

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 1-5 Hab Habitat Areas Defined by Benthic Infauna Sampling . 6-20-00 . gr



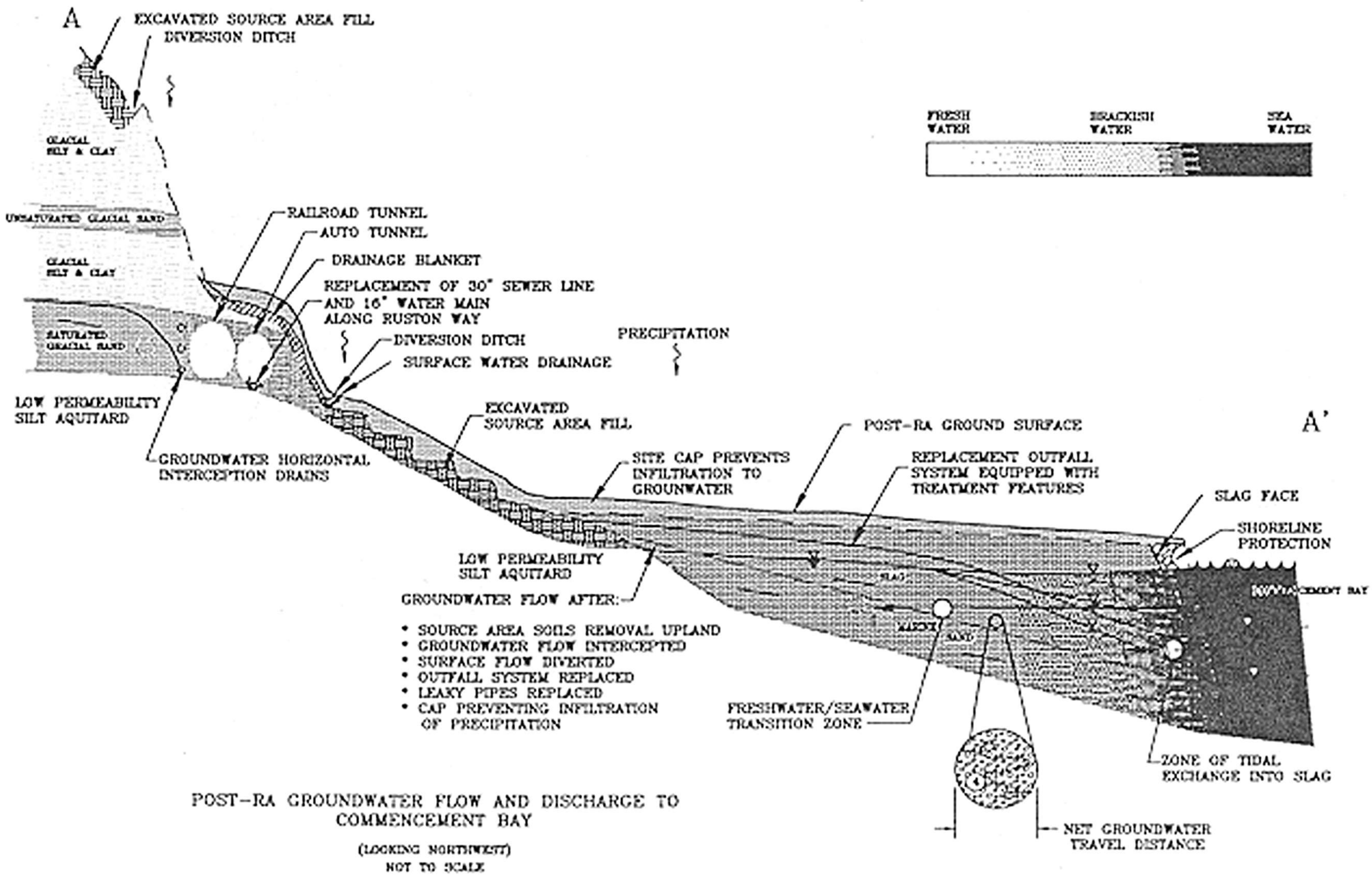
Source: Hydrometrics, Inc.

Figure 5-1 *1 of 2*

Source Areas and Selected Remedy for Operable Unit 06

Asarco Sediments/Groundwater OU 06 ROD

Expanded View of Figure 5-1 1 of 2 **Inset**



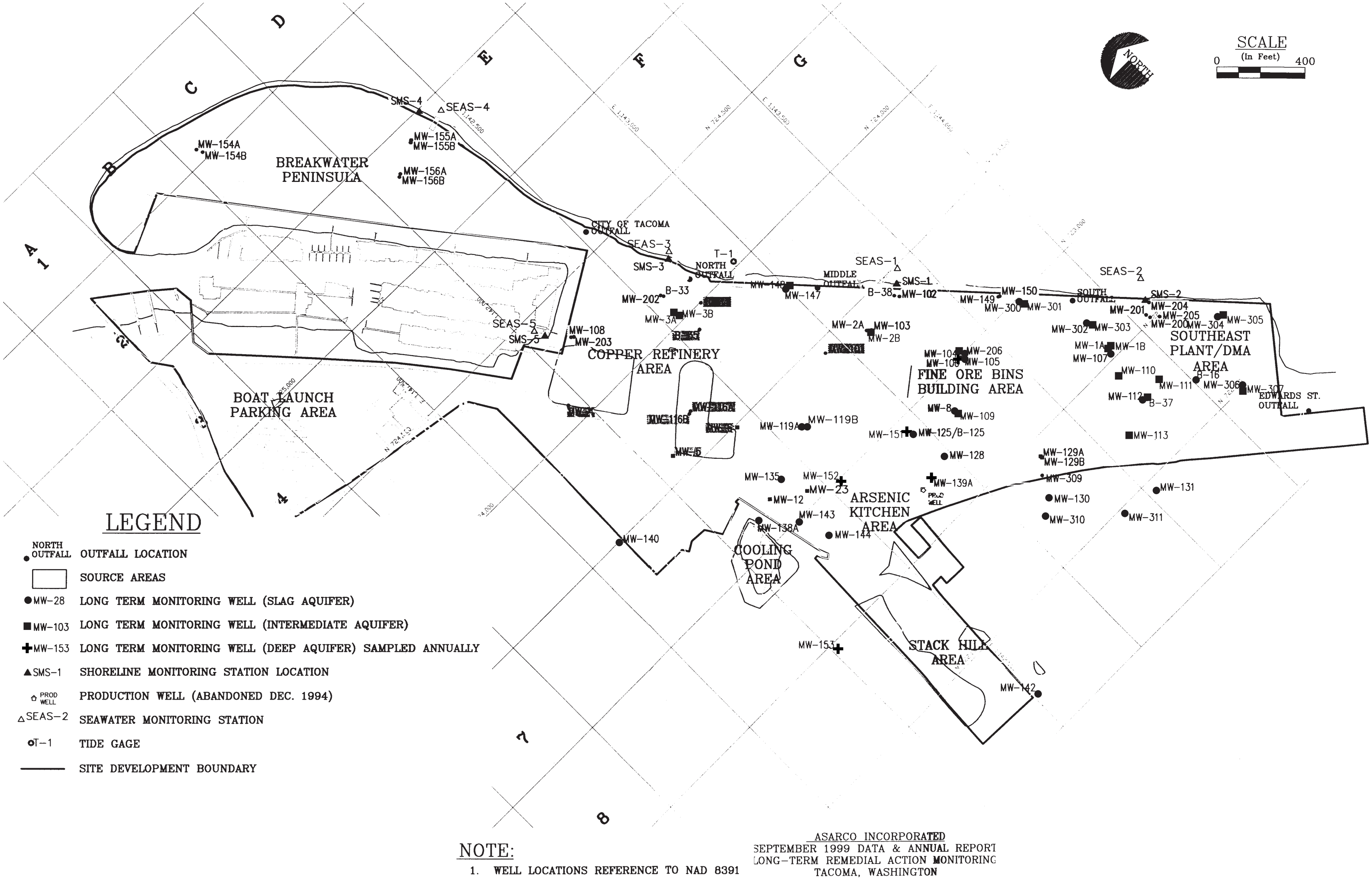
Source: Hydrometrics, Inc.

Figure 5-1 *2 of 2*

Source Areas and Selected Remedy for Operable Unit 06

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-1 2of2 Source Areas Selected Groundwater Remedy . 6-21-00 . gr

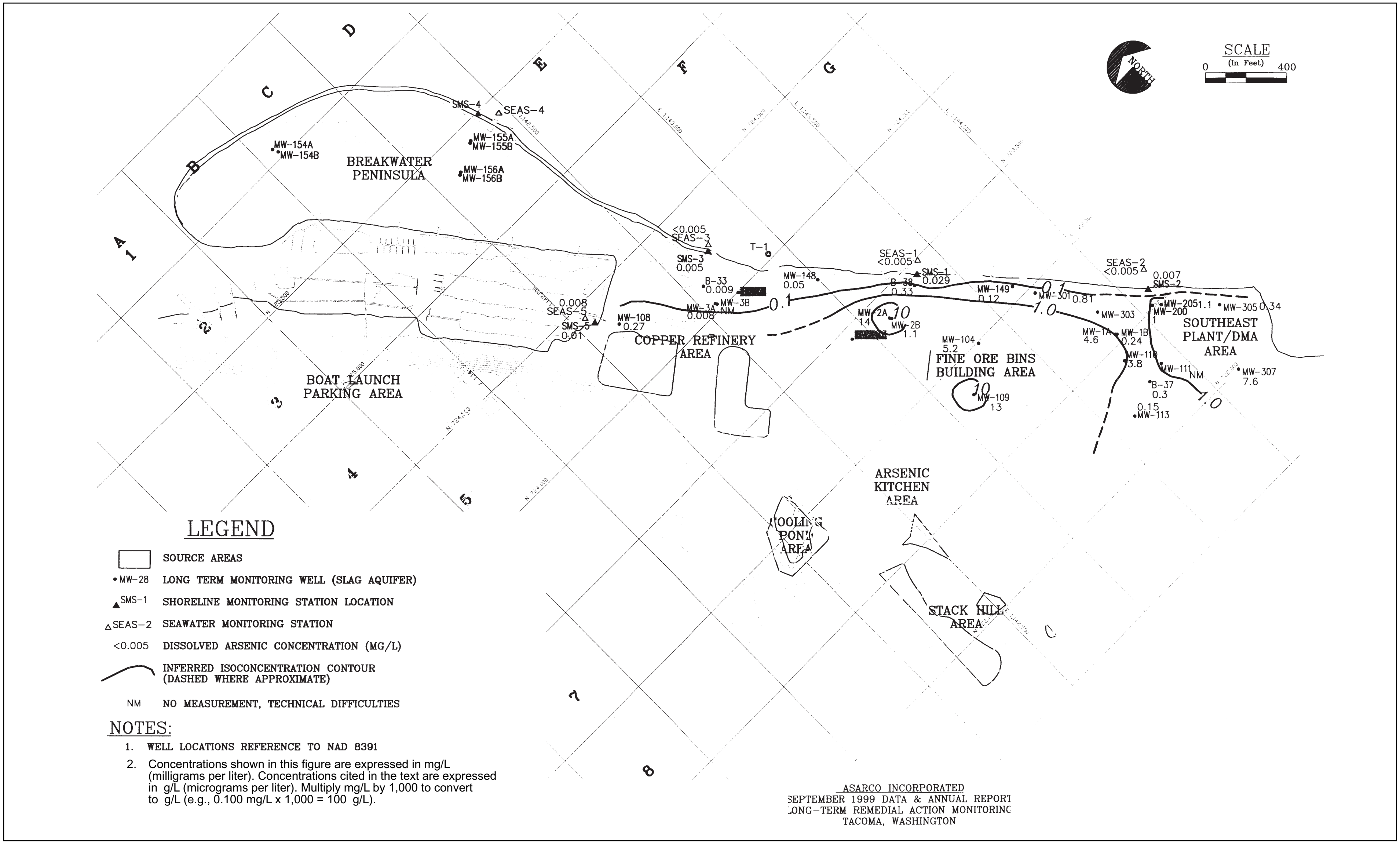


Source: Hydrometrics, Inc., March 2000.

Figure 5-2

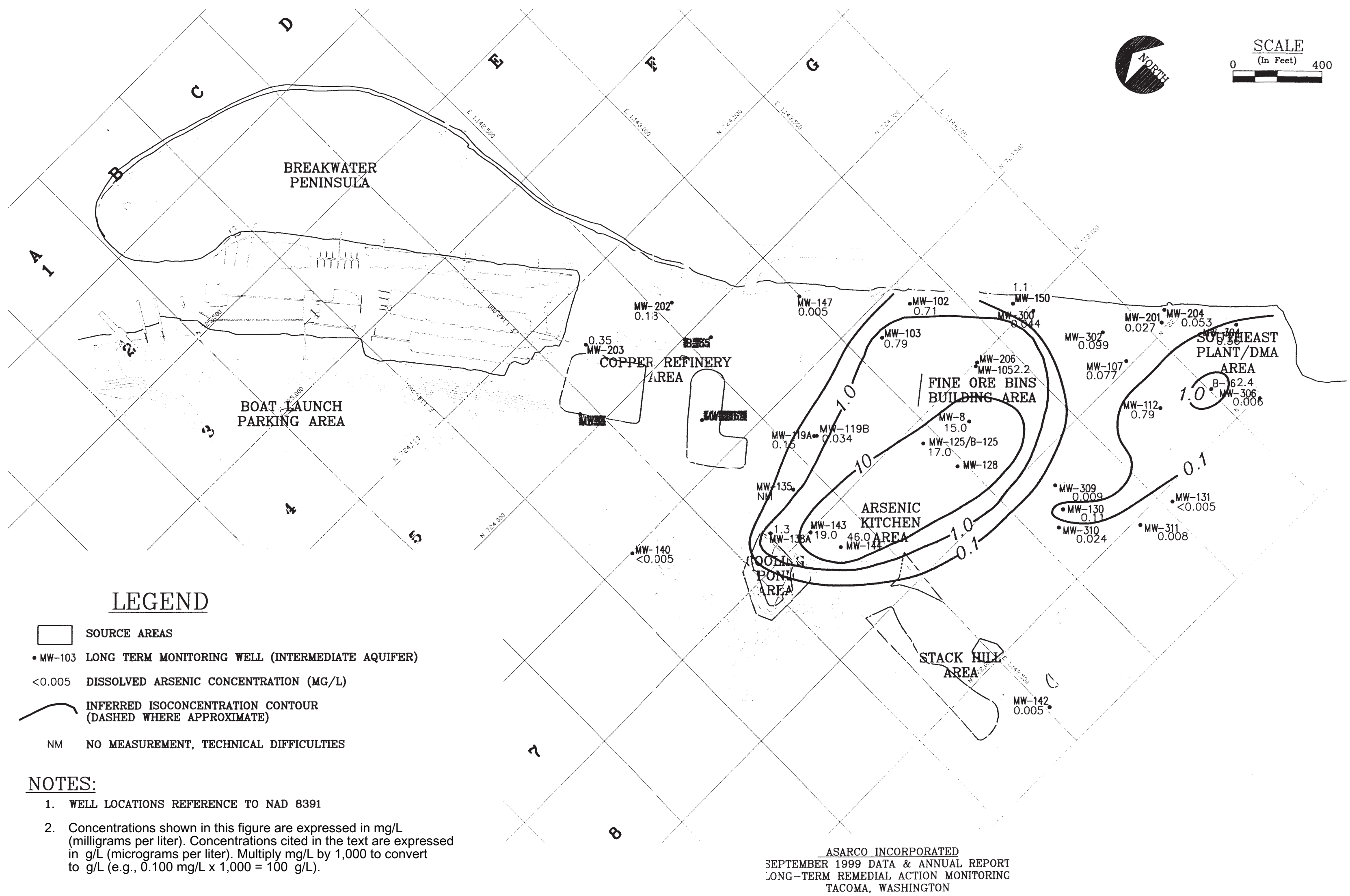
Monitoring Well Locations

Sediments/Groundwater OU 06 ROD



Source: HydroMetrics, Inc., March 2000.

Figure 5-3
Slag Wells
Dissolved Arsenic in Groundwater
September 1999
Asarco Sediments/Groundwater OU 06 ROD



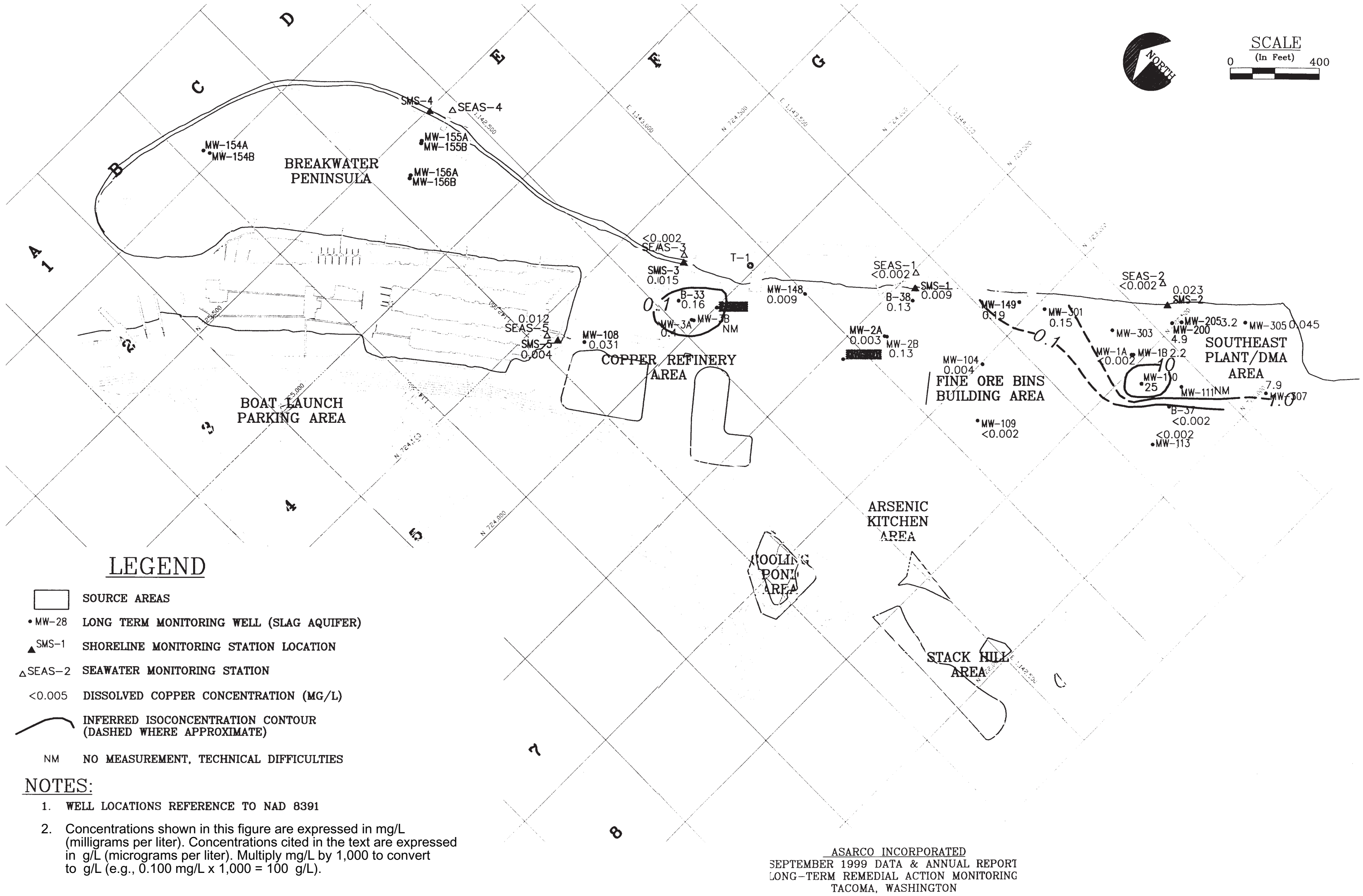
Source: HydroMetrics, Inc., March 2000.

Figure 5-4

Intermediate Wells
Dissolved Arsenic in Groundwater
September 1999

Asarco Sediments/Groundwater OU 06 ROD

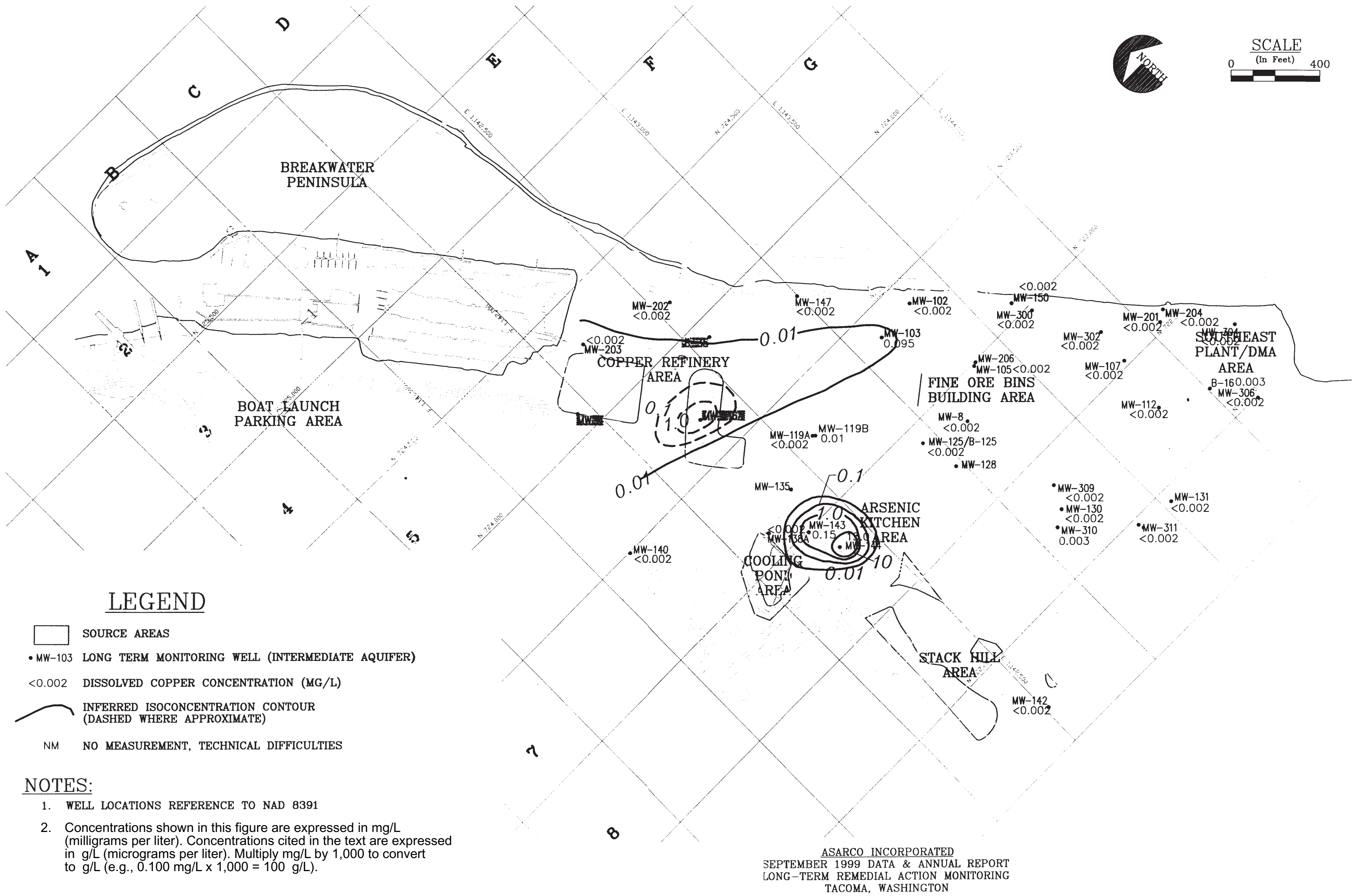
152679.PR.02_E062000009SEA . Fig 5-4 Intermediate Wells Dissolved Arsenic in Groundwater Sept 1999 . 6-21-00 . gr



Source: HydroMetrics, Inc., March 2000.

Figure 5-5
Slag Wells
Dissolved Copper in Groundwater
September 1999
Asarco Sediments/Groundwater OU 06 ROD

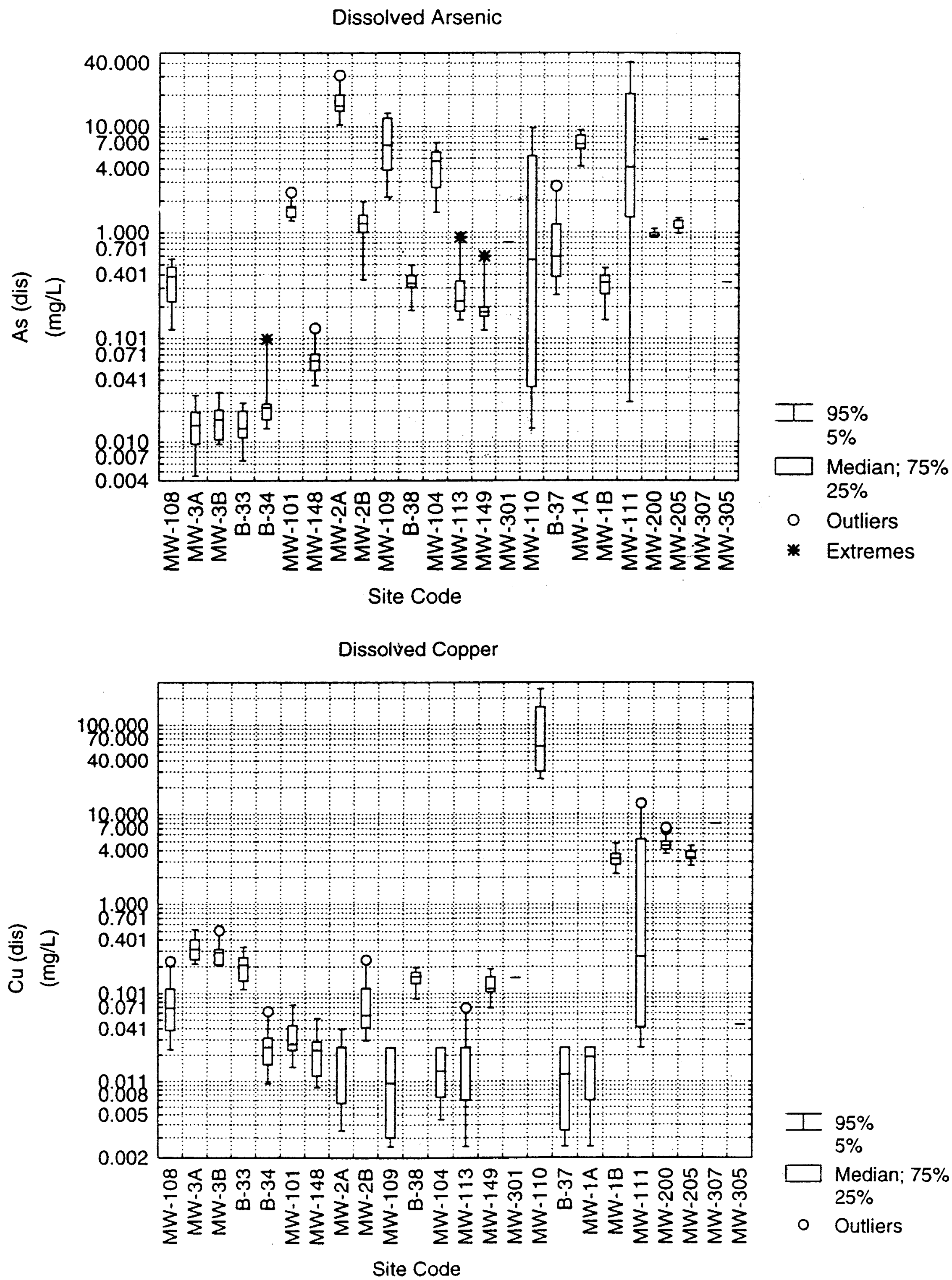
152679.PR.02_E062000009SEA . Fig 5-5 Slag Wells Dissolved Copper in Groundwater Sept 1999 . 6-21-00 . gr



Source: HydroMetrics, Inc., March 2000.

Figure 5-6
Intermediate Wells
Dissolved Copper in Groundwater
September 1999
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-6 Intermediate Wells Dissolved Copper in Groundwater Sept 1999 . 6-21-00 . gr



Source: Hydrometrics, Inc., March 2000.

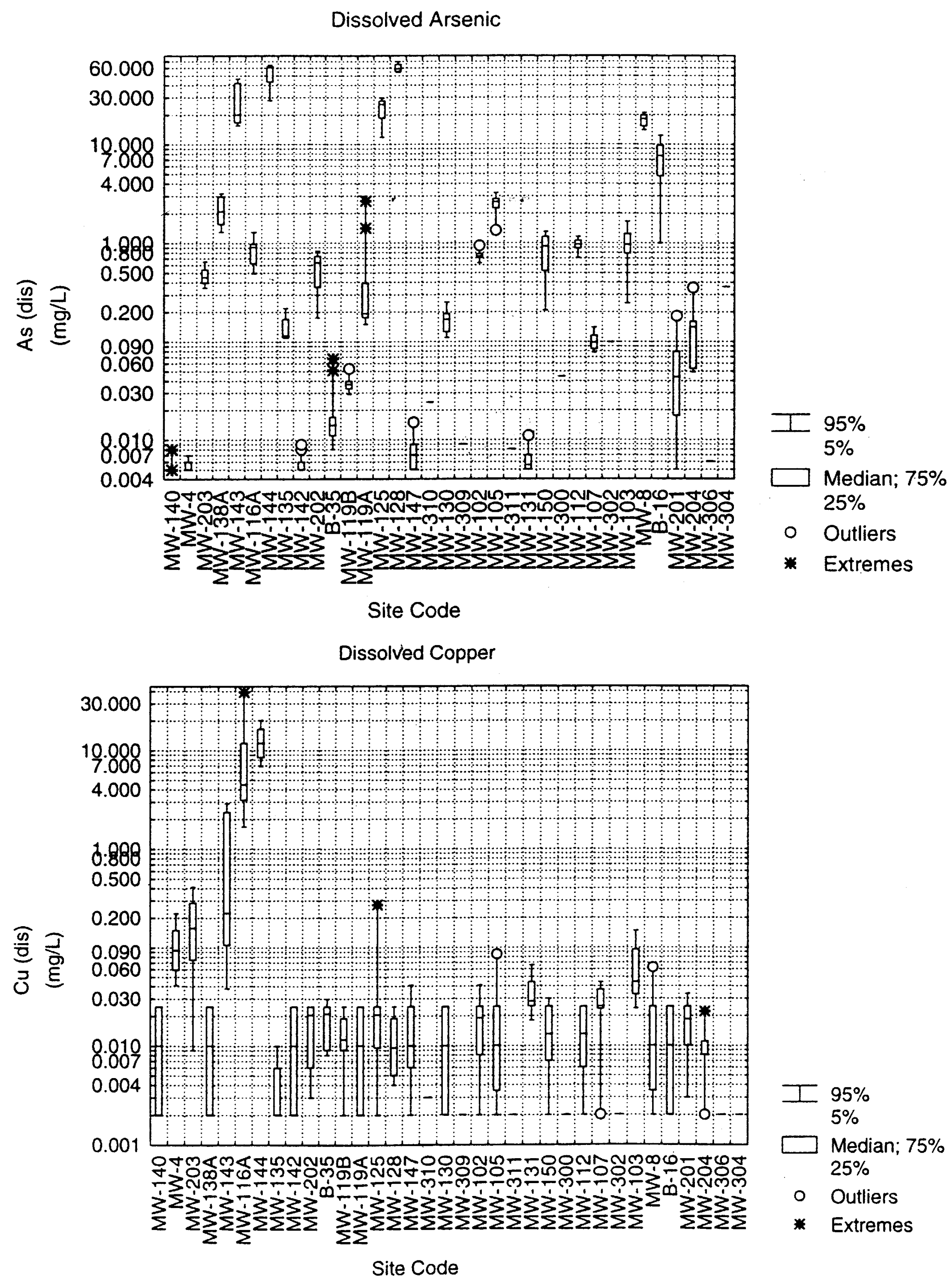
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure 5-7

Box Plots for Arsenic and Copper, Slag Wells

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-7 Box Plots for Arsenic Copper Slag Wells . 6-20-00 . gr



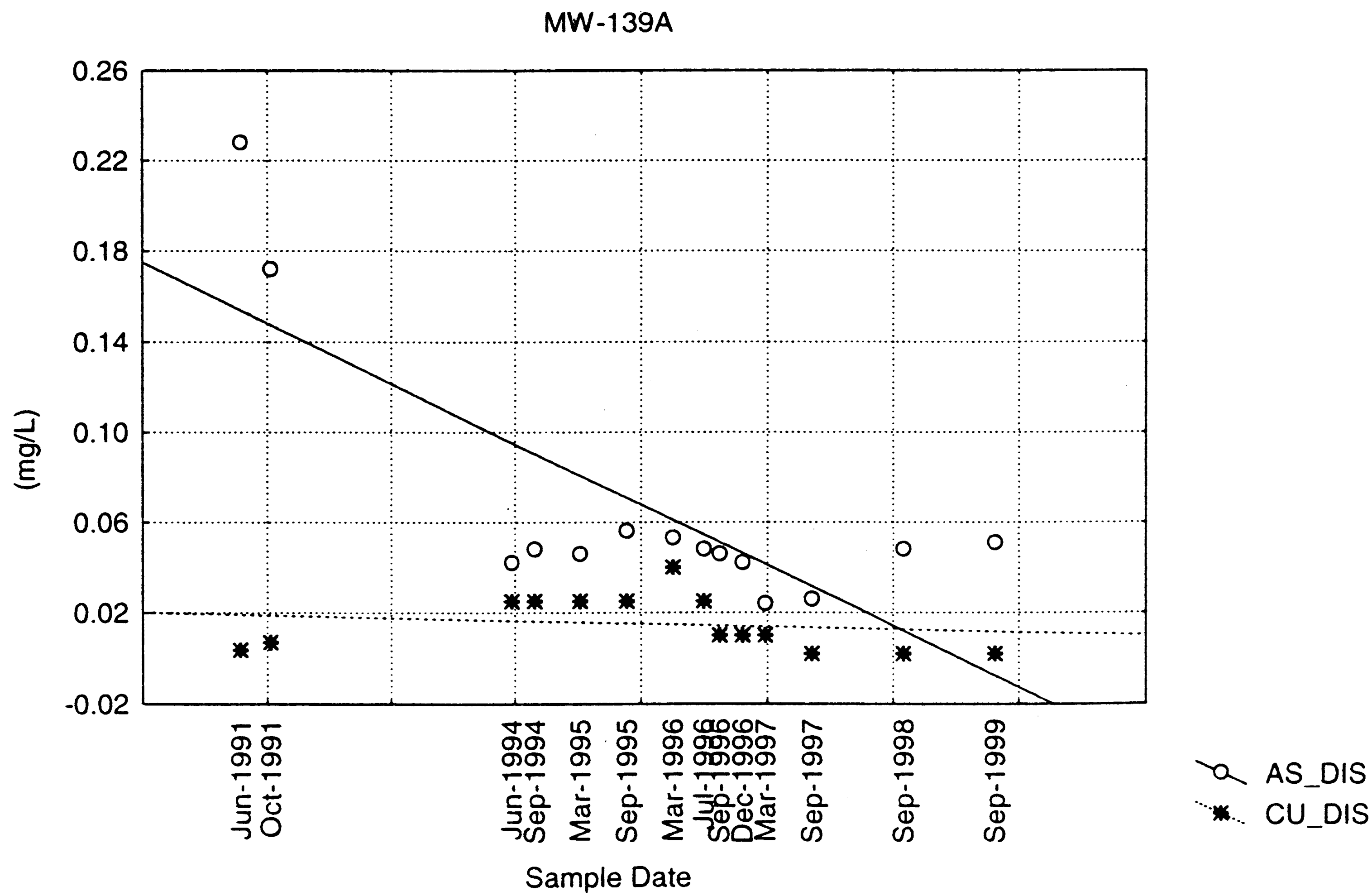
Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure 5-8

Box Plots for Arsenic and Copper, Intermediate Wells

Asarco Sediments/Groundwater OU 06 ROD



Source: Hydrometrics, Inc., March 2000.

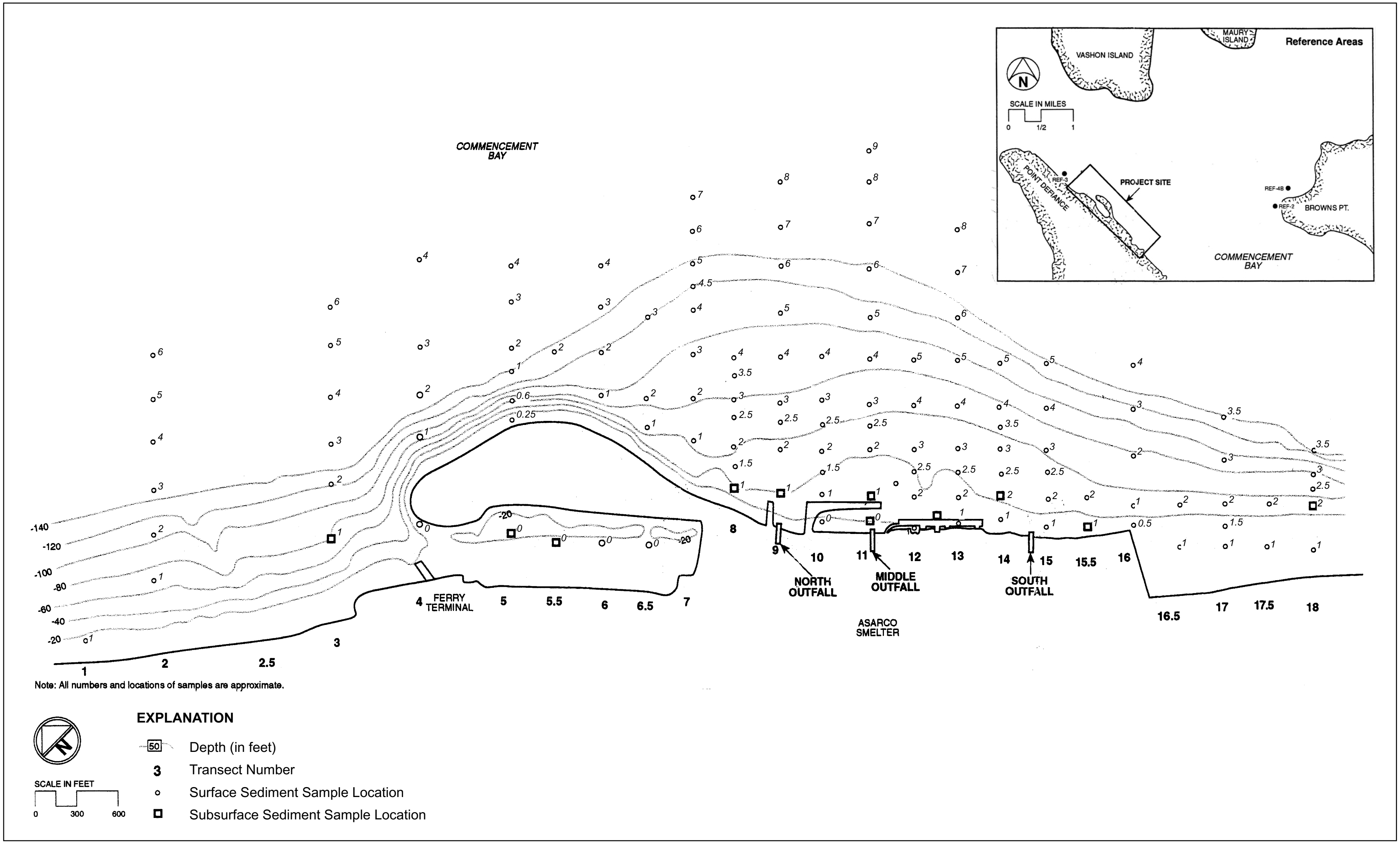
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure 5-9

Arsenic and Copper Trend at Well MW-139A

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-9 Arsenic and Copper Trend at Well MW-139A . 6-20-00 . gr



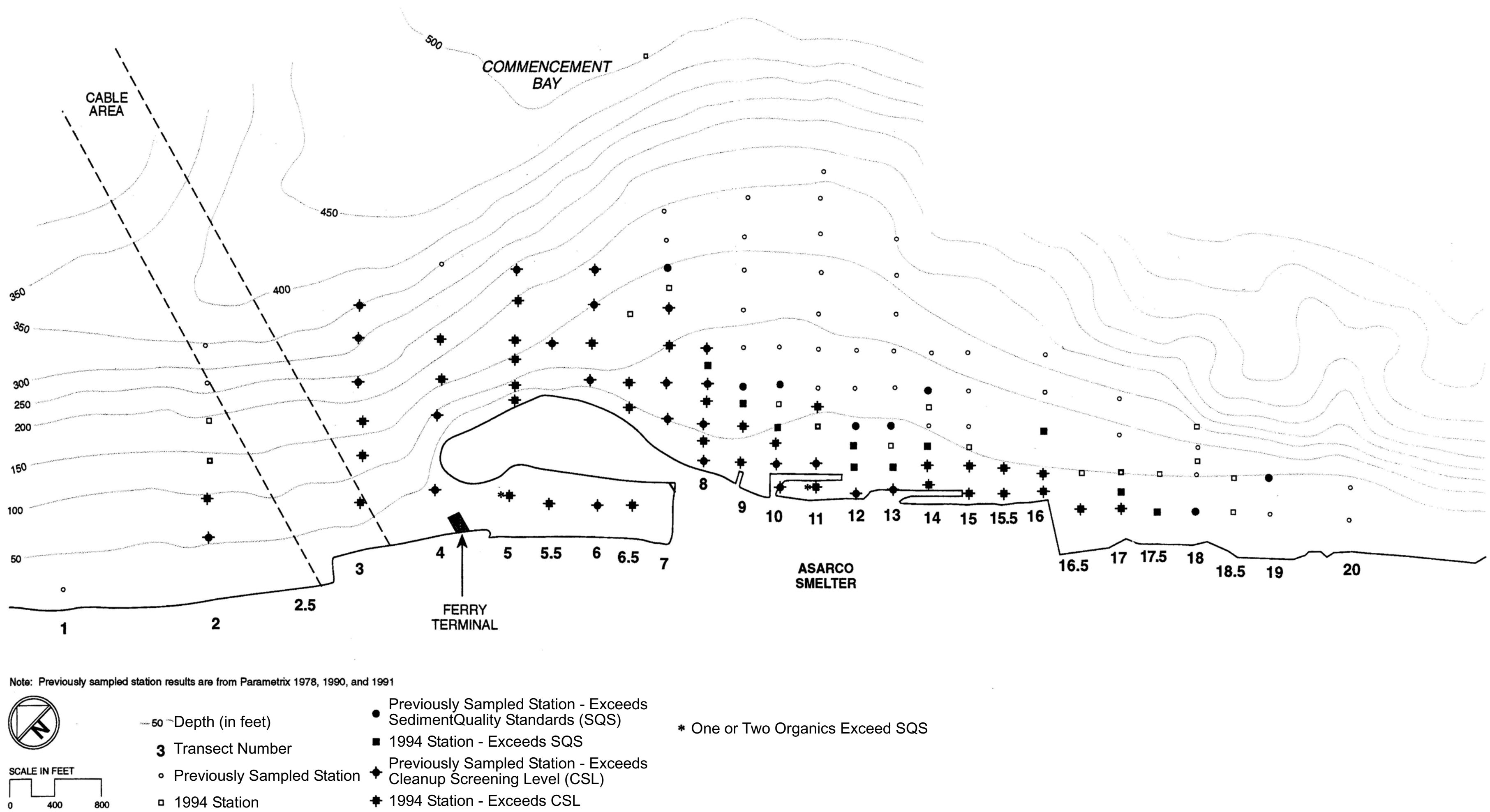
Source: Parametrix, Inc., April 1996.

Figure 5-10

Sediment Station Locations

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-10 Sediment Station Locations . 6-20-00 . gr



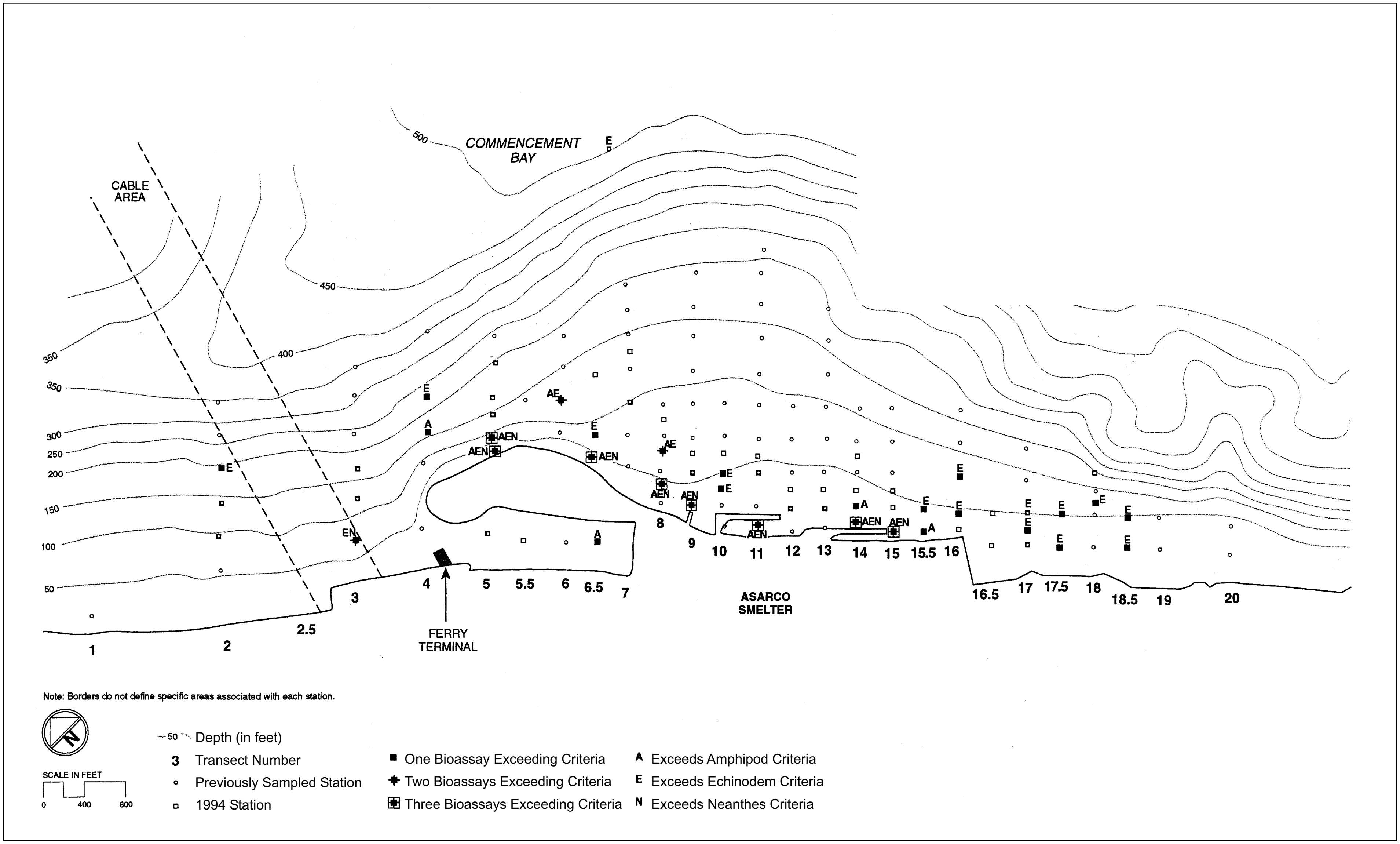
Source: Parametrix, Inc., April 1996.

Figure 5-11

Sediment Chemistry Comparison to State SMS Criteria

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 5-11 Sediment Chemistry Comparison to State SMS Criteria . 6-20-00 . gr

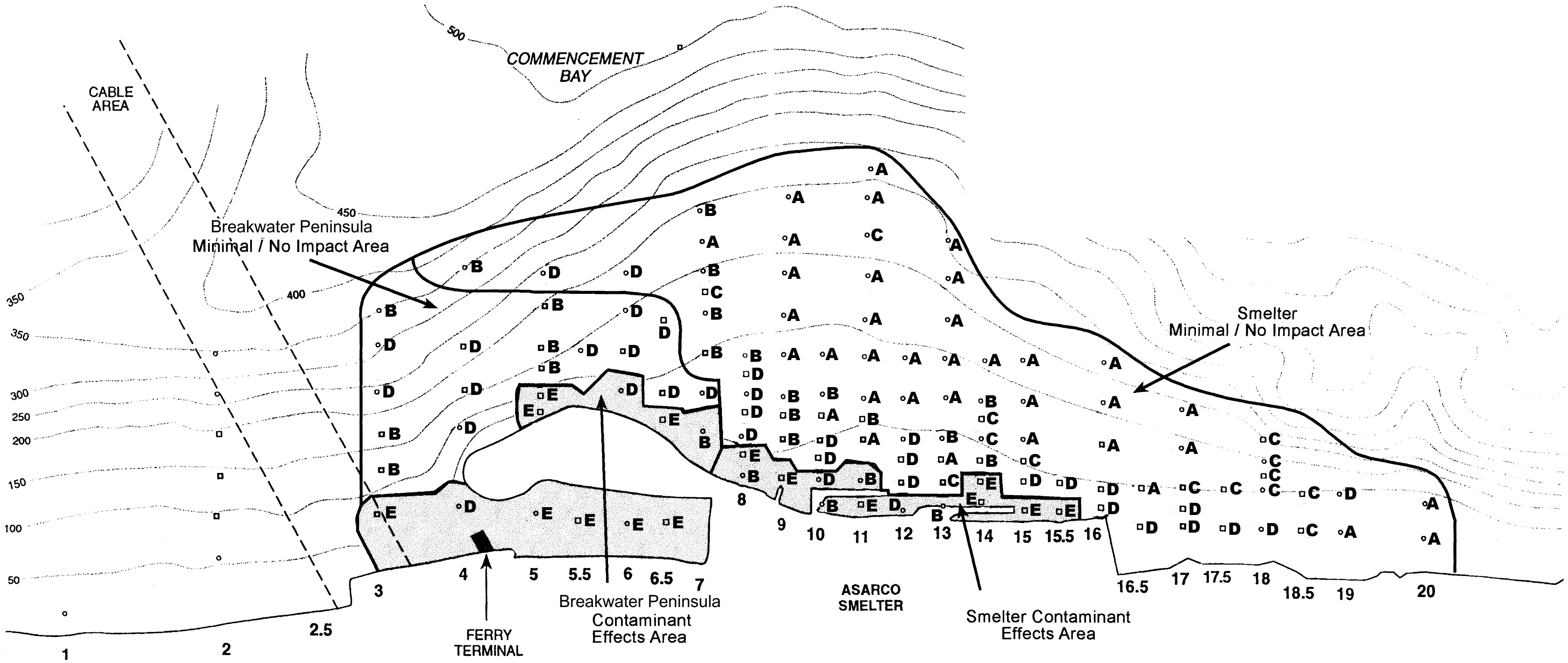


Source: Parametrix, Inc., April 1996.

Figure 5-12

Summary of Bioassay Results That Exceed One or More State SMS Criteria

Asarco Sediments/Groundwater OU 06 ROD



0 400 800
Scale in Feet

EXPLANATION

50 Depth (in feet)

3 Transect Number

○ Previously Sampled Station

□ 1994 Station

Contaminant Effects Area

IMPACT CATEGORIES

A No Current Impacts / Future Impacts Not Predicted

B No Known Current Impacts / Future Impacts Possible

C Current Minimal Impacts (Cause Uncertain) / Future Impacts Possible

D Current Minimal Impacts (Sediment Related) / Future Impacts Possible

E Current Moderate to Severe Impacts / Future Impacts Probable

Note: Figure adapted from Parametrix, 1995.

Figure 7-1
Cleanup Level Evaluation Areas
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 7-1 Cleanup Level Evaluation Areas OU 06 . 6-21-00 . gr

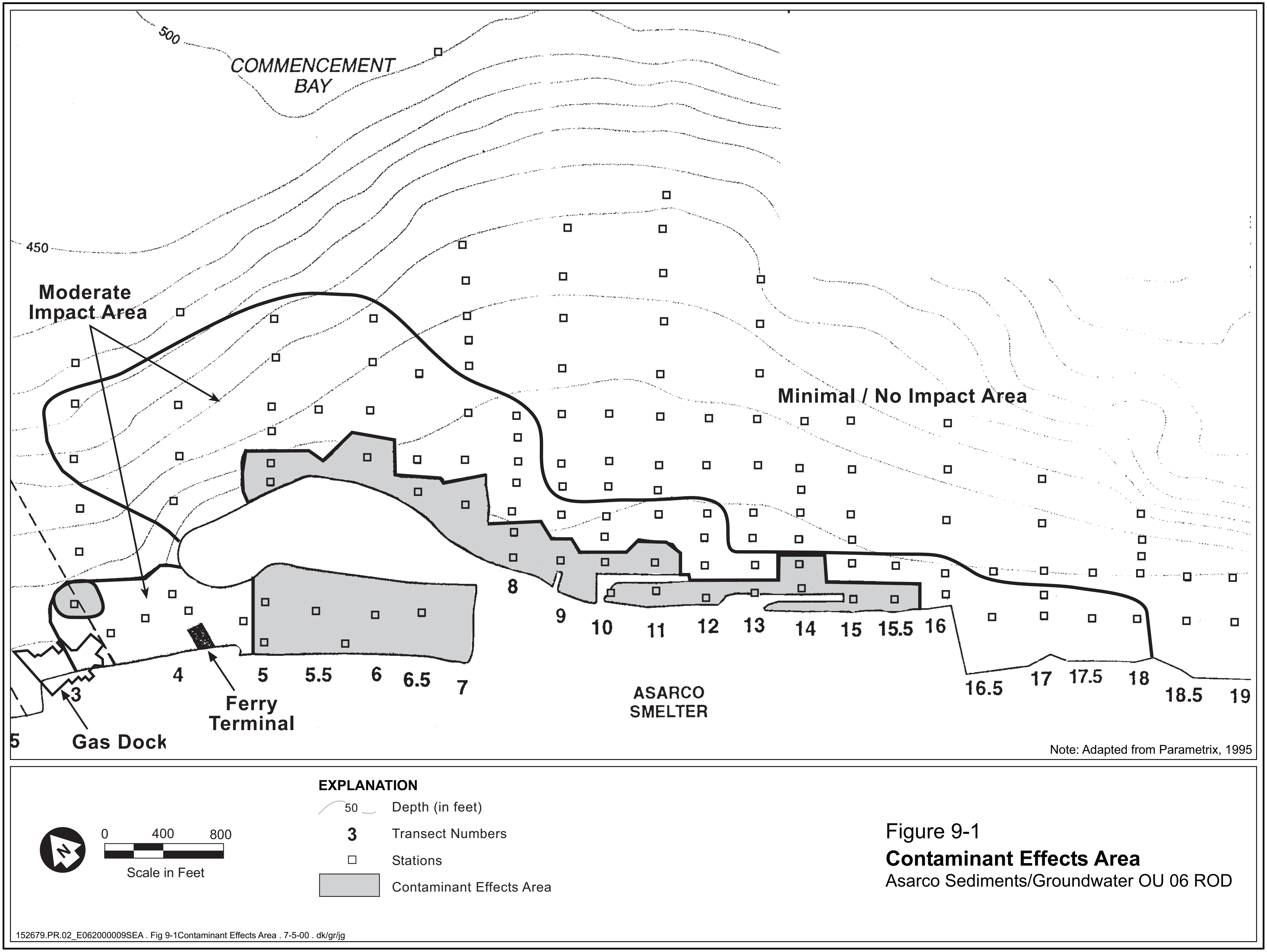
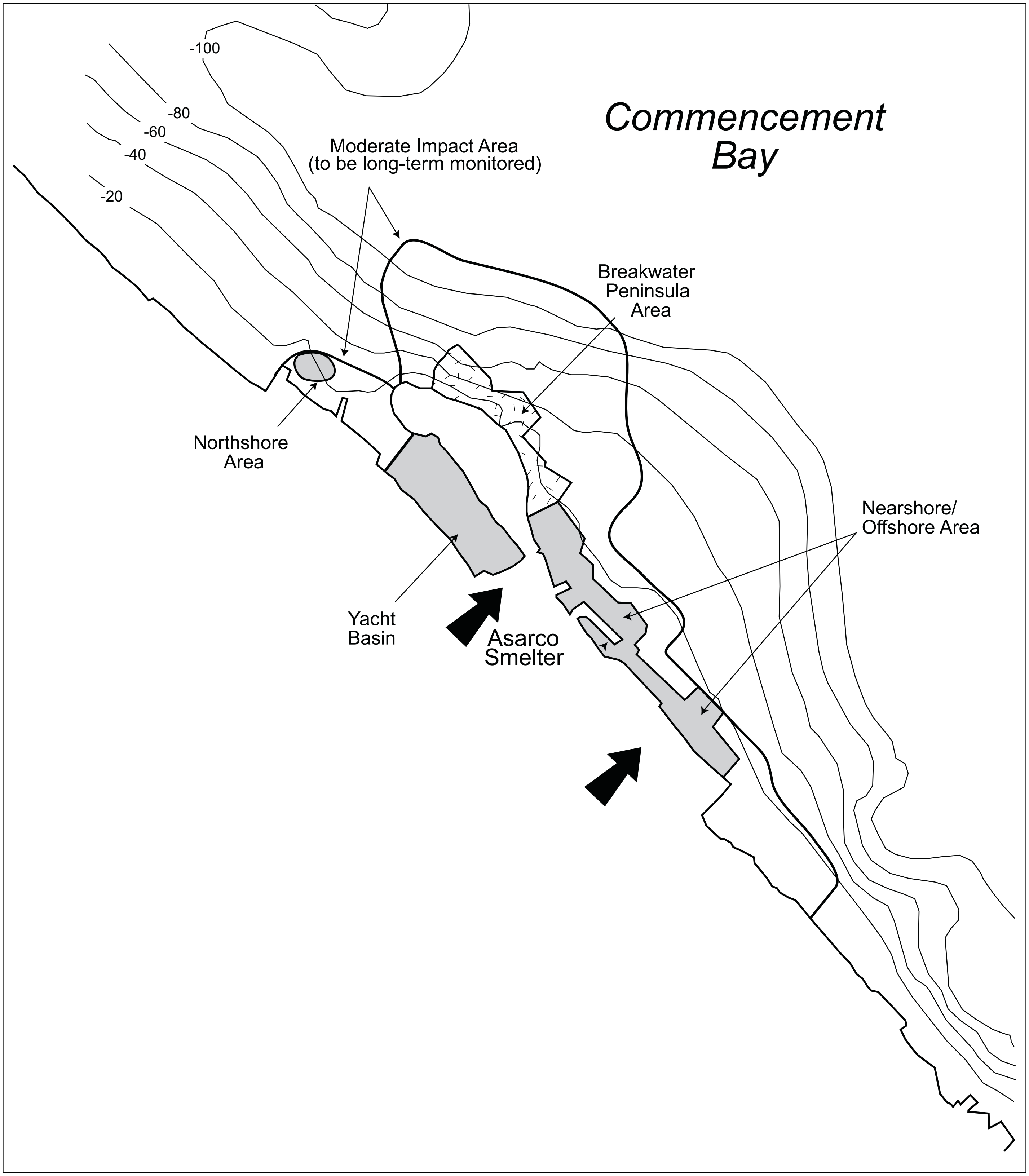


Figure 9-1
Contaminant Effects Area
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 9-1Contaminant Effects Area . 7-5-00 . dk/gr/jg

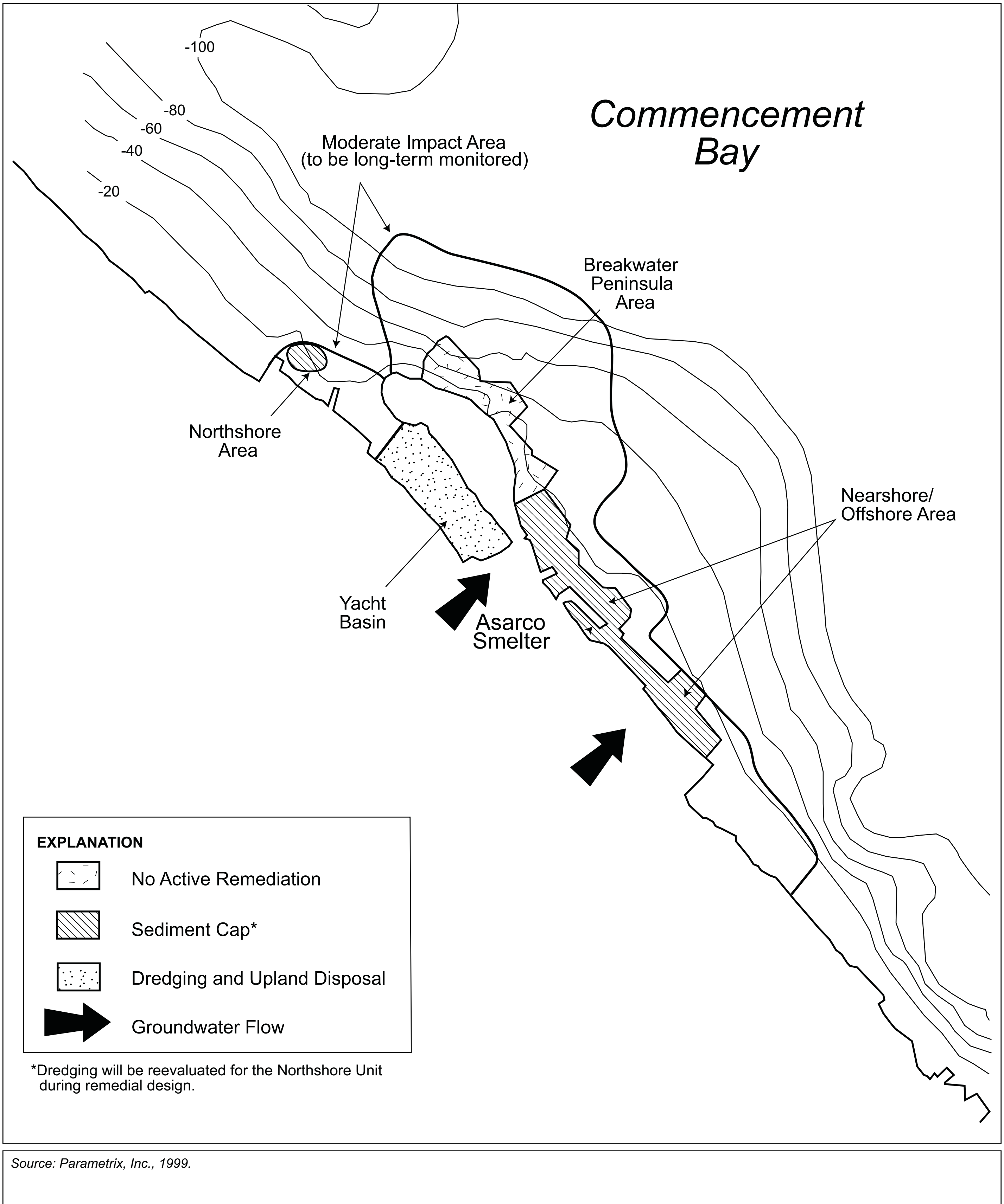


Source: Parametrix, Inc., 1999.

0 500 1000
Scale in Feet

Figure 9-2
Marine Sediment Remedy Units
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 9-2 Marine Sediment Remedy Units . 7-5-00 dk/gr/jg



Source: Parametrix, Inc., 1999.

Figure 12-1
Selected Remedy Marine Sediment
Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig 12-1 Selected Remedy . 7-5-00 dk/gr/jg

APPENDIX A

Trend Plots of DMA-Related Organic Compounds

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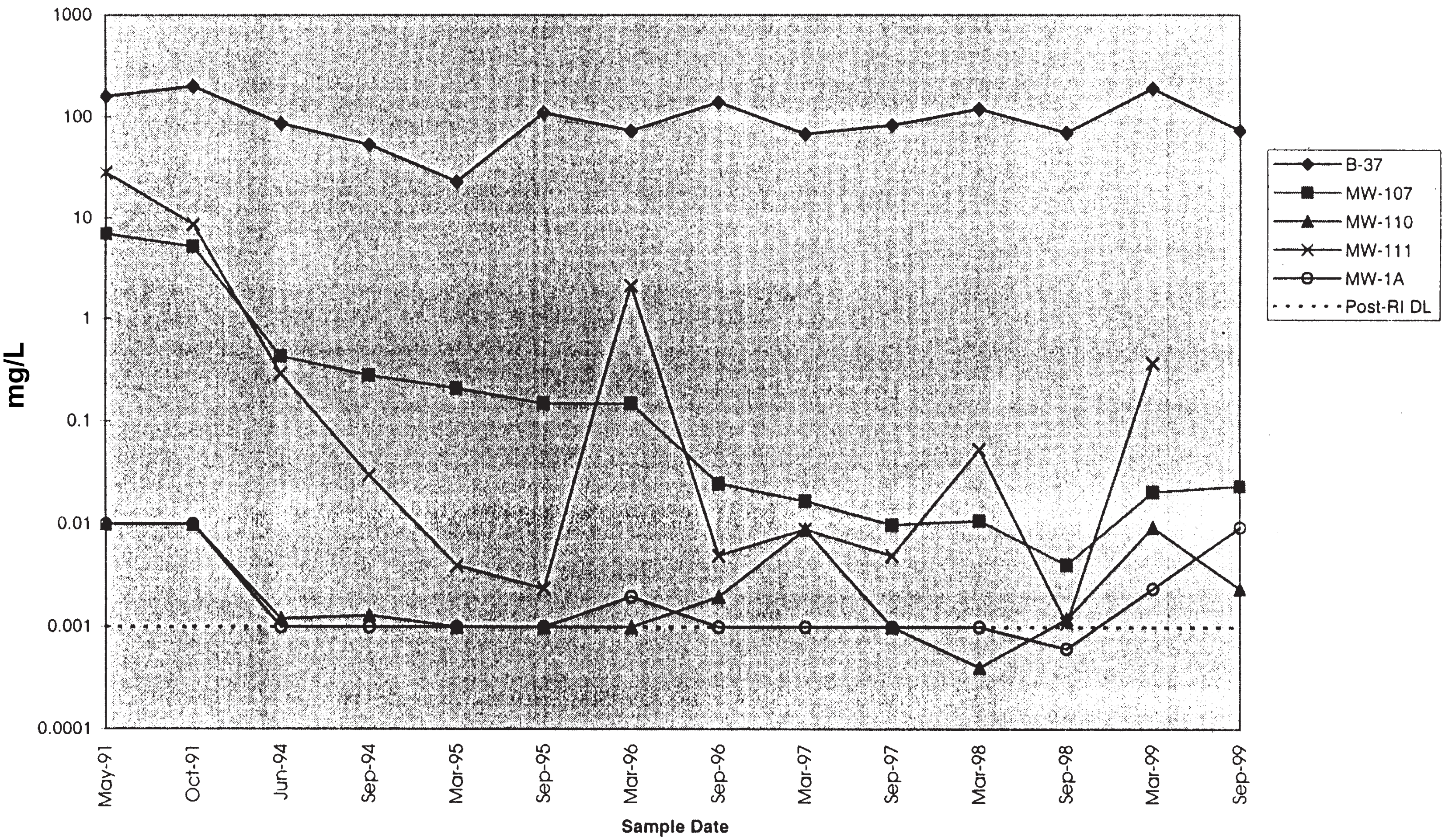


NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

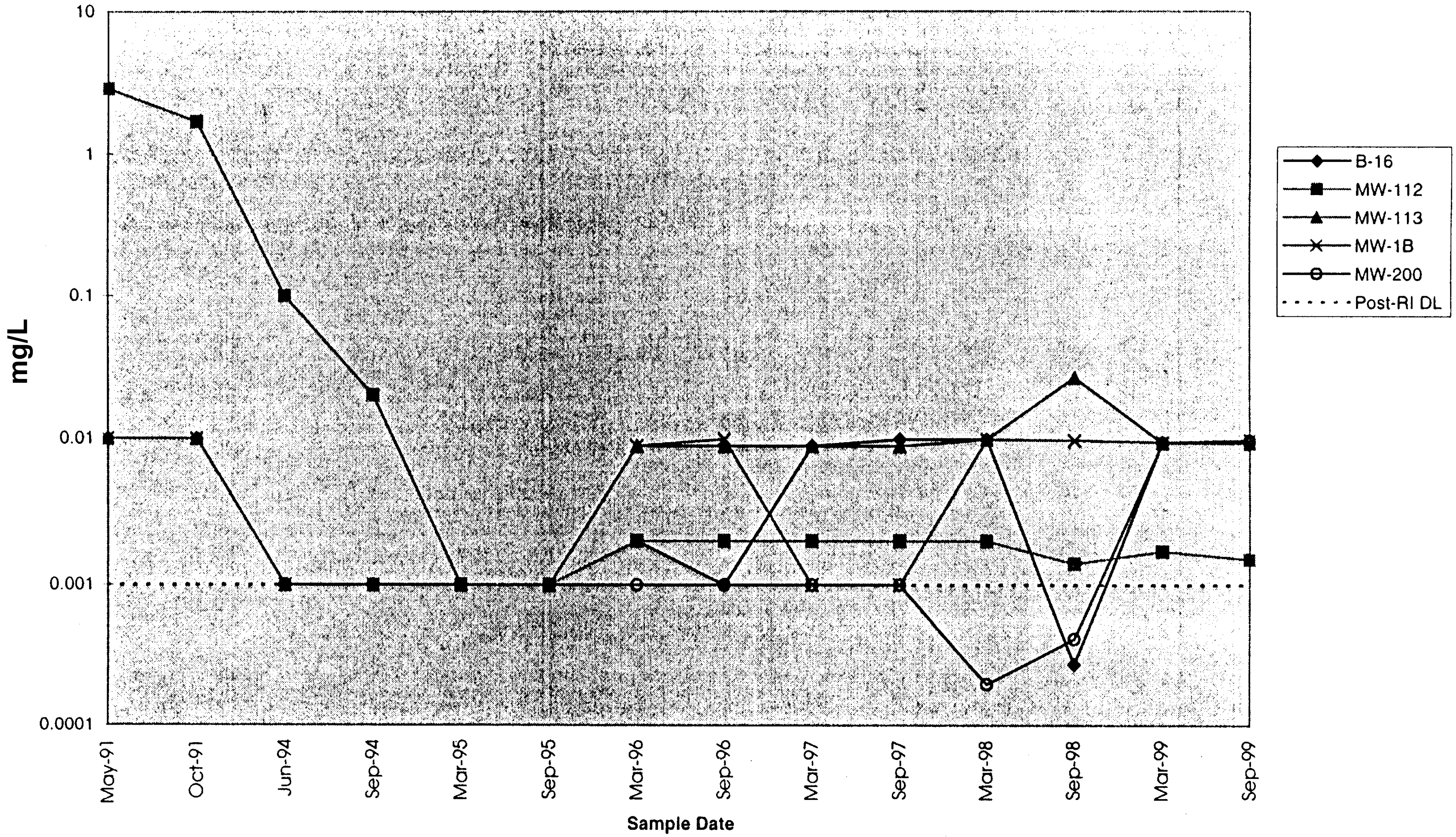
Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-1 *1 of 3*

Aniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

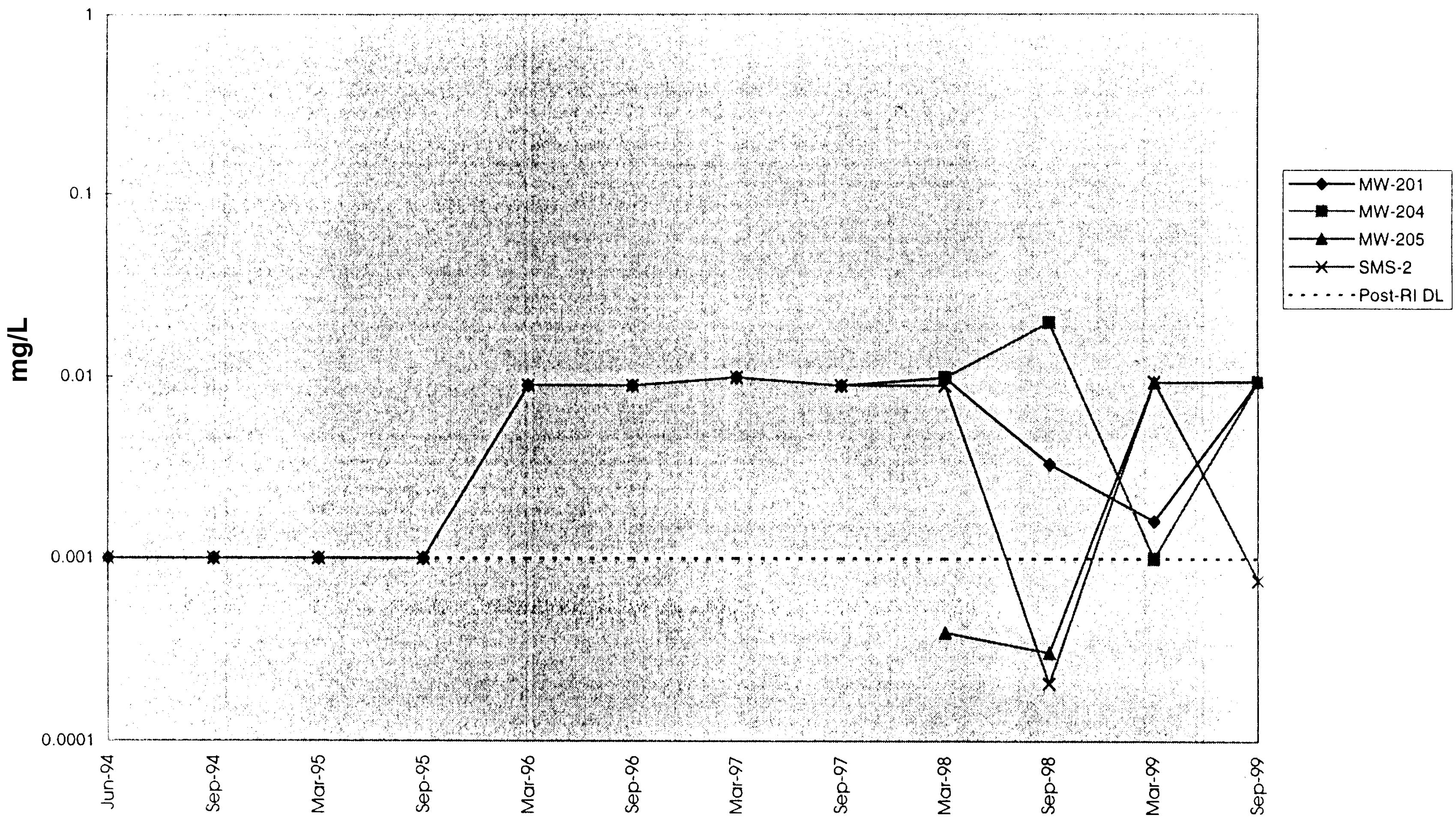
Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-1 *2 of 3*

Aniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

Source: Hydrometrics, Inc., March 2000.

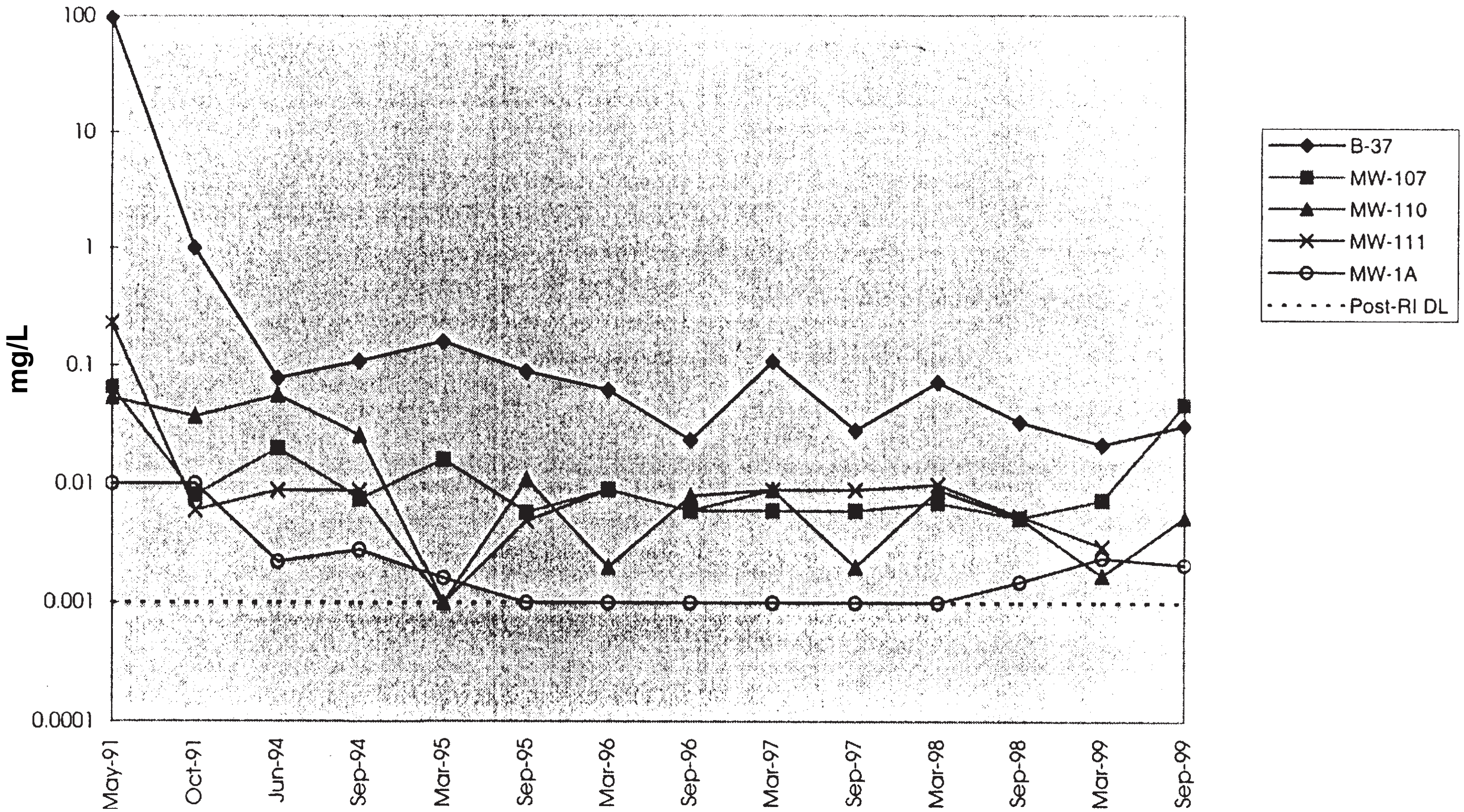
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-1 *3 of 3*

Aniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig A-1 3of3 Aniline Trend Plot . 6-20-00 . gr



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

Source: Hydrometrics, Inc., March 2000.

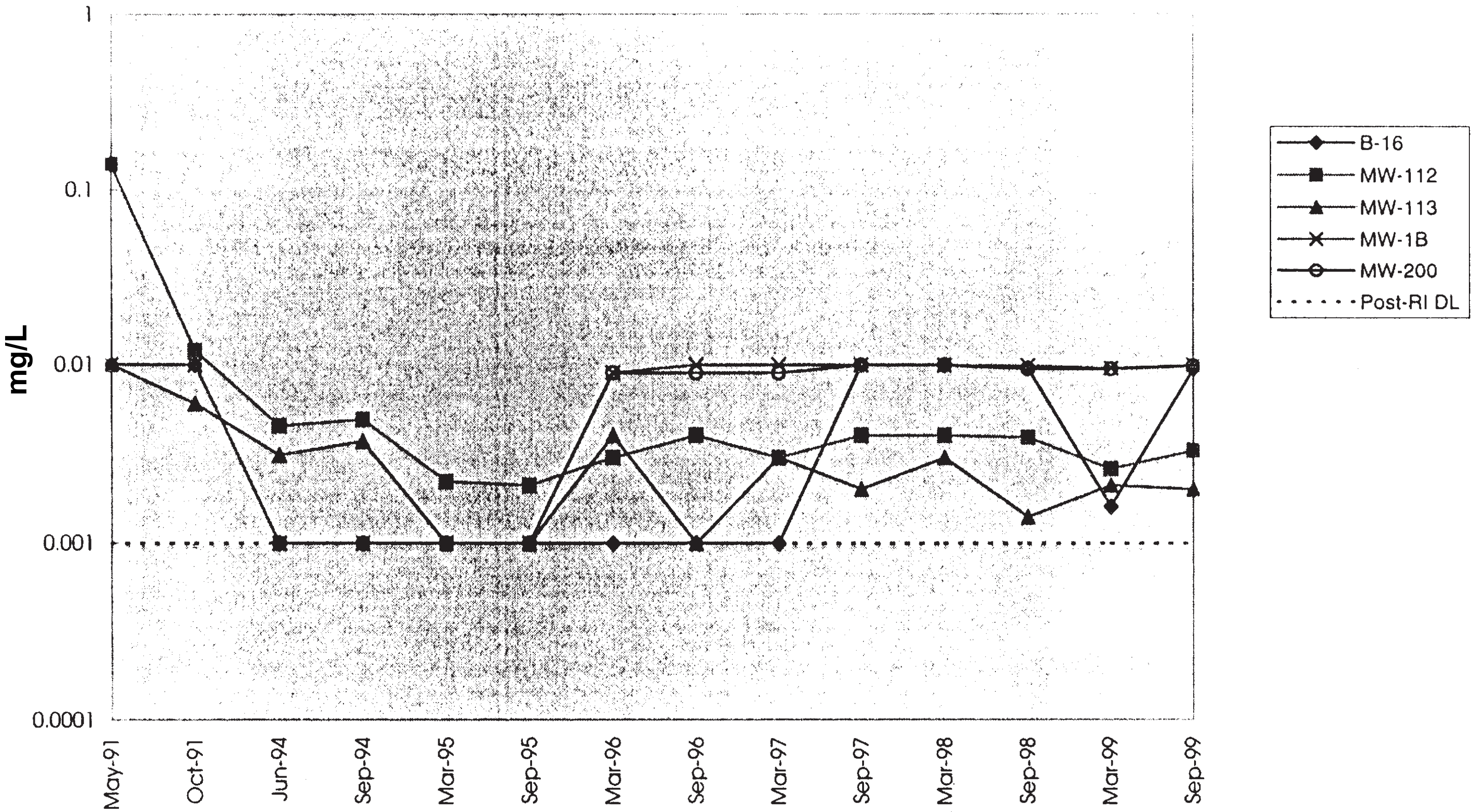
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-2 *1 of 3*

N, N-Dimethylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig A-2 1of3 N N-Dimethylaniline Trend Plot . 6-20-00 . gr



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

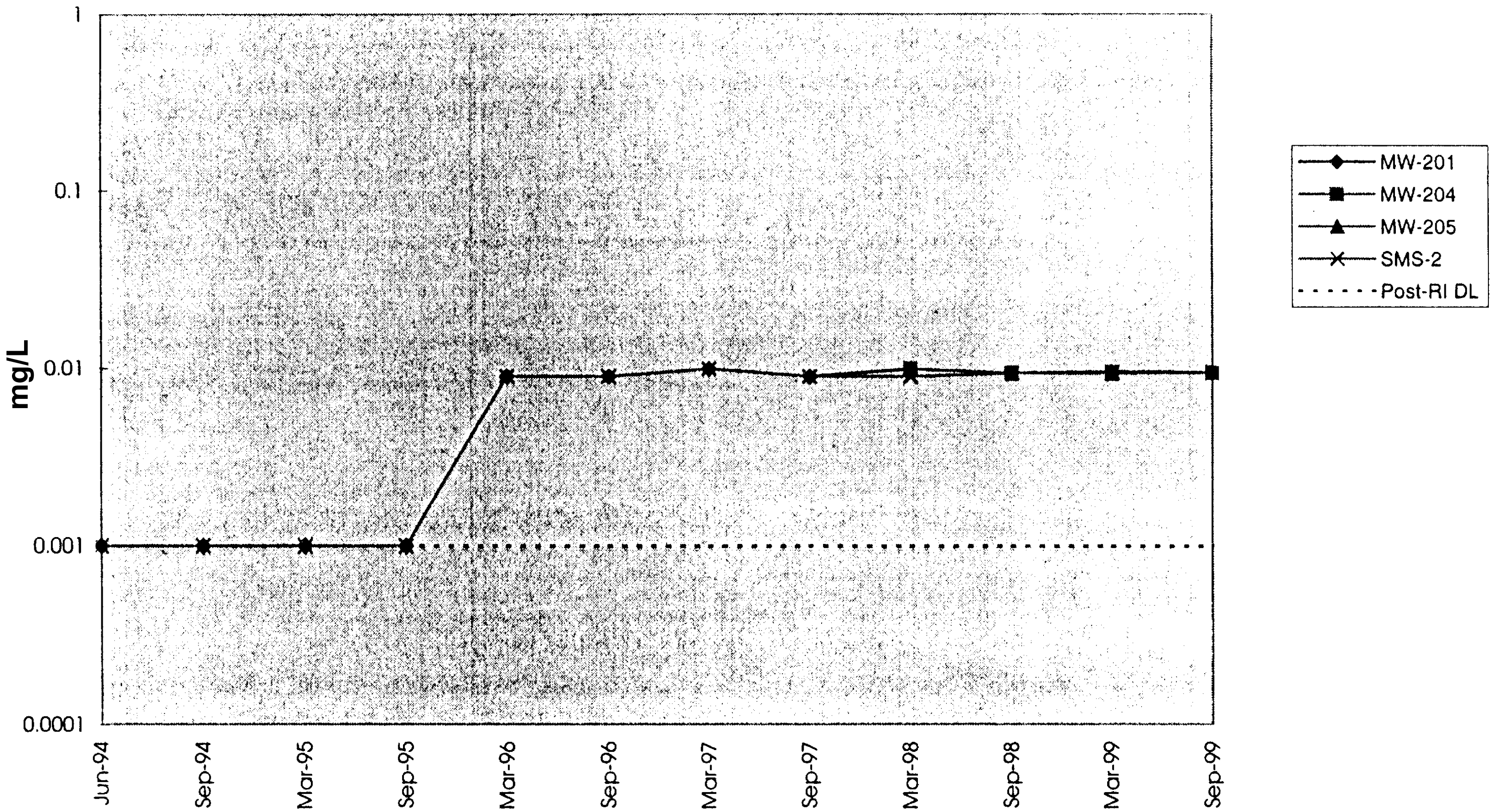
Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-2 *2 of 3*

N, N-Dimethylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

Source: Hydrometrics, Inc., March 2000.

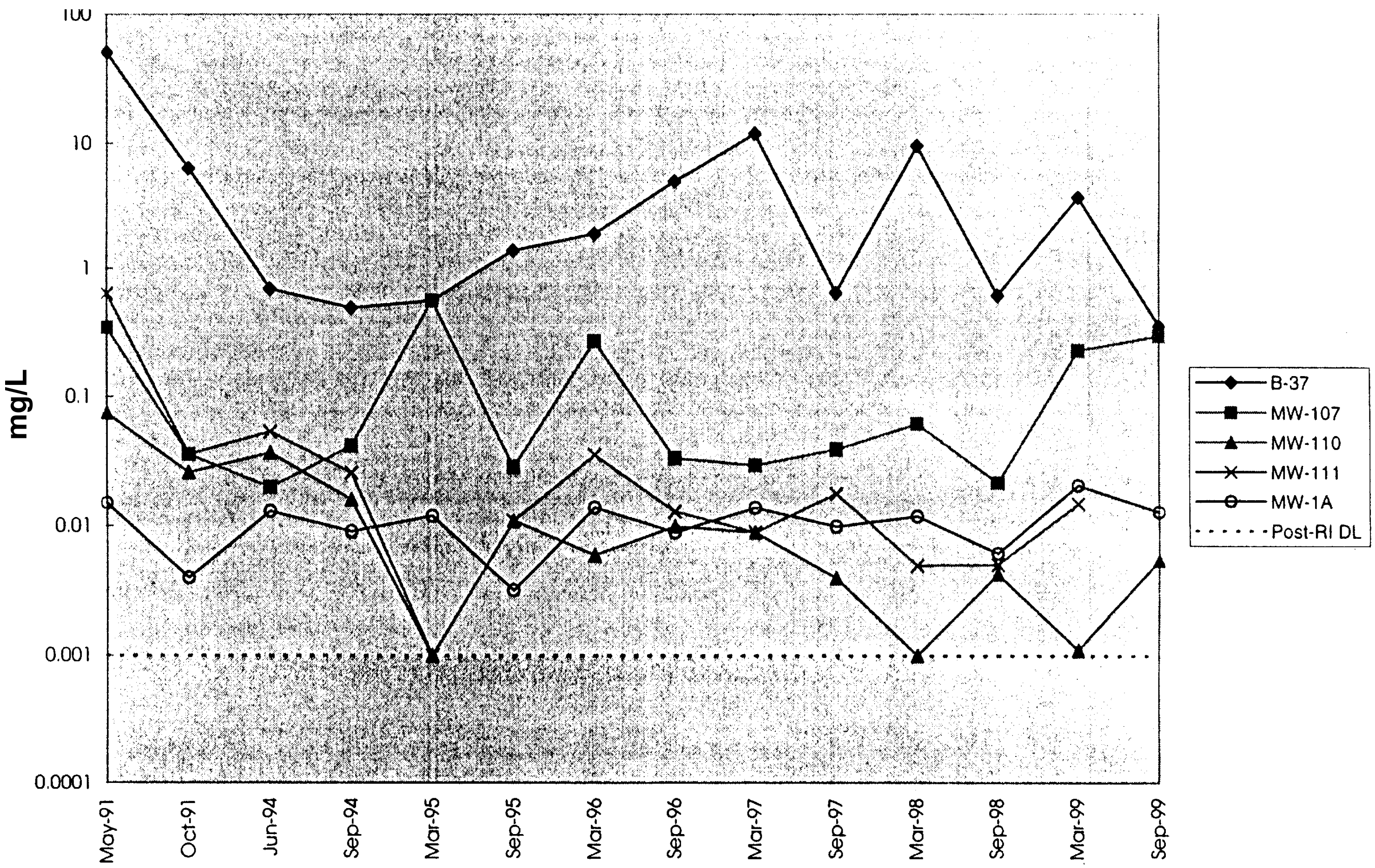
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-2 *3 of 3*

N, N-Dimethylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig A-2 3of3 N N-Dimethylaniline Trend Plot . 6-20-00 . gr



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

Source: Hydrometrics, Inc., March 2000.

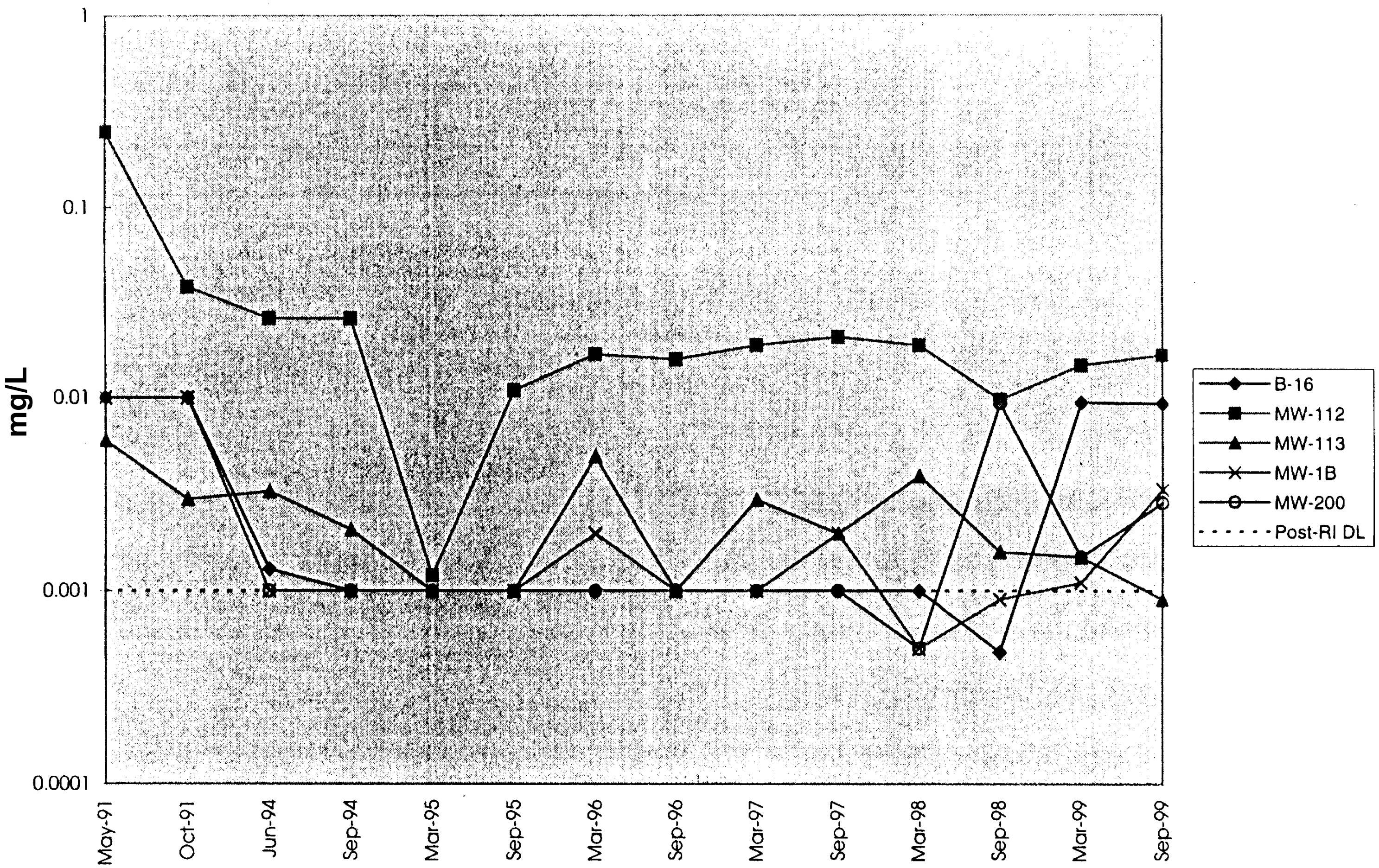
NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-3 *1 of 3*

N-Methylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig A-3 1of3 N-Methylaniline Trend Plot . 6-20-00 . gr



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

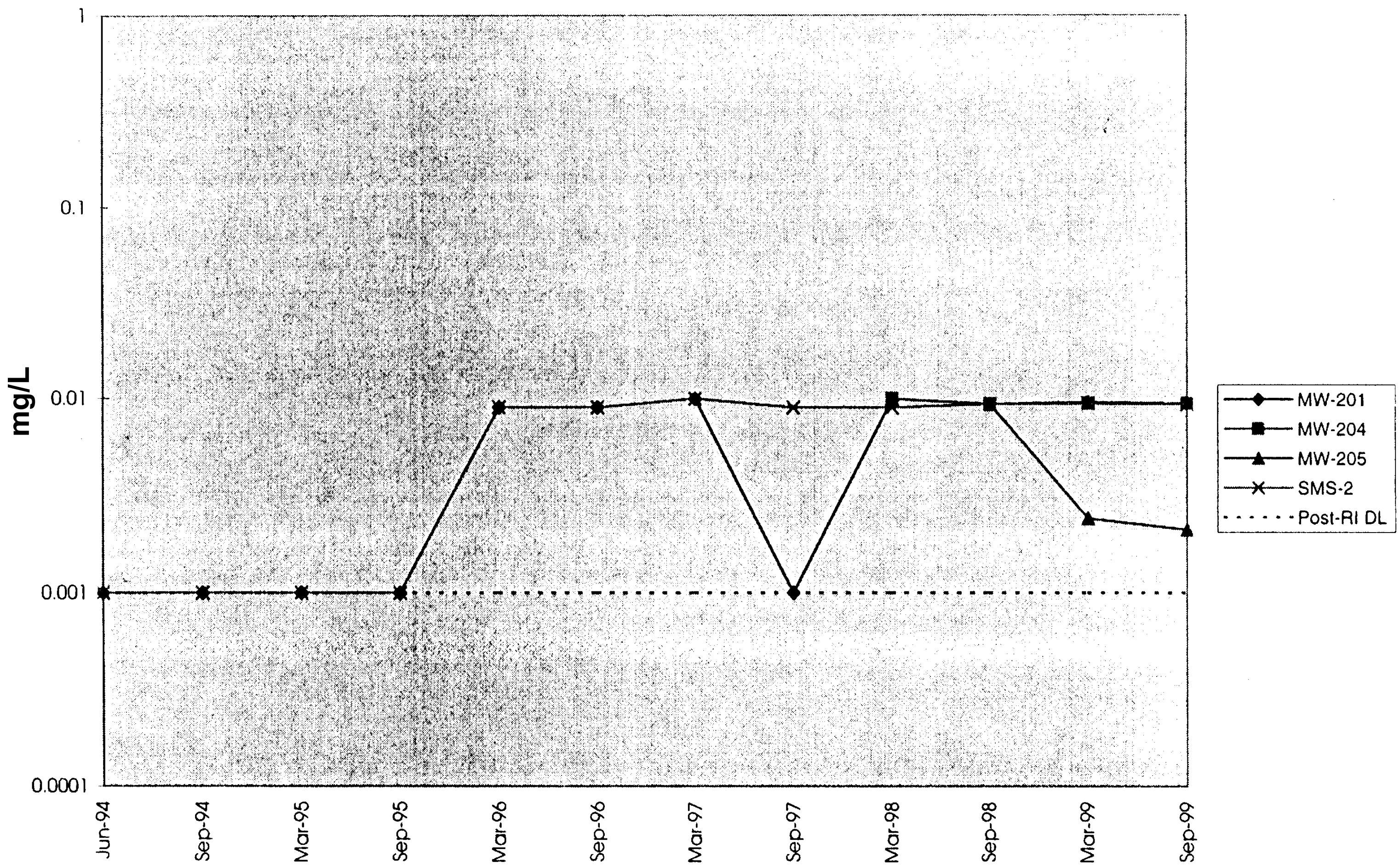
Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-3 *2 of 3*

N-Methylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD



NOTE: The typical detection limit is shown. However, the detection limit was occasionally higher or lower (see Data Validation Report, Appendix B).

Source: Hydrometrics, Inc., March 2000.

NOTE: Concentrations shown in this figure are expressed in mg/L (milligrams per liter). Concentrations cited in the text are expressed in g/L (micrograms per liter). Multiply mg/L by 1,000 to convert to g/L (e.g., 0.100 mg/L x 1,000 = 100 g/L).

Figure A-3 *3 of 3*

N-Methylaniline Trend Plot

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Fig A-3 3of3 N-Methylaniline Trend Plot . 6-20-00 . gr

APPENDIX B

Summary of Sediment Sampling Results

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Station	Year	As	Cu	Pb	Hg	Zn
1-1	1987[a]	23	60	52	ND	118
	1988	19	50	33	0.275J	68
2-1	1987[a]	320*	218	251	ND	850*
	1988	30	120	65	0.735J*	110
2-2	1987[a]	240*	147	158	ND	530*
2-3	1987[a]	70*	50	72	ND	223
2-5	1988	27	23	35	0.05J	91
2-6	1988	36J	27J	44J	0.075J	111J
	1988D	34J	28J	53J	0.055J	109J
3-1	1987[a]	1,620*	1,145*	1,805*	ND	6,940*
3-2	1987[a]	555*	381	830*	ND	4,305*
	1988	455*	244	488*	0.14	2,275*
	1988D	485*	248	540*	0.17	2,420*
3-3	1987[a]	170*	290	477*	ND	2,115*
	1989[b]	908*	387	822*	0.13	3,931*
3-4	1988	2,378*	998*	2,600*	0.26J	11,250*
	1989[b]	3,117*	1,259*	3,094*	0.14	11,250*
3-5	1988	1,940*	793*	1,565*	0.28J	6,175*
3-6	1988	1,130*	468*	845*	0.25J	2,725*
4-0	1987[a]	905*	725*	1,040*	ND	4,630*
4-1	1987[a]	4,915*	3,115*	6,650*	ND	18,000*
	1988	7,300*	3,500*	7,900*	0.2	19,700*
	1989[b]	7,502*	4,080*	7,976*	0.11	25,000*
4-2	1987[a]	6,600*	2,545*	6,100*	ND	1,625*
	1988	7,350*	3,025*	6,725*	0.17	17,625*
	1988D	6,825*	2,925*	6,200*	0.14	16,825*
4-3	1987[a]	4,985*	2,225*	3,785*	ND	11,450*
	1989[b]	6,964*	3,200*	4,501*	0.15	23,350*
4-4	1988	26	20	31	0.09J	95
5-0	1987[a]	100*	615*	191	ND	990*
	1988	86*	805*	243	0.34J	1,200*

See notes on Table B-1 *5 of 5*.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-1 *1 of 5*

Summary of Inorganics Data Measured at the Asarco Sediments Site During the Asarco RI/FS

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	As	Cu	Pb	Hg	Zn
5-1	1987[a]	6,450*	3,245*	5,400*	ND	19,050*
5-2	1987[a]	8,950*	3,450*	6,650*	ND	1,700*
	1990	8,000*	3,800*	6,725*	0.12	21,500*
5-3	1987[a]	1,400*	800*	1,355*	ND	3,830*
	1989[b]	1,577*	698*	1,257*	0.2	3,432*
5-4	1989[b]	99*	69	91	0.24	ND
5.5-2	1990	8,050*	3,925*	5,025*	0.06	21,100*
6-0	1987[a]	85*	725*	145	ND	378
6-1	1987[a]	8,400*	2,985*	9,400*	ND	20,850*
	1988	9,150*	3,375*	9,975*	0.16J	21,800*
	1990	9,025*	3,375*	10,300*	0.08	25,250*
6-2	1987[a]	6,350*	3,260*	5,950*	ND	16,750*
	1989[b]	7,274*	3,736*	6,142*	0.2	ND
	1990	7,800*	3,825*	7,675*	0.05	22,350*
6-3	1987[a]	1,620*	930*	1,630*	ND	4,290*
	1988	2,550*	1,203*	2,223*	0.25J	5,800*
	1990	3,400*	1,775*	3,400*	0.09	10,650*
6-4	1987[a]	100*	49	85	ND	202
	1989[b]	91*	63	83	0.15	260
6.5-2	1990	6,825*	3,525*	7,675*	0.08	26,011*
7-1	1987[a]	3,620*	7,600*	2,450*	ND	5,360*
7-2	1987[a]	6,700*	3,360*	5,000*	ND	17,900*
	1990	6,700*	3,575*	5,150*	0.05	20,675*
7-3	1987[a]	5,050*	2,535*	4,625*	ND	19,000*
7-4	1987[a]	100*	64	72	ND	215
7-5	1987[a]	65*	51	39	ND	117
7-6	1987[a]	18	35	26	ND	71
7-7	1987[a]	16	16	26	ND	54
8-1	1987[a]	4,585*	195	3,540*	ND	12,100*
8-2	1987[a]	565*	444*	462*	ND	1,285*
	1989[b]	521*	406*	411	0.62*	1,233*
8-3	1987[a]	320*	163	118	ND	394

See notes on Table B-1 *5 of 5*.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-1 *2 of 5*

Summary of Inorganics Data Measured at the Asarco Sediments Site During the Asarco RI/FS

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	As	Cu	Pb	Hg	Zn
	1989[b]	141*	126	104	0.26	329
8-4	1987[a]	160*	125	105	ND	330
	1988	55	70	62	0.19J	143
9-1	1987[a]	5,950*	8,950*	3,670*	ND	5,450*
9-2	1987[a]	200*	248	158	ND	355
9-3	1987[a]	65*	82	52	ND	155
9-4	1987[a]	29	55	39	ND	92
9-5	1987[a]	16	36	39	ND	75
9-6	1987[a]	25	25	32	ND	75
9-7	1987[a]	12	18	19	ND	62
9-8	1987[a]	9.5	19	19	ND	58
10-0	1987[a]	4,105*	18,300*	3,910*	ND	4,080*
10-1	1987[a]	665*	1,665*	690*	ND	1,010*
	1988	590*	1,873*	860*	1.8J*	1,000*
10-2	1987[a]	170*	243	118	ND	330
	1988	95*	152	77	0.6J*	176
	1989[b]	144*	223	113	0.9*	284
10-3	1987[a]	38	53	39	ND	100
	1989	77*	103	65	0.4	159
10-4	1987[a]	42	58	39	ND	109
11-1	1987[a]	4,995*	12,600*	3,135*	ND	2,430*
11-2	1987[a]	410*	1,075*	381	ND	505*
11-3	1987[a]	55	106	59	ND	100
11-4	1987[a]	47	80	46	ND	121
11-5	1987[a]	28	50	39	ND	104
11-6	1987[a]	21	87	39	ND	92
11-7	1987[a]	12	19	26	ND	58
	1988	13	21	28	ND	55
11-8	1987[a]	12	20	26	ND	62
11-9	1987[a]	7.5	15	26	ND	54

See notes on Table B-1 *5 of 5*.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-1 *3 of 5*

Summary of Inorganics Data Measured at the Asarco Sediments Site During the Asarco RI/FS

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	As	Cu	Pb	Hg	Zn
12-1	1987[a]	5,050*	7,650*	4,585*	ND	5,100*
	1988	2,355*	8,200*	3,275*	5.6J*	3,975*
12-2	1987[a]	190*	497*	138	ND	219
	1989	123*	371	109	0.8*	183
12-3	1987[a]	60*	200	72	ND	151
	1989	43	82	40	0.28	76
12-4	1987[a]	35	60	39	ND	79
12-5	1987[a]	16	46	46	ND	83
13-1	1987[a]	2,360*	5,400*	2,510*	ND	1,700*
13-2	1987[a]	60*	152	59	ND	88
13-3	1987[a]	65*	130	59	ND	121
13-4	1987[a]	24	47	39	ND	71
13-5	1987[a]	15	23	26	ND	49
13-6	1987[a]	33	16	19	ND	41
13-7	1987[a]	12	17	32	ND	54
13-8	1987[a]	11	14	19	ND	45
14-1	1987[a]	11,100*	3,850*	3,405*	ND	7,600*
	1989[b]	14,020*	4,874*	4,069*	35*	2,524*
14-2	1987[a]	160*	306	105	ND	249
	1988	69*	148	59	0.25	141
	1989[b]	71*	154	68	0.34	189
14-3	1987[a]	35	179	65	ND	134
	1988	49	119	46	0.34	122
14-4	1987[a]	60*	46	39	ND	75
14-5	1987[a]	29	31	32	ND	71
15-1	1988	20,225*	4,600*	4,430*	5.4*	2,825*
15-2	1987[a]	290*	300	118	ND	296
15-3	1987[a]	47	72	46	ND	79
15-4	1987[a]	30	37	32	ND	71
15-5	1987[a]	13	32	26	ND	58
16-1	1987[a]	270*	190	59	ND	141
	1988	48	141	44	0.22J	81

See notes on Table B-1 *5 of 5*.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-1 *4 of 5*

Summary of Inorganics Data Measured at the Asarco Sediments Site During the Asarco RI/FS

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	As	Cu	Pb	Hg	Zn
16-2	1987[a]	75*	57	32	ND	64
	1989[b]	41	58	31	0.22	89
16-3	1987[a]	26	27	19	ND	46
	1989[b]	29	33	16	0.12	68
16-4	1987[a]	11	24	13	0.12	68
	1988	16	21	19	ND	50
17-1	1987[a]	210*	910*	217	ND	223
17-2	1987[a]	39	84	26	ND	46
17-3	1987[a]	21	52	32	ND	64
17-4	1987[a]	7	26	19	ND	46
18-1	1987[a]	65*	295	72	ND	109
	1989[b]	57*	249	71	0.24	112
18-2	1987[a]	35	71	32	ND	64
	1988	33	65	35	0.12J	56
	1989[b]	20	61	23	0.22	82
18-3	1987[a]	26	38	26	ND	46
	1989[b]	37	44	24	0.18	69
19-1	1987[a]	26	77	26	ND	37
	1989[b]	15	56	20	0.16	33
19-2	1987[a]	120*	52	26	ND	41
	1989[b]	28	76	32	0.24	52
20-1	1987[a]	11	61	13	ND	28
20-2	1987[a]	20	54	32	ND	41

Notes: All data are in mg/kg.

1987 data are from Arasco RI Round 1
1988 data are from Arasco RI Round 2.
1989 data are from the 1990 Supplementary Marine Sediment Survey.
1990 data are from the 1990 Supplementary Marine Sediment Survey.

ND No data are available.
D Duplicate sample
* Exceeds LAETs.
a All As data from the 1987 sampling event where "J" qualified.
b The 1989 data for As, Cu, Pb and Hg are from the "heavy metal" Word Perfect table on the 3rd disk transmitted by Parametrix through PTI (Disk 3). Data for Zn are the values from Table 1 of Parametrix's 1990 Supplemental Marine Sediment Survey. For Stations 3-4, 4-1, 10-2 and 14-2 (sampled both in 1988 and 1989), the 89 Zn values are the differences of the "means" in Table 1 multiplied by two minus the 1988 value.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Summary of Inorganics Data Measured at the Asarco Sediments Site During the Asarco RI/FS

Asarco Sediments/Groundwater OU 06 ROD

Chemical	CSL*	SQS**	2-2	2-3	2-3 Dup	2-4	3-1	3-2	3-3	4-2	4-3	5-0	5-0 Dup	5-0.25
Arsenic	93	57	94	54	62	51	2,063	436	670	4,626	5,205 e	154 e	142 e	5,398
Cadmium	6.7	5.1	0.3 U	0.3 U	0.3 U	0.3 U	3.0	0.8	1.4	6.9	9.3 e	71.0 e	1.0 e	8.0
Chromium	270	260	34	33	39	149	68	36	42	100	161	28	38	290 e
Copper	390	390	94 e	47 e	52 e	43 e	1,110 e	211 e	321 e	1,883 e	2,542	942	882	3,835
Iron	- -	- -	18,190	19,950	19,570	18,740	88,290	33,930	42,090	130,300	168,500	36,870	36,090	179,000
Lead	530	450	106	70	74	90	1,755	417	704	3,928	3,586 e	1,763 e	282 e	4,252
Manganese	- -	- -	302	1,037	928	1,141	873	1,096	1,067	2,847	822	195	196	296
Nickel	- -	- -	27	31	34	91	44	31	33	64	102	17	18	67 e
Silver	6.1	6.1	0.4 A	0.2 U	0.2 U	0.2 U	2.9	0.4	0.9	9.1	5.3	2.7	2.5	11 e
Zinc	960	410	346	211	229	228	6,073	1,843	3,073	10,580	11,120	1,784	1,556	10,930
Mercury	0.59	0.41	0.095 e	0.066 e	0.075 e	0.170 e	0.200 e	0.072 e	0.091 e	0.051 e	0.03 e	0.230 e	0.280 e	0.05 U

Chemical	CSL*	SQS**	5-0.5	5-1	5-2	5-3	5.5-0	6-2	6.5-0	6.5-1	6.5-2	6.5-3	7-3	7-4.5
Arsenic	93	57	6,221	7,219 e	8,023 e	1,740 e	118 e	6,394 e	102 e	6649	7,435	115 e	98 e	27 e
Cadmium	6.7	5.1	5.5	12.0 e	17.0 e	5.4 e	0.8 e	8.3 e	1.4 e	8.0	11.0	0.3 Ue	9.3 e	0.3 Ue
Chromium	270	260	338 e	158	159	78	35	150	36	306 e	120	41	36	44
Copper	390	390	4,269	3,047	3,655	791	1,041	2,886	1,358	4,315	3,308 e	80	77	46
Iron	- -	- -	153,400	202,700	229,400	65,590	26,580	179,600	18,830	208,600	198,000	22,550	21,940	20,680
Lead	530	450	3,721	5,282 e	6,122 e	1,369 e	280 e	5,263 e	206 e	4,122	7,074	126 e	276 e	40 e
Manganese	- -	- -	220	974	826	922	169	1,853	140	607	1,721	872	657	928
Nickel	- -	- -	107 e	131	128	60	17	128	18	101 e	106	37	31	37
Silver	6.1	6.1	9.0	6.6	8.0	1.8	2.7	7.1	2.7	13	17	0.2 U	0.2 U	0.2 U
Zinc	960	410	10,450	14,730	17,110	3,861	972	14,160	468	13,150	21,150	367	300	109
Mercury	0.59	0.41	0.05 U	0.024 e	0.032 e	0.150 e	0.290 e	0.036 e	0.450 e	0.05 U	0.055 e	0.100 e	0.130 e	0.270 e

Source: Parametrix, Inc., April 1996.

NOTES:

1. Results presented in mg/kg dry weight.
2. See notes on Table B-2 *3 of 3.*

Table B-2 *1 of 3*

Metal Concentrations in Sediment (mg/kg dry weight)

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Table B-2 1of3 Metal Concentrations in Sediment mgkg dry wt . 6-20-00 . gr

Chemical	CSL*	SQS**	7-12	8-1.5	8-2.5	8-3.5	9-1	9-2	9-2.5	10-1.5	10-2	10-2.5	11-0	11-0 Dup
Arsenic	93	57	5.3	7,914 e	239	69	3,341	121	88	143	93	45	3,797	3,914
Cadmium	6.7	5.1	0.3 U	10.0 e	0.3	0.3 U	9.0	0.3	0.3 U	0.5	0.3 U	0.3 U	25.0	26.0
Chromium	270	260	32	155	28	30	55	28	28	22	26	29	44	42
Copper	390	390	15 e	3,729	192	90	7,261	206	117	421	193	95	9,350	9,228
Iron	--	--	14,410	228,600	24,070	20,140	101,600	18,670	18,060	14,400	16,590	16,230	37,030	34,780
Lead	530	450	15	6,312 e	196	74	2,900	120	80	170	105	52	3,450	3,650
Manganese	--	--	619	1,254	612	605	556	224	352	185	269	354	733	678
Nickel	--	--	31	105	26	29	90	23	23	19	20	23	89.0	79
Silver	6.1	6.1	0.2 U	7.6	0.56 A	0.2 UA	21	0.90 Ab	0.80 Ab	1.4 A	1.2 C	0.57 Ab	50.0	53.0
Zinc	960	410	37	19,760	592	180	6,895	289	192	304	225	125	3,532	3,279
Mercury	0.59	0.41	0.050 e	0.220 e	0.099	0.110	1.800	0.340	0.083	0.350	0.110	0.140	1.800	1.890

Chemical	CSL*	SQS**	11-2	11-2.5	12-2	12-2.5	13-2	13-2.5	14-1	14-2	14-2.5	14-3.5	15-1	15-2
Arsenic	93	57	52	43	68	69	43	54	8,677	96	63	54	26,410	197
Cadmium	6.7	5.1	0.3 U	0.3 U	0.5	0.3 U	0.3 U	0.3 U	31.0	0.3 U	0.3 U	0.3 U	22.0	0.6
Chromium	270	260	34	25	28	31	34	44	44	29	29	41	45	29
Copper	390	390	114	697	276	203	96.0	184	4195	213	167	117	4,365	383
Iron	--	--	14,700	14,730	15,930	13,390	15,560	13,950	79,220	13,730	13,230	20,330	94,190	15,150
Lead	530	450	50	50	115	90	40	70	3,510	118	58	59	4,150	160
Manganese	--	--	248	265	242	319	305	288	514	160	202	442	358	167
Nickel	--	--	24	21	27	23	21	29	45	20	20	33	54	23
Silver	6.1	6.1	0.70 Cb	0.80 Ab	1.1 Ab	1.1 Cb	0.40 Ab	1.1 Ab	12	1.2 C	1.2 C	0.89 Cb	16.0	2.4 A
Zinc	960	410	110	107	143	158	68	137	4,840	270	100	120	2,483	307
Mercury	0.59	0.41	0.220	0.130	0.140	0.085	0.027	0.300	3.500	0.190	0.180	0.160	17.700	0.220

Source: Parametrix, Inc., April 1996.

NOTES:

1. Results presented in mg/kg dry weight.
2. See notes on Table B-2 *3 of 3.*

Table B-2 *2 of 3*

Metal Concentrations in Sediment (mg/kg dry weight)

Asarco Sediments/Groundwater OU 06 ROD

Chemical	CSL*	SQS**	15-2.5	15.5-1	15.5-2	16-0.5	16-1	16-2	16.5-1	16.5-2	17-1	17-1.5	17-2	17.5-1
Arsenic	93	57	52	2,400	303	308	83	30	230	56	225	86	52	59
Cadmium	6.7	5.1	0.30 U	4.0	0.5	1.5	0.3	0.3 U	2.0	0.3 U	1.5	0.6	0.3 U	2.3
Chromium	270	260	27	54	33	32	31	62	41	25	31	28	25	19
Copper	390	390	97	2,434	544	497	191	63	1,066	178	601	296	149	320
Iron	--	--	13,660	149,100	18,850	45,750	12,020	14,550	17,460	11,486	14,390	12,310	12,120	11,799
Lead	530	450	40	1,340	146	330	77	31	317	65	165	84	73	125
Manganese	--	--	269	559	252	237	180	310	135	163	123	157	185	109
Nickel	--	--	19	105	30	31	22	41	36	19	26	24	20	19
Silver	6.1	6.1	0.90 Cb	14.7	2.4 A	0.93 AC	0.84	0.20 Ube	4.35	0.92 ACe	1.98	1.01	0.48 AC	0.65 AC
Zinc	960	410	84	1,820	359	480	166	69	230	79	170	105	104	131
Mercury	0.59	0.41	0.12	2.040	0.077	0.077	0.170	0.020 U	0.170	0.055	0.092	0.052	0.085	0.050

Chemical	CSL*	SQS**	17.5-2	18-2.5	18-3.5	18.5-1	18.5-2	Ref 2	Ref 3	Ref 4B
Arsenic	93	57	26	19.3	26	51	18.3	6	55 e	6.9
Cadmium	6.7	5.1	0.3 U	0.3 U	0.3 U	0.5	0.3 U	0.3 U	0.4	0.3 U
Chromium	270	260	23	22	39	36	35	27	47	20
Copper	390	390	91	41	41	167	51	19	59	11 e
Iron	--	--	9,702	10,820	26,750	11,200	10,850	13,530	16,110	16,290
Lead	530	450	34	24	21	61	26	15	72	5.7
Manganese	--	--	152	199	414	120	236	138	373	154
Nickel	--	--	19	18	42	27	25	17	26	17
Silver	6.1	6.1	0.36 AC	0.20 U	0.20 U	0.73	0.26 AC	0.59 Ab	0.20 U	0.2 U
Zinc	960	410	46	38	80	68	38	33	223	26
Mercury	0.59	0.41	0.061	0.020 U	0.020 U	0.020	0.027	0.025	0.020 Ue	0.040 e

* Washington State Cleanup Screening Levels
** Washington State Sediment Quality Standards
[single box] Value exceeds SQS
[double box] Value exceeds CSL and SQS

U = Undetected at the reported detection limit
A = Indicates value determined by Method of Standard Addition
C = Indicates the correlation coefficient for Method of Standard Addition is less than 0.995
b = Analyte found in blank
e = Estimated

Source: Parametrix, Inc., April 1996.

NOTE: Results presented in mg/kg dry weight.

Table B-2 *3 of 3*

Metal Concentrations in Sediment (mg/kg dry weight)

Asarco Sediments/Groundwater OU 06 ROD

	CSL	SQS	3-1	5-0	5.5-0	8-1	9-1	11-0	11-1	12.5-1	14-2	15.5-1
Foot 0-1												
Arsenic	93	57	470	101	43	6,737	1,008	3,560	127	6,024	19	1,933
Cadmium	6.7	5.1	1.0	0.50	0.50	9.5	3.2	23	1.0	28	0.5 U	3.5
Chromium	270	260	36	52	54	186	82	99	121	33	39	80
Copper	390	390	367	422	254	3,514	2,278	8,488	443	23,250	54	2,128
Lead	530	450	488	194	92	4,755	986	3,568	223	5,278	31	1,323
Nickel	- -	- -	20	29	29	97	76	106	73	40	24	88
Silver	6.1	6.1	1.5	1.5	1.5	11	8.5	60	3.0	90	1.0 U	9.5
Zinc	960	410	1,905	1,390	495	15,580	2,303	2,589	1,028	3,522	82	3,365
Mercury	0.59	0.41	0.31	0.26	0.29	0.27	1.7	4.3	1.3	1.6	0.094	8.5
Foot 1-2												
Arsenic	93	57	2.5 U	3.8		7,123	1,373	3,538	34	10,020	10	1,792
Cadmium	6.7	5.1	0.5 U	0.5 U		9.5	3.6	22	0.5 U	70	0.5 U	4.5
Chromium	270	260	45	45		237	54	55	92	80	109	109
Copper	390	390	18	22		3,629	2,671	8,383	117	43,840	32	2,370
Lead	530	450	13	25 U		4,821	1,290	4,315	51	22,450	26	1,086
Nickel	- -	- -	26	22		121	69	73	59	70	60	114
Silver	6.1	6.1	1.0 U	1.0 U		12	9.5	65	2.0	240	1.0 U	11
Zinc	960	410	57	48		15,730	3,032	2,458	123	10,370	51	3,366
Mercury	0.59	0.41	0.03 U	0.051		0.21	3.0	8.6	0.12	3.5	0.14	2.7
Foot 2-3												
Arsenic	93	57				7,898	925	3,563	144	3,832	2.5 U	2,245
Cadmium	6.7	5.1				10.00	2.6	19	1.0	22	0.5 U	7.5
Chromium	270	260				212	79	96	117	59	42	111
Copper	390	390				3,537	1,734	8,427	403	24,310	17	1,946
Lead	530	450				5,041	891	2,757	203	6,097	25 U	2,023
Nickel	- -	- -				105	63	118	75	174	39	121
Silver	6.1	6.1				12	7.0	37	2.5	88	1.0 U	8.0
Zinc	960	410				16,740	2,172	2,417	365	4,339	69	7,021
Mercury	0.59	0.41				0.042	1.8	2.6	0.33	6.2	0.022	1.1
Foot 3-4												
Arsenic	93	57					691	2,106	40	67		
Cadmium	6.7	5.1					2.4	14	0.5 U	0.5 U		
Chromium	270	260					72	54	96	65		
Copper	390	390					1,329	6,397	86	352		
Lead	530	450					554	1,798	33	63		
Nickel	- -	- -					52.0	74	50	75		
Silver	6.1	6.1					4	25	1.0 U	2.0		
Zinc	960	410					1,296	1,847	64	131		
Mercury	0.59	0.41					0.63	1.1	0.03	0.29		
Foot 4-5												
Arsenic	93	57					44	1,634				4,543
Cadmium	6.7	5.1					0.5 U	9				16
Chromium	270	260					46	39				106
Copper	390	390					64	3,467				3,836
Lead	530	450					25	1,278				5,268
Nickel	- -	- -					34	46				141
Silver	6.1	6.1					1.0 U	1				9
Zinc	960	410					102	1,389				17,400
Mercury	0.59	0.41					0.04	1.2				0.1

Note: Recovered core sections did not contain the entire 1 foot section in some cases. Figure 3-2 indicates recoveries for each sample.
U = Undetected

[single box] Indicates that the value exceeds SQS (Sediment Quality Standards).
[double box] Indicates that the value exceeds CSL (Cleanup Screening Levels).

Source: Parametrix, Inc., December 1996.

NOTE: Results presented in mg/kg dry weight.

Table B-3
Metals Concentrations in Subsurface Sediments (mg/kg dry weight)
Asarco Sediments/Groundwater OU 06 ROD

Chemical	CSL	SQS	5-0	5.5-0	8-1	9-1	11-0	11-1	12.5-1	14-2
Foot 0-1										
Fluorene	79	23	7 *	3 U	3 U	2	5	2	4 U	9 U*
Phenanthrene	480	100	83 *	15	14	9	55	10	16	9 U*
Fluoranthene	1,200	160	191 *	51	40	27	100	11	146	9 U*
Butyl benzyl phthalate	64	4.9	5 U*	3	[32]	1 U	3 U	1 U	4 U	9 U*
Bis(2-ethylhexyl)phthalate	78	47	29 *	[61]	[[137]]	2	13	1	4 U	9 U*
Foot 1-2										
Fluorene	79	23	11 U*		1	6	3	2 U	1	7 U*
Phenanthrene	480	100	11 U*		7	23	38	2 U	5	7 U*
Fluoranthene	1,200	160	11 U*		15	48	85	2 U	43	7 U*
Butyl benzyl phthalate	64	4.9	11 U*		2	[5]	3 U	3	1	7 U*
Bis (2-ethylhexyl) phthalate	78	47	11 U*		14	18	4	2 U	14	7 U*
Foot 2-3										
Fluorene	79	23			5 U*	3	[32]	12 *		11 U*
Phenanthrene	480	100			15 *	16	[184]	119 *		11 U*
Fluoranthene	1,200	160			27 *	51	[237]	181 *		11 U*
Butyl benzyl phthalate	64	4.9			5 *	3 U	[7] U	7 U*		11 U*
Bis (2-ethylhexyl) phthalate	78	47			10 *	11	20	7 U*		11 U*
Foot 3-4										
Fluorene	79	23					6		2 U	
Phenanthrene	480	100					43		10	
Fluoranthene	1,200	160					71		12	
Butyl benzyl phthalate	64	4.9					2 U		2 U	
Bis (2-ethylhexyl) phthalate	78	47					2		2 U	
Foot 4-5										
Fluorene	79	23					5			
Phenanthrene	480	100					52			
Fluoranthene	1,200	160					75			
Butyl benzyl phthalate	64	4.9					4 U			
Bis (2-ethylhexyl) phthalate	78	47					5			

Note: Recovered core sections did not contain the entire 1 foot section in some cases. Figure 3-2 indicates recoveries for each sample.

U = Undetected

* Organic carbon content is less than 0.5% in this sample and should not be directly compared to organic carbon normalized criteria.

[ ] Indicates that the value exceeds SQS (Sediment Quality Standards).

[[ ]] Indicates that the value exceeds CSL (Cleanup Screening Levels).

Source: Parametrix, Inc., December 1996.

NOTE: Results presented in mg/kg organic carbon.

Table B-4

Organic Compound Concentrations in Subsurface Sediments (mg/kg organic carbon)

Asarco Sediments/Groundwater OU 06 ROD

Chemical	AET Dry Wt.	5-0	5.5-0	8-1	9-1	11-0	11-1	12.5-1	14-2
Foot 0-1									
Fluorene	540	24	N/A	N/A	N/A	N/A	N/A	N/A	17 U
Phenanthrene	1500	290	N/A	N/A	N/A	N/A	N/A	N/A	17 U
Fluoranthene	1700	670	N/A	N/A	N/A	N/A	N/A	N/A	17 U
Butyl benzyl phthalate	63	19 U	N/A	N/A	N/A	N/A	N/A	N/A	17 U
Bis(2-ethylhexyl)phthalate	1300	100	N/A	N/A	N/A	N/A	N/A	N/A	17 U
Foot 1-2									
Fluorene	540	18 U		N/A	N/A	N/A	N/A	N/A	17 U
Phenanthrene	1500	18 U		N/A	N/A	N/A	N/A	N/A	17 U
Fluoranthene	1700	18 U		N/A	N/A	N/A	N/A	N/A	17 U
Butyl benzyl phthalate	63	18 U		N/A	N/A	N/A	N/A	N/A	17 U
Bis (2-ethylhexyl) phthalate	1300	18 U		N/A	N/A	N/A	N/A	N/A	17 U
Foot 2-3									
Fluorene	540			18 U	N/A	N/A	30		16 U
Phenanthrene	1500			54	N/A	N/A	310		16 U
Fluoranthene	1700			100	N/A	N/A	470		16 U
Butyl benzyl phthalate	63			18	N/A	N/A	17 U		16 U
Bis (2-ethylhexyl) phthalate	1300			38	N/A	N/A	17 U		16 U
Foot 3-4									
Fluorene	540					N/A		N/A	
Phenanthrene	1500					N/A		N/A	
Fluoranthene	1700					N/A		N/A	
Butyl benzyl phthalate	63					N/A		N/A	
Bis (2-ethylhexyl) phthalate	1300					N/A		N/A	
Foot 4-5									
Fluorene	540					N/A			
Phenanthrene	1500					N/A			
Fluoranthene	1700					N/A			
Butyl benzyl phthalate	63					N/A			
Bis (2-ethylhexyl) phthalate	1300					N/A			

Note: Recovered core sections did not contain the entire 1 foot section in some cases. Figure 3-2 indicates recoveries for each sample.

U = Undetected
N/A organic carbon content is greater than 0.5% in this sample. Value is normalized for TOC and reported in Table 3-3 .

Source: Parametrix, Inc., December 1996.

NOTE: Results presented in g/kg dry weight.

Table B-5

Organic Compound Concentrations in Subsurface Sediments (g/kg dry weight)

Asarco Sediments/Groundwater OU 06 ROD

Chemical	Marine EPA Criteria Chronic	Marine EPA Criteria Acute	PW 5025	PW 505	PW 651	PW 91	PW 1020	PW 132
Metals (µg/L)								
Arsenic +3	--	--	12	5 U	18	2,205	30	18
Arsenic +5	--	--	5 U	5 U	5 U	23	5 U	5 U
Total Arsenic	36	69	28 e	5 Ue	36 e	1,933	67 e	25
Cadmium	9.3	43	3 UEe	3 UEe	3 UEe	3 U	3 UEe	3 U
Chromium	50	1,100	10 Ue	10 Ue	10 Ue	10 U	10 Ue	10 U
Copper	2.9	2.9	30	25 U	26	25 U	25 U	77
Iron	1,000 a	--	50 U	50 U	50 U	867	50 U	68
Lead	8.5	220	5 U	5 U	5 U	5 Ue	5 U	5 e
Manganese	--	--	15 U	15 U	65	512 Ee	1,853	362 Ee
Nickel	8	75	50 Ue	50 Ue	50 U	50 U	50 U	50 U
Silver	0.92	2.3	1 Ue	1 Ue	1 Ue	1 U	1 Ue	1 U
Zinc	86	95	50 U	50 U	50 U	50 U	50 U	50 U
Mercury	1.1	2.1	0.40	0.44	0.44	0.20 e	0.20 U	0.37 e
Organics (µg/L)								
LPAH								
Acenaphthylene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Acenaphthene	710 b	485 b,c	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Anthracene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Fluorene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Naphthalene	214 f	1175 b,c	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Phenanthrene	4.6	7.7	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U.	6.7 U
2-Methylnaphthalene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Total LPAHs	--	--	21.0	23.1	23.1	35.0	39.9	46.9
HPAH								
Benzo(a)anthracene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Benzo(a) pyrene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Benzo(b)fluoranthene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Benzo(k)fluoranthene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Total benzofluoranthenes	--	--	6.0	6.6	6.6	10.0	11.4	13.4
Benzo(g,h,i)perylene	--	--	6.1 U	6.6 U	6.5 U	10.0 U	11.0 U	13.0 U
Chrysene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Dibenzo(a,h)anthracene	--	--	6.1 U	6.6 U	6.5 U	10.0 U	11.0 U	13.0 U
Fluoranthene	16 b	20 b,c	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Indeno(1,2,3,-cd)pyrene	--	--	6.1 U	6.6 U	6.5 U	10.0 U	11.0 U	13.0 U
Pyrene	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Total HPAHs	--	--	39.3	42.9	42.6	65.0	72.9	85.9
Total PAHs	30 d	150 b,c	60.3	66.0	65.7	100.0	112.8	132.8
Phthalates								
Bis(2-ethylhexyl) phthalate	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Butyl benzyl phthalate	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Diethyl phthalate	--	--	5.9	4.1	3.3 U	5.0 U	5.7 U	6.7 U
Dimethylphthalate	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Di-n-butyl phthalate	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Di-n-octyl phthalate	--	--	3.0 U	3.3 U	3.3 U	5.0 U	5.7 U	6.7 U
Conventionals								
pH	--	--	--	--	--	7.6	7.8	7.4
Ammonia (as nitrogen) (mg/L)	0.035	0.230	0.023	0.056	0.048	2.200	1.400	0.700
Sulfide (as hydrogen sulfide) (mg/	0.002	--	1.0 U	1.0 U	1.0 U	4.0 U	4.0 U	4.5

See notes on Table B-6 *2 of 2*.

Source: Parametrix, Inc., April 1996.

Table B-6 *1 of 2*

Pore Water Chemical Concentrations

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Table B-6 1of2 Pore Water Chemical Concentrations . 6-20-00 . gr

Chemical	Marine EPA Criteria Chronic	Marine EPA Criteria Acute	PW 1435	PW 1651	PW 1651 (Dup)	PW 172	PW 1851	PW 1852	PW REF 2	PW REF 6
Metals (µg/L)										
Arsenic +3	--	--	19	13	11	44	10	21	5	17
Arsenic +5	--	--	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Total Arsenic	36	69	49	70	74	40	6	21	22 e	42 e
Cadmium	9.3	43	3 U	3 U	3 U	3 U	3 U	3 U	3 Ue	3 Ue
Chromium	50	1,100	10 U	10 Ue	10 U	10 U	10 U	10 U	10 U	10 Ue
Copper	2.9	2.9	26	25 U	25 U	30	25 U	25 U	62 e	25 Ue
Iron	1,000 a	--	68	68	68	107	107	50 U	50 U	50 U
Lead	8.5	220	5 Ue	5 Ue	5 Ue	5 Ue	5 Ue	6 e	5 U	5 U
Manganese	--	--	6,076 Ee	72 Ee	72 Ee	971 Ee	185 Ee	1,428 Ee	692	952
Nickel	8	75	50 U	50 Ue	50 U	50 U	50 U	50 U	50 U	50 Ue
Silver	0.92	2.3	1 U	1 U	1 U	1 U	1 U	1 U	1 Ue	1 Ue
Zinc	86	95	50 U	50 U	50 U	50 U	50 U	67	50 U	50 U
Mercury	1.1	2.1	0.33 e	0.44 e	0.44 e	1.00 e	0.29 e	0.64 e	0.20 U	0.20 U
Organics (µg/L)										
LPAH										
Acenaphthylene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Acenaphthene	710 b	485 b,c	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Anthracene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Fluorene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Naphthalene	214 f	1175 b,c	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Phenanthrene	4.6	7.7	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
2-Methylnaphthalene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Total LPAHs	--	--	33.6	25.9	25.2	42.7	29.4	126.0	30.1	32.9
HPAH										
Benzo(a)anthracene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Benzo(a) pyrene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Benzo(b)fluoranthene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Benzo(k)fluoranthene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Total benzofluoranthenes	--	--	9.6	7.4	7.2	12.2	8.4	36.0	8.6	9.4
Benzo(g,h,i)perylene	--	--	9.6 U	7.4 U	7.2 U	12 U	8.3 U	36.0 U	8.5 U	9.4 U
Chrysene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Dibenzo(a,h)anthracene	--	--	9.6 U	7.4 U	7.2 U	12 U	8.3 U	36.0 U	8.5 U	9.4 U
Fluoranthene	16 b	20 b,c	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Indeno(1,2,3,-cd)pyrene	--	--	9.6 U	7.4 U	7.2 U	12 U	8.3 U	36.0 U	8.5 U	9.4 U
Pyrene	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Total HPAHs	--	--	62.4	48.1	46.8	78.7	54.3	234.0	55.6	61.1
Total PAHs	30 d	150 b,c	96.0	74.0	72.0	121.4	83.7	360.0	85.7	94.0
Phthalates										
Bis(2-ethylhexyl) phthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Butyl benzyl phthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Diethyl phthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Dimethylphthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Di-n-butyl phthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Di-n-octyl phthalate	--	--	4.8 U	3.7 U	3.6 U	6.1 U	4.2 U	18.0 U	4.3 U	4.7 U
Conventionals										
pH	--	--	7.7	7.7		7.5	7.3	7.6	7.8	7.8
Ammonia (as nitrogen) (mg/L)	0.035	0.230	2.700	1.900	2.000	1.300	0.640	0.810	1.200	0.700
Sulfide (as hydrogen sulfide) (mg/	0.002	--	3.2	2.2	4.0 U	1.0 U	4.0 U	1.0 U	1.0 U	4.0 U

a Freshwater criteria.
b Insufficient data to develop criteria. Value presented is the L.O.E.L.
c LC50 value divided by 2.
d Acute-to-chronic ratio of 10 used to develop criterion.
f Chemical specific acute-to-chronic ratio used to develop criterion.

E = Estimated.
U = Undetected at the reported detection limit.
e = Estimated.
-- = No data available.
[single box] Value exceeds chronic marine EPA criteria.
[double box] Value exceeds acute and chronic marine EPA criteria.

Source: Parametrix, Inc., April 1996.

Table B-6 *2 of 2*

Pore Water Chemical Concentrations

Asarco Sediments/Groundwater OU 06 ROD

Station	*Ampelisca* Sample Mortality (%)*	Echinoderm Combined Station Normality/Survivorship (%)**	*Neanthes* Mean Total Biomass (mg)§
Carr 2	13	89.6	97.35
Carr 4	19	83.9	137.30
REF 3	45 §§	39.0 #	96.63 §§
REF 4B	31 §§	55.8 #	89.36
2-2	26	73.3	67.85
2-3	43	81.4	74.36
2-4	30	44.9 [a,b]	87.59
3-1***	46	41.2 [a]	53.90 [c]
3-2	31	70.8	84.40
3-3	32	52.5	91.54
4-2	88 [a]	61.5	46.72
4-3	29	43.9 [a,b]	82.46
5-0	24	71.3	137.18
5-0.25	94 [a]	24.2 [a,b]	0.00 [b]
5-0.5	92 [a]	31.2 [a,b]	0.00 [b]
5-1	48	61.0	109.55
5-2	33	61.3	114.82
5-3	32	73.2	116.14
5.5-0	24	74.8	145.38
6-2	77 [a]	36.2 [a,b]	81.68
6.5-0	72 [a,b]	69.0	98.78
6.5-1	73 [a,b]	3.1 [a,b]	0.00 [b]
6.5-2	60	32.1 [a,b]	82.39
6.5-3	63	81.8	137.34
7-3	33	50.0	90.01
7-4.5	37	82.8	128.87
7-12	47	38.8 [a,b]	84.55
8-1.5	86 [a]	0.1 [a]	0.00 [b]
8-2.5	71 [a,b]	44.3 [a,b]	50.48
8-3.5	24	87.8	109.64
9-1***	100 [a]	8.5	42.29
9-2	33	60.0	83.69
9-2.5	43	63.8	105.49
10-1.5	47	43.5 [a,b]	84.60
10-2	40	48.8 [a,b]	92.48
10-2.5	37	50.9	91.58
11-0	99 [a]	0.2 [a,b]	0.00 [b]
11-2	17	58.7	46.06
11-2.5	34	73.8	98.97
12-2	27	83.0	109.66

See notes on Table B-7 *2 of 2*.

Source: Parametrix, Inc., April 1996.

Table B-7 *1 of 2*

Sediment Bioassay Results (Replicate Means) and Comparison to State Bioassay Criteria

Asarco Sediments/Groundwater OU 06 ROD

Station	*Ampelisca* Sample Mortality (%)*	Echinoderm Combined Station Normality/Survivorship (%)**	*Neanthes* Mean Total Biomass (mg)§
12-2.5	52	49.1	94.65
13-2	35	73.9	98.18
13-2.5	49	54.3	98.74
14-1	99 [a]	0.1 [a,b]	8.24 [b]
14-2	81 [a]	75.2	78.52
14-2.5	45	78.6	108.52
14-3.5	55	54.0	56.75
15-1	98 [a]	0.0 [a]	37.22 [b]
15-2	42	67.9	86.56
15-2.5	23	71.7	89.71
15.5-1	82 [a]	57.6	62.62
15.5-2	63	46.9 [a,b]	87.06
16-0.5	21	63.4	63.99
16-1	22	30.5 [a,b]	97.83
16-2	36	46.8 [a,b]	94.65
16.5-1***	29	53.1	94.12
16.5-2	32	48.6	100.75
17-1	54	52.4	79.53
17-1.5	20	32.4 [a,b]	78.85
17-2	24	47.8 [a,b]	93.13
17.5-1***	24	39.7	68.84
17.5-2	26	49.0 [a,b,c]	79.48
18-2.5	39	30.2 [a,b]	87.21
18-3.5	27	51.8	90.38
18.5-1	47	33.5 [a,b]	85.89
18.5-2	26	35.8 [a,b]	91.63

* State SQS criteria for amphipod bioassays: sediment fails if mortality is > 25% and significantly greater than reference.

** State SQS criteria for echinoderm larval bioassay: sediment fails if normal survivorship is < 85% of and significantly lower than reference.

*** Stations with greater than 20% fines that are compared to reference station Carr4.

§ State SQS criteria for polychaete bioassay: sediment fails if mean biomass < 70% of and significantly lower than reference.

§§ Does not meet reference station requirements defined by state criteria.

Does not meet reference station requirements defined by PSDDA.

[ ] Boxed values indicate the result exceeds state SQS and CSL criteria.

[a] Not significantly different from REF 3.

[b] Not significantly different from REF 4B.

[c] Not significantly different from Carr 2.

[d] Not significantly different from Carr 4.

Source: Parametrix, Inc., April 1996.

Table B-7 *2 of 2*

Sediment Bioassay Results (Replicate Means) and Comparison to State Bioassay Criteria

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	Bioassay[a]			Benthic Infauna[b]		
		Amphipod	Bivalve	Echinoderm	Polychaeta	Mollusca	Crustacea
1-1	1988	6	80	--	--	--	--
2-1	1988	4	87*	--	--	--	--
2-5**	1988	19	60	--	0.20*	0.10*	0.14*
3-2	1988	11	50	--	--	--	--
3-3	1989	16	--	24	0.55	0.11*	0.44
3-4**	1988	14	76	--	--	--	--
	1989	18	--	49*	0.71	0.14*	0.44
3-5**	1988	31*	80	--	0.41	0.18*	0.46
3-6	1988	3	54	--	--	--	--
4-0**	1990	14	--	72*	3.09	0.54	0.58
4-1**	1989	95*	--	27	2.26	0.78	0.74
4-2**	1988	49*	74	--	2.58	0.96	1.91
4-3**	1989	32	--	54*	1.80	0.23	1.56
5-0**	1988	9	86*/93*	--	--	--	--
	1990	14	--	56*	0.91	0.18*	0.06*
5-2**	1990	18	--	57*	0.62	0.21*	1.72
5-3	1989	20	--	16	0.38	0.13*	0.45
5-4**	1989	24	--	50*	--	--	--
5.5-2**	1990	32	--	85*	0.81	0.27*	1.29
6-0	1990	17	--	58	3.69	0.04*	0.37
6-1**	1988	97*	--	--	--	--	--
	1990	43	--	41	0.96	0.29*	1.00
6-2**	1989	23	--	30*	--	--	--
	1990	26	--	55*	0.85	0.28*	1.27
6-3	1988	22	69	--	0.95	0.72	1.65
	1990	16	--	45	0.75	0.33*	2.31
6-4	1989	12	--	10	0.28	0.12*	0.23
6.5-2**	1990	38	--	100*	0.88	0.22	1.34
7-2**	1990	48	--	89*	0.76	0.36	0.40
8-2	1989	13	--	38*	0.33	0.24	0.53

See notes on Table B-8 *2 of 2*.

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-8 *1 of 2*

Summary of Biological Data

Asarco Sediments/Groundwater OU 06 ROD

Station	Year	Bioassay[a]			Benthic Infauna[b]		
		Amphipod	Bivalve	Echinoderm	Polychaeta	Mollusca	Crustacea
8-3**	1989	17	--	44*	0.61	0.41	1.42
8-4	1988	17	70	--	0.86	0.65	1.73
10-1**	1988	14	99*/100*	--	1.46	0.20*	1.54
10-2**	1988	7	97*/91*	--	--	--	--
	1989	14	--	45*	1.39	0.54	1.80
10-3	1989	20	--	22	0.58	0.42	1.11
11-7**	1988	4	70/57	--	0.07*	0.03*	0.09*
12-1**	1988	62*	99*/93*	--	4.88	0.04*	0.43
12-2**	1989	16	--	45*	1.31	0.23	0.57
12-3	1989	11	--	40*	0.77	0.43	0.83
14-1**	1989	74*	--	99*	0.23	0.20*	0.14*
14-2	1989	7	--	21	0.47	0.55	0.39
14-3**	1989	15	--	63*	0.94	0.39	1.41
16-1	1988	5	86*/89*	--	0.60	0.23	1.34
16-2	1989	19	--	32*	0.38	0.26	0.58
16-3	1989	15	--	33*	0.47	0.23	0.55
16-4**	1988	17	98*/92*	--	0.36	0.20*	0.21*
18-1**	1989	19	--	40*	0.76	0.22*	2.59
18-2**	1988	14	98*/99*	--	--	--	--
	1989	12	--	48*	1.40	0.29	1.38
18-3**	1989	37*	--	2	--	--	--
19-1	1989	8	--	22	0.86	0.58	2.40
19-2	1989	24	--	2	0.85	0.23*	1.33

[a]Bioassay results in absolute mortality (amphipod) and combined abnormality/mortality (bivalve and echinoderm). For bivalves, assays were performed twice in 1988 at certain sample locations. Data from both sets of analyses are presented; the greater response was used to characterize the sample station.

[b]Benthic infauna is ratio of station to reference (i.e., indicated value = station abundance ÷ reference abundance).

* Exceeds problem area biological threshold value.

** Station identified as cleanup station based on at least one exceedance of MCUL biological criteria.

-- Data not collected during indicated sampling event

Source: Supplemental Feasibility Study, Commencement Bay Nearshore/Tideflats, Asarco Sediments Site, October 1993.

Table B-8 *2 of 2*

Summary of Biological Data

Asarco Sediments/Groundwater OU 06 ROD

Station	Polychaetes	Molluscs	Crustaceans	Miscellaneous
REF2	365	144	128	40
REF3	491	92	57	267
REF4B	235	64	23	20
2-2*	373	57	93	122
2-3*	235	39	81	70
2-4*	164	35	44	36
3-1	452	31	47	58
3-2	255	53	51	245
3-3*	423	43	79	86
4-2*	598	49	60	325
4-3*	382	46	92	556
5-0	519	134	19 b	12 a
5-1	574	94	124	125
5-2*	313	48	115	95
5-3*	139	24	37	28
5.5-0	1,586	191	83	13 a
6-2	465	68	98	165
6.5-0	539	31	46 b	3 a
6.5-2	321	40 b	37 b	63
6.5-3	146 a	30	33 b	30 a
7-12*	139	22	40	16
7-3	200 a	46	73	70
7-4.5	152 a	45 b	41 b	35 a
8-1.5	432	43 b	49 b	36 a
8-2.5	311	52	102	87
8-3.5	194 a	37	62	40 a
9-1	73	7	43	0
9-2	156 a	52 b	40 b	60 a
9-2.5	338	54	86	82
10-1.5	369	78	58	45 a
10-2	332	78	51 b	59 a
10-2.5	335	79	107	151
11-0	1	1	3	0
11-2	248	88	63	90
11-2.5	208	46 b	58	93
12-2	510	272	79	33 a
12-2.5	362	173	61	48 a
13-2	495	211	80	37 a
13-2.5	594	230	96	86
14-1	102	31	68	4 a
14-2	67	11	24 b	10 a
14-2.5	203	102	66	50 a
14-3.5	274	84	54	424
15-1	28	15	11 b	3 a
15-2	196 a	32	62 b	48 a
15-2.5	124	54	41 b	28 a

See notes on Table B-9 *2 of 2*.

Source: Parametrix, Inc., April 1996.

Table B-9 *1 of 2*

Replicate Mean Abundances of Major Taxa Compared to Reference Stations Using Kruskal-Wallis Tests

Asarco Sediments/Groundwater OU 06 ROD

152679.PR.02_E062000009SEA . Table B-9 1of2 Replicate Mean Abundances Major Taxa Compared to Ref Stations Using KW Tests . 6-21-00 . gr

Station	Polychaetes	Molluscs	Crustaceans	Miscellaneous
15.5-1	288	59	53 b	16 a
15.5-2	361	97	137	55 a
16-0.5	658	127	138	47 a
16-1	183 a	[33]	59 b	40 a
16-2	[96]	[25]	19 b	45 a
16.5-1	393	91	352	29
16.5-2	394	78	200	77
17-1	667	52 b	829	62 a
17-1.5	356	48 b	80	32 a
17-2	289	[31]	114	67 a
17.5-1	1,183	111	185	50
17.5-2	293	46	201	76
18-2.5	259	44 b	142	102
18-3.5	313	63	91	36 a
18.5-1	154 a	[19]	69	9 a
18.5-2	307	40 b	201	82

[ ] Boxed values indicate mean replicate abundance that is significantly less than all appropriate reference stations.

* These stations had depths greater than 150 feet and were compared to REF4B only.

a Replicate abundance significantly less than REF3 and depth less than 150 feet.

b Replicate abundance significantly less than REF2 and depth less than 150 feet.

Source: Parametrix, Inc., April 1996.

Table B-9 *2 of 2*

Replicate Mean Abundances of Major Taxa Compared to Reference Stations Using Kruskal-Wallis Tests

Asarco Sediments/Groundwater OU 06 ROD

Chemical	REF	1B	1B Dup.	2A	2B	3A	3B
Metals (mg/kg)							
Arsenic +3	0.002 U	0.002 U	0.002 U	0.007	0.002 U	0.002 U	0.003
Arsenic +5	0.017	0.034	0.180	0.39	0.081	0.021	0.030
Monomethyl Arsenic	0.005	0.002	0.007	0.011	0.002	0.002	0.003
Dimethyl Arsenic	1.5	4.5	5.3	7.7	7.0	2.2	3.3
Total Arsenic	0.40	0.85	10	1.9	1.7	0.92	0.75
Cadmium	0.02	0.01	0.02	0.02	0.02	0.02	0.02
Chromium	0.039	0.16	0.049	0.066	0.077	0.067	0.058
Copper	4.7	0.72	6.3	5.6	6.5	5.5	5.0
Mercury	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel	0.16	0.035	0.14	0.18	0.042	0.037	0.63
Lead	0.56	1.3	3.8	2.0	1.5	1.2	0.75
Silver	0.016	0.015	0.092	0.017 U	0.018 U	0.015	0.016
Zinc	14	12	24	14	16	14	14
Organics (µg/kg)							
LPAH							
Acenaphthylene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Acenaphthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Fluorene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Naphthalene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Phenanthrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
2-Methylnaphthalene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Total LPAHs	231	231	231	231	224	224	224
HPAH							
Benzo(a)anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(a) pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(b)fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(k)fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(g,h,i)perylene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Chrysene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Dibenzo(a,h)anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Indeno(1,2,3,-cd)pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Total HPAHs	330	330	330	330	320	320	320
Total PAHs	561	561	561	561	544	544	544
Phthalates							
Bis(2-ethylhexyl) phthalate	97	510	33 U	41	120	32 U	100
Butyl benzyl phthalate	33 U	33 U	170 U	33 U	160 U	32 U	69
Diethyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Dimethyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Di-n-butyl phthalate	44	33 U	33 U	33 U	32 U	32 U	32 U
Di-n-octyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Conventionals							
Moisture (%)	78	77	76	79	78	80	76
Lipids (%)	5.3	15	9.0	5.5	5.8	6.0	6.2

U = Undetected at reported detection limit.

[ ] Boxed values are greater than Reference values for that station.

Source: Parametrix, Inc., April 1996.

Table B-10

Rock Sole Whole Body Tissue Chemical Concentrations (wet weight)

Asarco Sediments/Groundwater OU 06 ROD

Chemical	REF	1B	1B Dup.	2A	2B	3A	3B
Metals (mg/kg)							
Arsenic +3	0.002 U	0.002 U	0.002 U	0.007	0.002 U	0.002 U	0.003
Arsenic +5	0.017	0.034	0.180	0.39	0.081	0.021	0.030
Monomethyl Arsenic	0.005	0.002	0.007	0.011	0.002	0.002	0.003
Dimethyl Arsenic	1.5	4.5	5.3	7.7	7.0	2.2	3.3
Total Arsenic	0.40	0.85	10	1.9	1.7	0.92	0.75
Cadmium	0.02	0.01	0.02	0.02	0.02	0.02	0.02
Chromium	0.039	0.16	0.049	0.066	0.077	0.067	0.058
Copper	4.7	0.72	6.3	5.6	6.5	5.5	5.0
Mercury	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel	0.16	0.035	0.14	0.18	0.042	0.037	0.63
Lead	0.56	1.3	3.8	2.0	1.5	1.2	0.75
Silver	0.016	0.015	0.092	0.017 U	0.018 U	0.015	0.016
Zinc	14	12	24	14	16	14	14
Organics (µg/kg)							
LPAH							
Acenaphthylene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Acenaphthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Fluorene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Naphthalene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Phenanthrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
2-Methylnaphthalene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Total LPAHs	231	231	231	231	224	224	224
HPAH							
Benzo(a)anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(a) pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(b)fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(k)fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Benzo(g,h,i)perylene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Chrysene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Dibenzo(a,h)anthracene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Fluoranthene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Indeno(1,2,3,-cd)pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Pyrene	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Total HPAHs	330	330	330	330	320	320	320
Total PAHs	561	561	561	561	544	544	544
Phthalates							
Bis(2-ethylhexyl) phthalate	97	510	33 U	41	120	32 U	100
Butyl benzyl phthalate	33 U	33 U	170 U	33 U	160 U	32 U	69
Diethyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Dimethyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Di-n-butyl phthalate	44	33 U	33 U	33 U	32 U	32 U	32 U
Di-n-octyl phthalate	33 U	33 U	33 U	33 U	32 U	32 U	32 U
Conventionals							
Moisture (%)	78	77	76	79	78	80	76
Lipids (%)	5.3	15	9.0	5.5	5.8	6.0	6.2

U = Undetected at reported detection limit.
[ ] Boxed values are greater than Reference values for that station.

Source: Parametrix, Inc., April 1996.

Table B-11

Rock Sole Fillet Tissue Chemical Concentrations (wet weight)

Asarco Sediments/Groundwater OU 06 ROD

Chemical / Species	REF *Evasterias*	1A *Evasterias*	1B *Evasterias*	2A *Evasterias*	2B *Evasterias*	3A *Evasterias*	3B *Evasterius*	4A *Evasterius*	REF *Mediaster*	2A *Mediaster*	2B *Mediaster*	3B *Mediaster*
Metals (mg/kg)												
Arsenic +3	0.002 U	0.006 U	0.002 U	0.015	0.002	0.002 U	0.002 U	0.002 U	--	0.003	0.002	0.002
Arsenic +5	0.012	0.012 U	0.009	0.485	0.007	0.019	0.005	0.008	--	0.043	0.019	0.020
Total Arsenic	0.70	0.96	0.46	2.0	0.68	0.56	0.73	1.10	3.40	4.10	4.80	3.70
Cadmium	0.62	0.50	0.92	0.52	0.28	0.46	0.42	0.07	9.90	5.10	5.80	6.30
Chromium	0.43	0.28	0.11	0.24	0.17	0.23	0.15	0.04	0.25	0.22	0.05	0.05
Copper	2.8	13.0	6.8	6.9	3.2	2.3	3.3	8.1	17.0	20.0	19.0	18.0
Mercury	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel	0.30	0.18 U	0.15	0.064	0.05	0.11	0.14	0.044	1.50	0.17	0.20	0.082
Lead	0.15	0.26	0.43	0.16	0.05	0.59	0.55	0.26	0.30	0.38	0.59	0.50
Silver	0.24	0.13	0.06	0.14	0.16	0.16	0.10	0.11	0.24	0.18	0.16	0.13
Zinc	15.0	17.0	15.0	11.0	13.0	12.0	8.9	25.0	13.0	10.0	12.0	9.7
Organics (µg/kg)												
LPAH												
Acenaphthylene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Acenaphthene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Anthracene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Fluorene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Naphthalene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Phenanthrene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
2-Methylnaphthalene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Total LPAHs	231	224	231	231	231	231	231	224	231	231	224	231
HPAH												
Benzo(a)anthracene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Benzo(a) pyrene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Benzo(b)fluoranthene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Benzo(k)fluoranthene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Benzo(g,h,i)perylene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Chrysene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Dibenzo(a,h)anthracene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Fluoranthene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Indeno(1,2,3,-cd)pyrene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Pyrene	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Total HPAHs	330	320	330	330	330	330	330	320	330	330	320	330
Total PAHs	561	544	561	561	561	561	561	544	561	561	544	561
Phthalates												
Bis(2-ethylhexyl) phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	58	32 U	33 U
Butyl benzyl phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	110	32 U	91
Diethyl phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Dimethyl phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Di-n-butyl phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Di-n-octyl phthalate	33 U	32 U	33 U	33 U	33 U	33 U	33 U	32 U	33 U	33 U	32 U	33 U
Conventionals												
Moisture (%)	74	80	85	78	88	79	84	71	72	68	68	74
Lipids (%)	3.0	4.1	9.8	3.6	4.5	6.2	4.6	2.4	2.2	2.9	3.8	4.4

Source: Parametrix, Inc., April 1996.

Table B-12 *1 of 2*

Benthic Invertebrate Tissue Chemical Concentration (Wet Weight)

Asarco Sediments/Groundwater OU 06 ROD

Chemical	Species	REF *Stichopus*	1A *Stichopus*	1B *Stichopus*	2A *Stichopus*	2B *Stichopus*	3A *Stichopus*	3B *Stichopus*	4A *Crangon*
Metals (mg/kg)									
Arsenic +3		0.002 U	0.006 U	--	0.002	0.002 U	0.002 U	0.002 U	--
Arsenic +5		0.013	0.012 U	--	0.077	0.019	0.018	0.010	--
Total Arsenic		0.25	0.37	0.53	0.71	0.26	0.42	0.23	0.84
Cadmium		0.04	0.08	0.06	0.13	0.07	0.01 U	0.01 U	0.15
Chromium		0.05	0.10	0.05	0.05	0.13	0.03	0.11	0.02
Copper		0.4	0.4	0.3	0.7	0.2	0.2	0.3	41.0
Mercury		0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
Nickel		0.05	0.18	0.03	0.03	0.03	0.05	0.04	0.19
Lead		0.04	0.05	0.16	0.68	0.10	0.09	0.11	0.89
Silver		0.02 U	0.02 U	0.01	0.01	0.01	0.01	0.02	0.32
Zinc		2.7	3.8	3.9	4.0	2.0	3.4	1.9	16.0
Organics (µg/kg)									
LPAH									
Acenaphthylene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Acenaphthene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Anthracene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Fluorene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Naphthalene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Phenanthrene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
2-Methylnaphthalene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Total LPAHs		217	224	231	231	231	231	231	--
HPAH									
Benzo(a)anthracene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Benzo(a) pyrene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Benzo(b)fluoranthene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Benzo(k)fluoranthene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Benzo(g,h,i)perylene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Chrysene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Dibenzo(a,h)anthracene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Fluoranthene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Indeno(1,2,3,-cd)pyrene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Pyrene		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Total HPAHs		310	320	330	330	330	330	330	--
Total PAHs		527	544	561	561	561	561	561	--
Phthalates									
Bis(2-ethylhexyl) phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Butyl benzyl phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Diethyl phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Dimethyl phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Di-n-butyl phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Di-n-octyl phthalate		31 U	32 U	33 U	33 U	33 U	33 U	33 U	--
Conventionals									
Moisture (%)		94	94	94	93	88	93	95	79
Lipids (%)		2.2	0.97	1.2	0.1 U	0.1 U	2.0	2.7	1.1

Source: Parametrix, Inc., April 1996.

Table B-12 *2 of 2*

Benthic Invertebrate Tissue Chemical Concentration (Wet Weight)

Asarco Sediments/Groundwater OU 06 ROD

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APPENDIX C

Outcome of Preponderance of Evidence Approach for Marine Sediments

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Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
1-1a	N	N	--	N/A	N/A	N/A	N/A	N/A	1	No identified exceedances of SQS chemical criteria; bioassay data suggest no current impacts based on lack of significant differences from reference responses.
2-1a	[Y]	N	L	N/A	N/A	N/A	N/A	N/A	4	Sediment concentrations of As and Hg exceed CSL criteria and minimal adverse biological effects indicated by one bioassay response (bivalve larval effective mortality) significantly higher than reference.
2-2	[Y]	N	--	--	--	--	N	N	2	Sediment concentration of As exceeded CSL criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
2-3	N	N	--	--	--	--	N	N	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
2-4	N	N	[L]	--	--	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by one bioassay response (echinoderm larval effective mortality) significantly higher than reference.
2-5a	N	N	--	[C,M,P]	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by benthic infaunal abundances of three major taxonomic groups significantly depressed relative to reference.
2-6a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
3-1	[Y]	N	[L,P]	[C,M]	--	--	Y	Y	5	Multiple exceedances of CSL criteria for sediment chemicals (As, Cu, Pb, Zn) and bioassay and benthic responses significantly different from reference, combined with dominance of pollution-tolerant taxa, suggestive of moderate to severe impacts.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
3-2	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
3-3	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As, Pb and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
3-4a	[Y]	N	[L]	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference and mollusc abundance significantly lower than reference.
3-5a	[Y]	N	A	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb and Zn exceed CSL criteria and minimal adverse biological effects indicated by amphipod mortality significantly higher than reference and mollusc abundance significantly lower than reference.
3-6a	[Y]	N	--	N/A	N/A	N/A	N/A	N/A	2	Sediment concentrations of As, Cu, Pb and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses.
4-0a	[Y]	[Y]	[L]	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, Zn, and individual PAHs exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
4-1a	[Y]	N	[A]	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb and Zn exceed CSL criteria and minimal adverse biological effects indicated by amphipod mortality significantly higher than reference.
4-2	[Y]	N	[A]	--	--	J	Y	N	4	Sediment concentrations of As, Cd, Cu, Pb, Ag, and Zn exceed CSL criteria and minimal adverse biological effects indicated by amphipod mortality significantly higher than reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
4-3	[Y]	N	[L]	--	--	H,J,S,SDI	N	N	4	Sediment concentrations of As, Cd, Cu, Pb and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference and diversity indices lower than reference.
4-4a	N	[Y]	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of a phthalate ester in exceedance of the CSL criterion.
5-0	[Y]	Y	--	--	--	H,J,S,SDI	Y	Y	5	Dominance of the benthic community by pollution-tolerant polychaetes indicative of moderate to severe benthic impacts.
5-0.25	[Y]	N	[A,L,P]	N/A	N/A	N/A	N/A	N/A	5	In the absence of benthic data, the multiple CSL chemical exceedances (As, Cd, Cr, Cu, Pb, Ag, and Zn), combined with multiple bioassay responses significantly different from reference, considered sufficient evidence of moderate to severe impacts.
5-0.5	[Y]	N	[A,L,P]	N/A	N/A	N/A	N/A	N/A	5	In the absence of benthic data, the multiple CSL chemical exceedances (As, Cr, Cu, Pb, Ag, and Zn), combined with multiple bioassay responses significantly different from reference, considered sufficient evidence of moderate to severe impacts.
5-1	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As, Cd, Cu, Pb, Ag, and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
5-2	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As, Cd, Cu, Pb, Ag, and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
5-3	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As, Cu, Pb, and Zn exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
5-4a	[Y]	N/A	[L]	N/A	N/A	N/A	N/A	N/A	4	Sediment concentration of As exceeded CSL criterion and minimal adverse biological effects indicated by one bioassay response (echinoderm larval effective mortality) significantly higher than reference.
5.5-0	[Y]	N	--	C	--	H,J,S,SDI	Y	Y	5	Dominance of the benthic community by pollution-tolerant polychaetes indicative of moderate to severe benthic impacts.
5.5-2a	[Y]	N/A	[L]	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference and mollusc abundance significantly lower than reference.
6-0a	[Y]	N	--	M	N/A	N/A	N/A	Y	5	Dominance of the benthic community by pollution-tolerant polychaetes indicative of benthic impacts.
6-1a	[Y]	N	[A]	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, and Zn exceed CSL criteria and minimal adverse biological effects indicated by amphipod mortality significantly higher than reference and mollusc abundance significantly lower than reference.
6-2	[Y]	N	[A,L]	--	--	--	N	N	4	Sediment concentrations of As, Cd, Cu, Pb, Ag, and Zn exceed CSL criteria and minimal adverse biological effects indicated by amphipod mortality and echinoderm larval effective mortality significantly higher than reference.
6-3a	[Y]	N	--	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, and Zn exceed CSL criteria and minimal adverse biological effects indicated by significantly depressed mollusc abundance relative to reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
6-4a	Y	N	--	M	N/A	N/A	N/A	N/A	4	Sediment concentration of As only exceeded SQS criterion but minimal adverse biological effects suggested by significantly depressed mollusc abundance relative to reference.
6.5-0	[Y]	N	[A]	M	TR	H,J,S,SDI	Y	Y	5	Multiple biological results, including bioassay and benthic endpoints that were significantly different from reference and dominance by pollution-tolerant species, suggestive of moderate to severe impacts.
6.5-1	[Y]	N	[A,L,P]	N/A	N/A	N/A	N/A	N/A	5	In the absence of benthic data, the multiple CSL chemical exceedances (As, Cd, Cr, Cu, Pb, Ag, and Zn), combined with multiple bioassay responses significantly different from reference, considered sufficient evidence of moderate to severe impacts.
6.5-2	[Y]	N/A	[L]	--	--	--	N	N	4	Sediment concentrations of As, Cd, Cu, Pb, Ag, and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
6.5-3	[Y]	N	--	M	TA,DA	--	N	N	4	Sediment concentration of As exceeded CSL criterion and minimal adverse biological effects indicated by mollusc abundance and overall community abundance and dominant taxa abundance significantly lower than reference.
7-1a	[Y]	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As, Cu, Pb, and Zn in excess of CSL criteria.
7-2a	[Y]	N	[L]	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
7-3	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As and Cd exceeded CSL criteria but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
7-4a	[Y]	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As in excess of CSL criterion.
7-4.5	N	N	--	--	TA,DA	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by benthic infaunal total abundance and dominant taxa abundance significantly depressed relative to reference.
7-5a	Y	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As in excess of SQS criterion.
7-6a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
7-7a	N	Y	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of a phthalate ester in excess of SQS criterion.
7-12	N	N	[L]	M	--	--	Y	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm effective mortality significantly higher than reference and mollusc abundance significantly depressed relative to reference.
8-1a	[Y]	[Y]	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As, Pb, Zn, and a phthalate ester in excess of CSL criteria.
8-1.5	[Y]	N	[A,L,P]	--	--	H	Y	Y	5	Multiple biological results, including bioassay and benthic endpoints that were significantly different from reference and dominance by pollution-tolerant species, suggestive of moderate to severe impacts.
8-2a	[Y]	N	L	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Hg, and Zn exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
8-2.5	[Y]	N	[A,L]	--	--	--	N	N	4	Sediment concentrations of As and Hg exceed CSL and SQS criteria, respectively, and minimal adverse biological effects indicated by amphipod mortality and echinoderm larval effective mortality significantly higher than reference.
8-3a	[Y]	N	[L]	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As exceeded CSL criterion and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
8-3.5	Y	N	--	M	--	--	N	N	4	Sediment concentration of As only exceeded SQS criterion but minimal adverse biological effects suggested by significantly depressed mollusc abundance relative to reference.
8-4a	Y	N	--	--	N/A	N/A	N/A	N/A	2	Sediment concentrations of As exceeded SQS criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic abundance data.
9-1	[Y]	N	[A,L,P]	[C,M,P]	TA,DA,TR,DR	H,J,S,SDI	Y	Y	5	Multiple indicators of biological impacts, including significantly reduced abundance and richness values, diversity values less than reference, and bioassay responses significantly different from reference.
9-2	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of As exceeded CSL criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
9-2.5	Y	N	--	--	--	--	N	N	2	Sediment concentrations of As exceeded SQS criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
9-3a	Y	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As in excess of CSL criteria.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
9-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
9-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
9-6a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
9-7a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
9-8a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
10-0a	[Y]	[Y]	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As, Cu, Pb, Zn, and individual PAHs in excess of CSL criteria.
10-1a	[Y]	[Y]	[L]	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, and Zn exceed CSL criteria and minimal adverse biological effects indicated by bivalve larval effective mortality significantly higher than reference.
10-1.5	[Y]	N	[L]	--	--	--	N	N	4	Sediment concentrations of As and Cu exceed CSL criteria and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
10-2	Y	N	[L]	--	--	--	N	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
10-2.5	N	N	--	--	--	--	N	N	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
10-3a	Y	N	--	--	N/A	N/A	N/A	N/A	2	Sediment concentrations of As exceeded SQS criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic abundances.
10-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
11-0	[Y]	Y	[A,L,P]	[C,M,P]	TA,DA,TR	H,SDI	Y	Y	5	Multiple indicators of moderate to severe biological impacts, including significantly reduced abundance and richness values, diversity values less than reference, and bioassay responses significantly different from reference.
11-1a	[Y]	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As, Cu, Pb, and Zn in excess of CSL criteria.
11-2	N	N	--	--	--	--	N	N	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
11-2.5	[Y]	N	--	--	--	--	N	N	2	Sediment concentrations of Cu exceeded CSL criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic abundances.
11-3a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
11-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
11-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
11-6a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
11-7a	N	N	--	[C,M,P]	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by major benthic taxonomic group abundances significantly depressed relative to reference.
11-8a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
11-9a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
12-1a	[Y]	[Y]	[A,L]	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As, Cu, Pb, Hg, and Zn exceed CSL criteria and minimal adverse biological effects indicated by bioassay mortality responses significantly higher than reference and mollusc abundance significantly lower than reference.
12-2	Y	N	--	--	TR,DR	H,J,SDI	N	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by richness and diversity values lower than reference.
12-2.5	Y	N	--	--	--	H, SDI	N	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by diversity values lower than reference.
12-3a	Y	N	L	--	N/A	N/A	N/A	N/A	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
12-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
12-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
13-1a	[Y]	[Y]	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As, Cu, Pb, Zn, and an individual PAH in excess CSL criteria.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
13-2	N	N	--	--	--	J	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by a diversity value less than reference.
13-2.5	N	N	--	--	--	--	N	N	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
13-3a	Y	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As in excess of the SQS criterion.
13-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
13-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
13-6a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
13-7a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
13-8a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
14-1	[Y]	N	[A,L,P]	[M,P]	TA,DA,TR	H,SDI	Y	Y	5	Multiple indicators of moderate to severe biological impacts, including significantly reduced abundance and richness values, diversity values less than reference, and bioassay responses significantly different from reference.
14-2	[Y]	N	[A]	[M,P]	TA,DA,TR	H	Y	Y	5	Multiple indicators of moderate to severe biological impacts, including significantly reduced abundance and richness values, diversity values less than reference, and bioassay responses significantly different from reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
14-2.5	Y	N	--	--	--	--	N	N	2	Sediment concentrations of As exceeded SQS criterion but current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic abundances.
14-3a	N	N	[L]	--	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effectively mortality response higher than reference.
14-3.5	N	N	--	--	--	J	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by a diversity value less than reference.
14-4a	Y	N	N/A	N/A	N/A	N/A	N/A	N/A	2	Biological data not available, but minimal impacts considered possible based on sediment concentrations of As in excess of the SQS criterion.
14-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
15-1	[Y]	N	[A,L,P]	[M,P]	TA,DA,TR	H,SDI	Y	Y	5	Multiple indicators of moderate to severe biological impacts, including significantly reduced abundance and richness values, diversity values less than reference, and bioassay responses significantly different from reference.
15-2	[Y]	N	--	M	--	--	N	N	4	Sediment concentrations of As exceeded CSL criterion and minimal adverse biological effects indicated by mollusc abundance significantly depressed relative to reference.
15-2.5	N	N	--	P	TA,DA	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by overall abundance and polychaete abundance significantly depressed relative to reference.
15-3a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
15-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
15-5a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
15.5-1	[Y]	N	[A]	--	--	H,J,S,SDI	Y	Y	5	Differences in benthic community structure, combined with diversity measures lower than reference, considered sufficient evidence of moderate to severe impacts.
15.5-2	[Y]	N	[L]	--	--	--	Y	N	4	Sediment concentrations of As and Cu exceeded CSL criterion and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
16-0.5	[Y]	N	--	--	TR,DR	J	N	N	4	Sediment concentrations of As and CU exceeded CSL criteria and minimal adverse biological effects indicated by richness values significantly depressed relative to reference and diversity indices lower than reference.
16-1	Y	N	[L]	M	--	--	N	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference and mollusc abundance significantly depressed relative to reference.
16-2	N	N	[L]	[M,P]	TA,DA	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by benthic abundance values significantly depressed relative to reference and bioassay exceedances of reference.
16-3a	N	N	L	--	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
16-4a	N	N	[L]	[C,M]	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by benthic abundance values significantly depressed relative to reference and bioassay exceedances of reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments (Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
16.5-1	[Y]	N	--	--	--	J	N	N	4	Sediment concentrations of As and Cu exceed CSL criteria and minimal adverse biological effects indicated by diversity value lower than reference.
16.5-2	N	N	--	--	--	--	N	N	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
17-1	[Y]	N	--	--	--	H,J,SDI	N	N	4	Sediment concentrations of As and Cu exceed CSL criteria and minimal adverse biological effects indicated by diversity values lower than reference.
17-1.5	Y	N	[L]	--	--	H	N	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by diversity value lower than reference.
17-2	N	N	[L]	M	--	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by mollusc abundance significantly depressed relative to reference and echinoderm larval effective mortality significantly higher than reference.
17-3a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
17-4a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
17.5-1	Y	N	[L]	--	--	H,J,S,SDI	Y	N	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by diversity values lower than reference.
17.5-2	N	N	[L]	--	--	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
18-1a	Y	[Y]	L	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As and individual PAHs exceed SQS and CSL criteria, respectively, and minimal adverse biological effects indicated by bioassay and benthic abundance values significantly different from reference.
18-2a	N	N	[L]	--	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
18-2.5	N	N	[L]	--	--	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
18-3a	N	N	[A]	N/A	N/A	N/A	N/A	N/A	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by amphipod mortality significantly higher than reference.
18-3.5	N	N	--	--	--	--	Y	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by results of community structure evaluations.
18.5-1	N	N	[L]	M	TA,DA,TR	H,SDI	Y	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by community structure evaluations, benthic richness and abundance values, and bioassay results.
18.5-2	N	N	[L]	--	--	--	N	N	3	No identified exceedances of SQS chemical criteria, but minimal adverse biological effects indicated by echinoderm larval effective mortality significantly higher than reference.
19-1a	N	N	--	--	N/A	N/A	N/A	N/A	1	No identified exceedances of SQS chemical criteria and current biological impacts not suggested given lack of significant differences from reference in bioassay responses and benthic community structure.
19-2a	Y	N	--	M	N/A	N/A	N/A	N/A	4	Sediment concentrations of As exceeded SQS criterion and minimal adverse biological effects indicated by mollusc abundance significantly lower than reference.

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation
20-1a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.
20-2a	N	N	N/A	N/A	N/A	N/A	N/A	N/A	1	Biological data not available, but impacts not predicted based on lack of sediment chemical exceedances of SQS criteria.

Station Notes

a: Data obtained from the SFS (WESTON, 1993)

General Response Notes

N: No
Y: Yes
[ ]: Response exceeded chemical or biological CSL criteria
N/A: Data not available.

Bioassay Response Notes

A: Amphipod (*Rhepoxynius abronius* or *Ampelisca abdita*) bioassay
L: Larval (*Crassostrea gigas* or *Dendraster excentricus*) bioassay
P: Polychaete (juvenile *Neanthes arenaceodentata*) bioassay

Benthic Response Notes

C: Crustacean abundance
M: Molluscan abundance
P: Polychaete abundance

Abundance and Richness Notes

TA: Total abundance
DA: Dominant taxa abundance
TR: Total richness
DR: Dominant taxa richness

Table C-1— Outcome of Preponderance of Evidence Approach for Marine Sediments
(Source: Roy F. Weston, Inc., October 1996, Table 7-1)

Station	Exceeds Inorganic SQS?	Exceeds Organic SQS?	Bioassay SQS Exceedances	Benthic SQS Exceedances	Abundance & Richness Significant Depressions	Diversity Indices Below Reference	Community Structure Suggestive of Impacts?	Species-Level Data Suggestive of Impacts?	Impact Category	Basis for Impact Category Designation

Diversity Index Notes

H: Shannon-Weiner Diversity Index
J: Evenness Index
S: Simpson's Index
SDI: Swartz's Dominance Index

Impact Categories

1: No current impacts; future impacts not predicted
2: No current impacts; future impacts possible
3: Current minimal impacts (cause uncertain); future impacts possible
4: Current minimal impacts (sediment-related); future impacts possible
5: Current moderate to severe impacts; future impacts probable

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APPENDIX D

Comment Letters Received During the Proposed Plan Public Comment Period

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Coastal Protection and Restoration Division
c/o EPA Region X (ECL-117)
1200 Sixth Avenue
Seattle, Washington 98101

March 27, 2000

Mr. Lee Marshall
Project Manager
U.S. EPA Region X (ECL-111)
1200 Sixth Avenue
Seattle, WA 98101

Subject: NOAA Comments on the Proposed Plan for the Asarco / Sediments/Groundwater Operable Unit

Dear Mr. Marshall,

The National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to comment on the proposed plan for the Asarco groundwater and sediment operable unit. Overall, we are pleased with the plan and support EPA's proposal.

General comments:

NOAA appreciates the efforts the two remedial project managers and ASARCO have made to incorporate previous NOAA technical comments and suggestions into the overall cleanup of the former ASARCO Smelter Facility. By combining parts of both operable units, it appears that the sediment remediation will be accomplished sooner than originally scheduled and the use of the upland disposal site for the Yacht Club sediments further streamlines the cleanup.

The natural resource agencies have expended considerable time and effort providing technical advice to EPA, Ecology, ASARCO, and their consultants - this Proposed Plan suggests that it was worth the effort since most of NOAA's previous concerns about the sediments have been addressed. We want to encourage EPA, Ecology, and ASARCO to continue to seamlessly integrate the sediment remediation with the shoreline stabilization. In this way, there should be no wasted efforts between the two operable units cleanups and the impacts to the natural resources will be minimized while the on-going exposures to contaminants will be curtailed sooner rather than later.

NOAA strongly supports EPA's requirement for long-term monitoring of the remedy. Our only concern with the proposed monitoring is that it does not include measuring contaminant concentrations in the waters of Commencement Bay adjacent to the facility shoreline. As explained in our section-specific comments below, we think that monitoring water quality in Commencement Bay is critical and we recommend that EPA include offshore monitoring in the final plan.

As we noted in our recent comments on the Nov. 1999 Explanation of Significant Differences (ESD) for the Commencement Bay Nearshore/Tideflats Superfund Site (2 Feb. 2000), NOAA has consistently based our evaluation of the Commencement Bay investigations and cleanup plans on five basic principles:

1. that cleanup(s) progress sooner rather than later to reduce continued exposure of trust resources to contaminants;
2. a preference for complete removal of contaminants from the aquatic environment (most contaminants originated from the uplands);
3. if the aquatic environment must continue to serve as the repository for the contaminated sediments, we prefer that contamination not be transferred from impacted waterways to otherwise clean areas for disposal;
4. where remedial actions cause adverse impacts (during cleanup or disposal), mitigation for lost natural resources or their services is required; and
5. cleanup and disposal decisions must be made under a baywide planning and evaluation effort, especially for threatened/endangered trust resources and their habitats.

This Proposed Plan appears to satisfy our principles 1,2,3, and 5. Where mitigation is required (principle 4) based on cleanup action details yet to be specified, we would strongly recommend the enhancement of the nearshore/intertidal area immediately south of the slag peninsula along Ruston Way. This could entail the removal of wood wastes from the bottom and re-contouring to allow eelgrass propagation from the existing bed further south. We look forward to reviewing a detailed Clean Water Act 404 analysis and/or mitigation plan.

Section-specific Comments:

Pg 2: Elements of the Preferred Alternative, Groundwater: The first item identifies limiting groundwater "loading" *to Commencement Bay* as a remedial objective. The second item identifies monitoring of groundwater as the method to document success or failure of the remedy. However, the Groundwater-Sediments Task Force determined that two processes at the site complicate calculations of contaminant loading to Commencement Bay from discharging groundwater:

(1) Tidal cycles in Commencement Bay cause significant fluctuations in the hydraulic gradient at the CB shoreline; these tidal waters intermittently enter the fractures in the slag along the shoreline and mix with discharging groundwater, altering the groundwater gradient, discharging water volumes and the concentration of conservative constituents, such as chloride (Cl); and

(2) The solubility of the metal and metalloid (e.g., arsenic) ions that are contaminants of concern at the site varies with changes in pH and/or redox conditions, both of which are altered as the groundwater mixes with saline, oxygenated seawater within the fractured slag before discharging into Commencement Bay. These processes are described at the bottom of page 7 in the Proposed Plan, also.

COMMENT: Because measurements of groundwater gradients and contaminant concentrations in upland wells are an incomplete predictor of the contaminant loading to Commencement Bay (as explained above), and the dilution from tidal mixing at the shoreline is significant but not precisely quantified; the only way to determine if the shoreline water of Commencement Bay is not contaminated by the metal and metalloid contaminants from the site is to sample the shoreline waters of Commencement Bay and analyze for these constituents.

Pg 5: State Sediment Management Standards - Sediment Cleanup Criteria:
BASIS: Numerous sediment samples at the site had extremely high concentrations of metals and metalloids, variable laboratory bioassay results, and benthic community analyses that did not show any statistically significant differences from reference. The apparent absence of the

expected response (mortality leading to benthic community alterations) at these stations may result from the physical structure of the slag that contains most of the contamination. However, very high concentrations of contaminants remain at the site, and ecological indicators of an adverse response to these contaminants were varied. The toxicity of some of these contaminants can change with changing environmental conditions, e.g. temperature or oxygen availability, and toxicity can vary by organism lifestage. Therefore, it is important that areas where high concentrations of contaminants remain in contact with ecological receptors are monitored over the long-term to demonstrate continued ecological protectiveness.

COMMENT: NOAA supports the proposal not to require active remediation of these areas on the condition that EPA require long-term monitoring to demonstrate whether this decision continues to be protective. It is recommended that this monitoring be coordinated with the long-term monitoring of benthic communities in remediation areas that are dredged and/or capped to make efficient use of equipment and labor.

Pg. 7, Sec. 3.1 Groundwater: "Groundwater at the Facility flows from the southwest to northeast and ultimately discharges to Commencement Bay."

COMMENT: Because Commencement Bay is the ultimate recipient of the contaminated groundwater, and because ecologic receptors along the Commencement Bay shoreline can be adversely affected by these contaminants, NOAA supports the preferred remedy on the condition that long-term monitoring of the site include collection of shoreline water samples for contaminant quantification.

Pg. 8, Sec. 3.1 Groundwater: "DMA-related organic compounds are also present in the shallow groundwater system. However, the DMA, arsenic, and copper in the DMA area do not appear to result in any greater exceedances of surface water criteria in the adjacent Commencement Bay than observed elsewhere at the Facility. For this reason, no special groundwater remedial action is planned for the DMA area. However, *groundwater monitoring* in the DMA area will be part of the post-remedial action monitoring program."

COMMENT: NOAA can support a decision not to take action to reduce contaminants in groundwater at the DMA area, only if there will be long-term monitoring of the receiving water along the shoreline of Commencement Bay where NOAA trust resources are potentially affected by these contaminants, and with a commitment that if the monitoring data indicate this decision is not protective of the environment, that other remedies will be evaluated for the DMA area.

Pg. 10, Sec. 3.2, Sediment: "Some concentrations of metals and/or biological impacts (as measured with bioassays) exceeded the CSL outside of the Contaminant Effects Area in what is depicted as the "Moderate Impact Area" (Figure 5). The benthic communities in the Moderate Impact Area appear healthy. Because active cleanup might result in greater net negative impacts through destruction of existing habitats than if not remediated, long-term monitoring is proposed in these areas to verify that the overall health of the ecosystem (after the upland and offshore cleanup activities are completed) is remaining the same or improving."

COMMENT: NOAA supports the proposal not to require active remediation of these areas on the basis that EPA will require long-term monitoring to demonstrate whether this decision continues to be protective. It is recommended that this monitoring be coordinated with the long-term monitoring of benthic communities in remediation areas that are dredged and/or capped to make efficient use of equipment and labor.

Pg. 13, Sec. 5.2, Ecological Risk Assessment, Groundwater: "The findings of the Task Force regarding the impact of groundwater on the sediments and waters of Commencement Bay indicate the following:

- The amount of metals currently being discharged (pre-remediation conditions) by ground-water and surface water discharges to Commencement Bay results in the exceedance of applicable water standards for certain metals (e.g., arsenic and copper) within a few feet of the shoreline. The metals load discharged to Commencement Bay by groundwater is expected to decrease after remediation because the most highly contaminated source materials will have been removed and groundwater flow to Commencement Bay will be reduced."

COMMENT: NOAA agrees with EPA's assessment and strongly supports all efforts to reduce groundwater flows through the site which would continue to transport metals into the marine environment. Early interception of the groundwater upstream of the site should be maximized , the placement of an impervious cap over the site to eliminate surface water percolation downward then seaward is imperative, and co-precipitation treatment of collected runoff waters on site should be emphasized, if this technique removes significant levels of metals. However, we want to emphasize that the only means to ascertain whether the remedial actions have reduced the discharge of metals (and metalloids such as arsenic) along the shoreline of Commencement Bay to bring them into compliance with applicable water standards is to include sampling of the shoreline water of Commencement Bay in the post-remediation monitoring. Only a well-designed sampling plan can demonstrate to all parties that the selected remedy has caused shoreline areas to achieve the applicable water quality criteria.

Pg. 15, Sec 6.1, Groundwater Cleanup Objectives:

- "Prevent discharge (to Commencement Bay) of groundwater that exceeds applicable marine surface water quality standards or background concentrations (if background concentrations are higher than the standards)."

AND: "The cleanup goal of 3.1 ug/L for copper is protective of human health and marine life in Commencement Bay. It is acknowledged, however, that the background concentration for copper in the vicinity of the Facility is 40 ug/L , and it may not be possible to achieve the 3.1 ug/L cleanup goal. If not, copper in groundwater will be managed to the 40 ug/L background concentration."

COMMENT: These statements are ambiguous. The information provided above documents that the (upgradient groundwater) background concentration for copper is higher than the acute and chronic ambient water quality criteria. On the basis of the wording of the Groundwater Cleanup Objective, this would indicate that for copper in groundwater the cleanup objective is 40 ug/L. However, the ecologic receptors and the applicable criterion apply to waters of Commencement Bay. It is questionable whether a remedy that does not lead to compliance with the water quality criteria is ecologically protective, and it is possible that even if the groundwater copper concentration is controlled to 40 ug/L, that the shoreline waters of Commencement Bay will not meet the water standard. There are other sources of copper (and other metals and metalloids) contamination along the shoreline such as contaminated surface water runoff and the large deposits of slag, but these sources also are affected by former actions of Asarco.

It is the position of NOAA, as the federal Natural Resource Trustee for marine organisms and habitats, that a goal of the overall remedy should be the attainment of water quality criteria for the protection of marine life in all areas of Commencement Bay affected by former site smelting, manufacturing, and/or disposal activities.

Pg. 16, Sec 6.1, Groundwater Cleanup Objectives:
- "Long-term monitoring"

COMMENT: NOAA recommends that this be amended to read; "Long-term monitoring of groundwater and (Commencement Bay) receiving water" in order to demonstrate that the water column used by marine organisms along the shoreline of Commencement Bay is protected by the remedy.

Pg. 21, Sec 7.1 Groundwater: "No remedial action is planned for the Slag Peninsula area (approximately 85,000 yd^2 or 17.5 acres) because the water depths and steep slopes make capping or dredging technically impracticable."

COMMENT: NOAA supports EPA's position of not trying to actively remediate the steep portions of the Slag Peninsula Unit located in deep water. Conventional capping techniques do not appear to be productive because of the steep slopes and water depths. NOAA prefers intertidal and shallow subtidal capping to be placed only when equivalent (or more) fill is removed so that there is no net loss of aquatic habitat; for that approach to be used on the slag peninsula it would require the removal of too much of the peninsula before reaching gentle enough slopes for the capping material to repose in perpetuity. We are unaware of any other cost-effective and environmentally-sensitive remediation technology to solve these problems.

Pg. 22, Sec. 8.1 Overall Protection of Human Health and the Environment, Groundwater: There isn't any discussion of how the range of alternatives will protect the environment of Commencement Bay, which receives the discharging groundwater. The marine habitat of Commencement Bay is composed of the waters of Commencement Bay as well as the sediments.

Pg. 23-24, Sec. 8.2 Compliance with Federal and State Environmental Standards, Groundwater: "Samples of Commencement Bay water collected at the shoreline confirm that current laws for marine water quality are not currently met at all locations and at all times. However, metals concentrations in groundwater flowing toward the shoreline are expected to decrease in future years in response to the site-wide changes (i.e., reduced groundwater discharge) affected by the cleanup. These changes are expected to allow state and federal laws to be met at the end of the remedy."

COMMENT: NOAA agrees with the preceding analysis and believes that monitoring of water quality along the shoreline, where contaminated slag will remain in place, is necessary to demonstrate that the remedy has resulted in compliance with Federal and State Environmental Standards for the waters (and habitats) of Commencement Bay. NOAA recommends that the Washington State Water Quality Criteria for protection of marine life be utilized as benchmarks for protection of the water column component of marine habitat.

Pg. 25, Sec. 8.3, Long-Term Effectiveness and Permanence, Sediment: NOAA agrees with the analysis in the Proposed Plan and supports the preferred approach which is to dispose dredged contaminated sediments in the upland containment facility with other contaminated materials. The consolidation of contaminated site materials into a few engineered upland facilities is expected to make long-term operation, maintenance and monitoring of these disposal facilities more efficient and reliable than would disposal into near-shore or sub-aquatic disposal facilities.

Pg. 29, Sec. 9.2.1 *In Situ* Sediment Capping: "*In situ* capping is the Preferred Alternative for the Nearshore/Offshore area and Northshore area. Approximately 88,000 sq. yd. (18 acres) of existing contaminated sediments in the Nearshore/Offshore area will be capped with a minimum of 1 meter of clean sediment from an upland source and approximately 7,000 sq. yd. (1.5 acres) of existing contaminated sediments in the Northshore area will be capped with a minimum of 1 meter of clean sediment. The cap thickness will be designed such that it provides chemical isolation, is stable, and provides a cap surface that will allow recolonization of benthic communities."

COMMENT: While NOAA was originally pessimistic about the feasibility of capping the contaminated sediments in the remaining Nearshore and Offshore Units, the initial results of the Pilot Project supports this approach. Obviously, a fairly coarse material (sand and gravel) will be needed; such materials are often low in organic content(usually in the silt and clay fractions). However, it would be desirable if there is some way that increased organic content could be incorporated into the capping material to enhance biological repopulation. This is a challenge since the organics are usually associated with the finer components which can be swept away by the currents during emplacement. EPA should keep the goal of benthic recolonization in mind during design.

NOAA believes that nothing less than a 1-meter cap will effectively isolate contaminated sediment at the ASARCO site. One of the objectives for the sediment component of the remedy is "Restore and preserve aquatic habitats by limiting and/or preventing the exposure of environmental receptors to sediments with contaminants above Washington State Sediment Management Standards (SMS, WAC 173-204)" (See bottom of pg. 16). In order to accomplish this goal, the habitat value of the sediments must be restored. It is likely that burrowing organisms will recolonize the cap material soon after it is placed, as occurred in the pilot study cap at the site (see the monitoring reports prepared for Asarco by Parametrix, Inc.). One organism thought to inhabit the sediment offshore of the Asarco facility is a ghost shrimp (also called mud shrimp). This organism is known to construct burrows 2 feet deep (Garman, personal communication). Other researchers report that ghost shrimp burrow to a depth of three feet (Ricketts and Calvin, 1962). Bases on this information, we conclude that one meter is the minimum cap thickness that would be effective. It is necessary to isolate contaminated sediment from ghost shrimp and other burrowing organisms to prevent the biota from facilitating transfer of the contaminants to the sediment surface, the water column, and to higher trophic level organisms.(G. F. Riedel et. al., 1989).

Pg. 30, Sec. 9.2.2 Yacht Basin: "For the dredging alternative, the material would be dewatered, and then placed in a controlled, upland location (known as Crescent Park, in the central part of the upland Facility), that will be monitored for many years. This allows for the long-term effectiveness of the remedy to be monitored. Further, the mobility of the contaminants would be reduced, as the sediment would be in a location that does not have contact with water. There will also be contingency plans should the upland cap begin to fail (i.e., get cracks in it)."

COMMENT: NOAA supports the preferred alternative because it permanently removes contamination from a site area that is perturbed by marina activities and only dredging to remove the contamination will allow the marina to continue operations in the future without restrictions on dredging. In addition, isolating the contaminated materials in an upland facility with contingencies for any incipient failure of the containment structure should be easy to monitor and implement because these upland site areas also will be used for isolation of contaminated soils and/or debris.

I hope that these comments are useful to you in reaching a final decision for the cleanup of contaminated groundwater and sediments at the Asarco facility. We look forward to reviewing the design, and especially wish to review the monitoring plan. If you have any questions about NOAA's comments, you may contact me (206/553-2101) or Gayle Garman (206/526-4542).

Sincerely,

Helen E. Hillman

Helen Hillman
Coastal Resource Coordinator

cc: Alyce Fritz, NOAA/ NOS, file copy
Gayle Garman, NOAA/NOS
Robert Clark, NOAA/ NMFS/RC
Robert Taylor, NOAA/GCNR
Rachel Friedman, NOAA/NMFS/HCD
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Michelle Wilcox, WA Dept. of Ecology
John Carleton, WDFW
Bill Graeber, WDNR
Bill Sullivan, Puyallup Tribe
Glen St. Amant, Muckleshoot Tribe

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ASARCO

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APR 03 2000
Environmental Cleanup Office

Thomas L. Aldrich
Site Manager
Tacoma Plant

March 27, 2000

Mr. Lee Marshall
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, ECL-113
Seattle, WA 98401

RE: Response to EPA's Proposed Plan
Asarco Sediments/Groundwater Operable Unit
Surface Water Drainage and Control – (1103)

Dear Mr. Marshall:

In January EPA submitted a Proposed Plan for the sediments/groundwater clean up. Attached are Asarco comments. Asarco appreciates the opportunity to work with EPA and resolve any outstanding issues on the Preferred Alternative.

Please contact Dave Nation or me to further discuss these issues.

Very truly yours,
ASARCO Incorporated

Thomas L. Aldrich
Site Manager

Enclosures

cc: Bruce Cochran - Washington Dept. of Ecology
David Nation, Hydrometrics
Doug Holsten, CH2M Hill
Don Weitkamp & Jim Good, Parametrix

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Environmental ... Office

Asarco Comments on:
EPA's
Asarco Sediments and Groundwater Proposed Plan
(January 2000)

General Comments

Overall, the Proposed Plan and Preferred Alternative for sediment and groundwater looks very much like what Asarco and EPA have been working towards for a long time. However, there are several areas of the Proposed Plan that should be clarified or revised to make the Plan more easily implemented while maintaining the protectiveness of the Plan. The main areas where Asarco believes the Proposed Plan should be improved are:

1. Definition and identifications of impacted sediment areas
2. Sediment cleanup objectives
3. Sediment cap thickness
4. Sediment monitoring requirements
5. Source of sediment capping material
6. Arsenic and copper Remedial Goals and compliance point
7. Need for additional groundwater capture
8. Treatment of surface water baseflows

Definition and Identification of Impacted Areas

As Asarco understands the Expanded RI/FS data and the Proposed Plan, all impacted areas that require remediation and can practicably be remediated will be remediated. However, the use of the terms "moderately impacted" and "minimally impacted" in the Proposed Plan are potentially misleading and may imply that some impacted areas will not be remediated. These terms also seem to ignore the sophisticated approach that EPA and Asarco have taken to identify and characterize areas with contaminant effects. Asarco would prefer that areas simply be identified as "impacted" and "non-impacted" as determined by the preponderance of evidence approach and the extensive sediment effects data.

The approach to identification of impacted areas presented by Asarco in Phase 1 of the Expanded RI/FS was substantially more complex and complete than the approach described in the Proposed Plan. In comparison to the Phase 1 approach, it is extremely simplistic to use "...benthic results...to identify the most highly impacted areas...". Asarco prefers to base impact determinations on all of the detailed sampling and data analysis work that Asarco and EPA have conducted rather than the highly simplistic approach described in the Proposed Plan, which is only a slight modification of the Sediment Management Standards (SMS).

In Phase 1, Asarco evaluated measures of chemistry, bioassays, benthic community results and other types of sampling (e.g., pore water chemistry, pore water bioassays, tissue chemistry, sequential extraction analyses of slag) to determine those measures that appeared to be most highly correlated. The benthic results were evaluated in many ways including relatively simplistic SMS measures and much more powerful data analysis tools (e.g., proportional similarity index and principal coordinates analysis). All of these measures were evaluated and chemistry, sediment bioassays, and numerous measures of benthic abundance and diversity were used in the final preponderance-of-evidence approach. In this approach, some benthic community measures were given greater weighting than other benthic measures, sediment bioassays, and chemistry. Bulk sediment chemistry results were given the least weight in the preponderance-of-evidence approach. Some other evidence was judged to be inappropriate for use in cleanup decisions.

The purpose of the preponderance-of-evidence approach was to define those areas exhibiting contaminant effects. No "moderate impact areas" were defined in the Phase 1 Report. The preponderance-of-evidence either "tipped the scale" into contaminant effects designation or it did not. Thus, one significantly different bioassay result or a particularly high chemistry result does not indicate a "moderately impacted" area. In such cases, the preponderance of other evidence (mainly various measures of the benthic community) indicates that this area is not impacted. Defining stations that have one significantly different bioassay and/or chemistry result as "moderately impacted" ignores all of the evidence presented in the Phase 1 and 2 Reports that clearly indicate the effects of slag may confound typical SMS interpretations of bioassay and particularly bulk sediment chemistry results. The preponderance-of-evidence approach was not designed to define "in between" or "moderately impacted" areas (see Responses to comments on Phase 1 Report). Consequently, Asarco has never agreed to the proposed definitions of moderately impacted areas.

In the Proposed Plan, the only areas that receive the designation "non-impacted" are those that do not exceed the bulk sediment chemistry Sediment Quality Standard (SQS). Asarco has collected and reported a vast amount of information indicating that where slag particles are present, bulk sediment chemistry is often irrelevant to the actual toxicity of the sediments. Some sediment stations at the Asarco site were well above the SQS and showed no other evidence by any measure of contaminant effects, yet in Section 5.2 of the Proposed Plan these stations are defined as "minimally impacted". Because there is no evidence of contaminant effects, it is inappropriate to define these stations as impacted in anyway.

The reason described for the minimal impact designation is that the sediments "...may have impacts in the future..." However, EPA provides no scientific evidence to clarify what action or event might reasonably be expected to cause these sediments to have impacts in the future. There is no evidence available from any of the numerous studies completed to support this supposition of potential future impacts. All available information, particularly regarding slag metals availability (e.g., the sequential extraction analysis) and the present healthy state of the benthic community, do not support this supposition. Because there is no evidence that these sediments would reasonably pose future impacts, these sediments should be designated as "non-impacted".

Similarly, Asarco does not agree that stations with "minor biological CSL exceedances" should be designated as "minimally impacted". As stated in the previous comment, Asarco believes this simplistic approach ignores the preponderance of evidence for these stations (all the other benthic and/or bioassay measures) that indicate these stations are not impacted in any way. These stations should also be designated as "non-impacted".

Finally, consistent with the above comments, the remediation area should be defined simply as "impacted stations" not "severely impacted stations."

Sediment cleanup objectives

The Proposed Plan describes the sediment clean up objectives for remediation as the State Sediment Management Standards (SMS). Asarco agrees that the SMS may be a useful relatively simple initial measure that can be used as a guideline of the success of the remediation. However, it should not be the sole determination of whether the remediation is successful as defined in Section 6.2 of the Proposed Plan.

As discussed above, the SMS uses bulk sediment chemistry, bioassays, and relatively simplistic measures of benthic abundance. Both the data analysis presented in the Phase 1 Report and EPA's own methodology for determining contaminant effects areas presented in the draft Proposed Plan go beyond the simple SMS approach. It is therefore unreasonable to go back to the SMS approach when evaluating the success of remediation.

If the physical and chemical properties of the sediments (e.g., particularly slag particles) can confound the determination of cleanup areas, they can certainly confound the determination of cleanup success. To be consistent with all of the knowledge gained on Asarco sediments over the years, an achievable reasonable sediment cleanup objective must allow for these potentially confounding effects and go beyond a simple SMS type approach.

Asarco recommends that a preponderance of evidence approach as presented in the Phase 1 Report be used to determine the cleanup success. Because this approach may require extensive sampling and data analysis, cleanup success could be determined through a tiered process. The tiered process would use progressively more complex and accurate analyses to determine whether the sediments have indeed been cleaned up similar to PSDDA and the SMS itself. One possible approach would be as follows:

Tier 1. Compare bulk sediment chemistry to SQS values. If sediment chemistry is below SQS, then cleanup objective has been met. If sediment chemistry is above SQS, proceed to Tier 2.

Tier 2. Conduct bioassays (suite to be determined) and compare results to reference sediments (similar to SMS). If bioassays not significantly different (exact criteria to be determined) from reference, then the cleanup objective has been met. If bioassays are significantly different, then proceed to Tier 3.

Tier 3. Conduct benthic community analysis and analyze various measures (to be determined but similar to Phase 1 Report) of abundance and diversity. (In this case the simple SMS benthic measures might be used but some other more complex data analysis must also be included).

Immediately after cap construction, only Tiers 1 and 2 could be used, because no benthic community would be present. However, recourse to Tier 3 would be available several years after construction.

In addition, the use of the word "prevent" in the cleanup objective definition appears to be inappropriate. Asarco agrees that the exposure of receptors to contaminant effects can be "limited" or "minimized". However, cleanup success should not be measured in terms of absolute prevention of all exposure to contaminants to all potential receptors. It is possible that minor exposures might take place, but in overall terms the remediation would still be successful. The success of the remediation should be measure in terms of whether the entire cleanup meets the overall goals of protection of human health and the environment.

Sediment cap thickness

EPA's Proposed Plan for the Asarco Sediments/Groundwater Operable Unit provides for sediments to "be capped with a minimum of 1 meter of clean sediment from an upland source." None of the information Asarco has developed during the sediment investigations justifies the "minimum of 1 meter" thickness. Asarco is concerned that EPA has specified a considerably thicker cap than is necessary for protection of the environment of Commencement Bay and human health.

EPA proposes a minimum cap thickness rather than a nominal cap thickness as well as an increase from the 0.6 m (60 cm or 2 ft) cap proposed in the Refinement of Remedy (Parametrix, 2000) to the thicker 1 m cap. These increases represent almost twice as much cap material as originally considered by Asarco and evaluated in the pilot cap tests. Thus, the EPA proposal would be considerably more expensive than the Asarco proposal of a nominal cap thickness of 0.6 m.

No evidence has been provided by EPA that the considerably thicker cap will provide greater protection of the environment in Commencement Bay. Requiring the minimum cap thickness of 1 m requires technical or scientific justification that this increase would provide a substantial increase in protection. No such justification has been provided by EPA or any other entity in the Asarco Sediments evaluations. It appears then, that EPA's requirement for a minimum 1 meter cap is arbitrary, capricious and beyond the scope of the agency's authority given the persuasive evidence for a nominal 0.6 meter cap in the pilot study. Also, under the National Contingency Plan, selected remedies are required to be cost- effective. If a remedy is both protective of human health and the environment, and meets ARARs, it must also be cost-effective. 40 CFR § 300.430(f)(1)(ii)(D). Under the regulation, cost-effectiveness is determined by evaluating three criteria – long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, and short-term effectiveness. One then compares overall effectiveness with cost to see whether the cost is proportional to effectiveness. Both a nominal 0.6 meter cap and a minimum 1 meter cap are protective of human health and the environment and meet ARARs. However, the cost increase attributable to the minimum 1 meter cap is disproportionate to its effectiveness given that the nominal 0.6 meter cap is equally effective. If the remedy is not cost-effective, EPA can't select it.

The rationale for requirement of a minimum cap thickness of 1 m appears to have its origins in the Navy Homeport deliberations of the 1980's. At that time, deepwater disposal and capping of Everett Harbor sediments dredged from the Homeport site was proposed.

Opponents to this action maintained that a minimum cap thickness of 1 m should be required to eliminate any potential that the contaminated harbor sediments would be exposed if ghost shrimp should burrow into the cap. This was based on the theory that ghost shrimp can burrow up to nearly 1 m deep, and that their burrowing would move sufficient quantities of contaminated sediments to the surface to incur a risk to the marine environment.

Asarco has searched, but been unable to find factual information that supports this concern. There appears to be a misconception that the burrowing shrimps (ghost shrimp and/or blue mud shrimp) are a demonstrated threat to a sediment cap in Puget Sound. The potential threat of these shrimp is that their burrowing activities will lead to sufficient contaminated sediment redistributed to the surface layers of the cap to raise contaminant levels above biological effects concentrations. This would require the shrimp to:

- burrow to depths that would penetrate well into the existing sediments or
- actively burrow within the contaminated sediments moving large volumes of the contaminated sediment to the surface, or
- pump large amounts of water through the contaminated sediments extracting substantial concentrations of metals.

None of these actions are probable.

It is valuable to review what is known about the local species of burrowing shrimp. There are two species of subtidal burrowing shrimp in Puget Sound, ghost shrimp (*Neotrypaea californiensis* formerly *Callianassa californiensis*) and the blue mud shrimp (*Upogebia pugettensis*). *Neotrypaea* lives primarily at middle intertidal levels, commonly decreasing in abundance at lower intertidal elevations due to predation (Posey 1985, Posey 1986, Swinbanks and Luternauer 1987). *Upogebia* also tends to be intertidal but is found commonly at lower elevations. Both species are also found in subtidal areas. *Neotrypaea* is a deposit feeder that actively burrows in the top 10 cm of the sediments where it also constructs a single less active extension of its burrow generally about 30 cm deep, but sometimes as deep 40-50 cm (Swinbanks and Murray 1981). *Upogebia* is a filter feeder that forms a lined burrow that remains constant over time. Its burrow is Y shaped with the lower extension reaching as deep as 50-60 cm. *Upogebia* appears to actively pump water through the U shaped upper portion of its burrow to obtain food.

To our knowledge there have been no investigations demonstrating that sufficient numbers of ghost shrimp are likely to burrow to sufficient depths and move sufficient material to represent any demonstrated risk to the marine environment. We believe it is more likely that small numbers of ghost shrimp might burrow as deep as 60 cm in a cap, and that if they did the quantity of material they would move would not raise surface concentrations of metals to near the sediment quality standards. *Upogebia* does pump water through the upper portions of its burrows to provide food and oxygen. Because its burrows are lined and the active pumping is likely restricted to the upper U shaped portion of their burrows, there is little reason to expect that this water flow would extract measurable levels of contaminants even if the bottom of the burrow did extend into contaminated sediments.

Asarco has been unable to find any reports of burrowing shrimp actually changing the contaminant concentrations of sediments within a cap, or at the surface of a cap. The concern for contaminant redistribution appears to be theoretical rather than demonstrated.

Asarco also believes there is little risk in providing a 60-cm cap. Additional cap material can be added at a later date if monitoring determines there is actual evidence that ghost shrimp or other means are moving contaminants to the upper layer of the cap. The Proposed Plan (page 31) provides for the addition of material if monitoring indicates additional material is warranted.

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Sediment Monitoring

Asarco agrees that monitoring of remediated areas is needed to verify cleanup success. However, Asarco does not believe that extensive long-term monitoring of other areas is necessary and believes the cost of this monitoring is substantial given the limited benefit of monitoring non-remediated areas. Asarco believes that EPA's proposed plan for this sampling implies that the RI/FS process was somehow incomplete and that contaminant effects area have not been adequately identified. This is not true. In fact, Asarco and EPA have come to a consistent and scientifically supported decision on areas exhibiting contaminant effects. Asarco also believes that monitoring constitutes a remedial action for these areas and that EPA does not have authority under CERCLA to require actions for these non-impacted areas.

The Proposed Plan indicates that monitoring of areas outside remediation units will be conducted to "...confirm the assumptions and conditions..." used to make clean up decisions. The Plan further indicates that based on this monitoring, some further action may be needed. Sediment sampling to "confirm assumptions and conditions" regarding areas and volumes of sediments that may exhibit contaminant effects was conducted during the RI and FS studies consistent with Superfund Guidance. The primary purpose of the Expanded RI/FS process was to determine those areas that exhibit contaminant effects, and therefore, require remediation. Prior to conducting the Phase 1 sampling, an extensive monitoring plan was developed with the full participation of EPA and its consultants including methods for evaluating the results of that sampling. It was agreed at that time that a "preponderance-of-evidence" approach would be used to evaluate the numerous types of sampling and data analysis that were conducted. This original concept is entirely consistent with the Superfund RI process, which should define the areas and volumes of contaminated materials to be remediated. It has been Asarco's position since completion of the Phase 1 Report that the sampling and analysis effort provided more than sufficient information to determine areas where action such as remediation is needed (with some exceptions in the marina and north shore areas, which were addressed in subsequent sampling).

Under CERCLA Section 104, EPA can take action when a hazardous substance is released into the environment or threatened to be released. EPA can also take action if a there is a release or threat of a release of a pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare. A "pollutant or contaminant" is anything that, when released into the environment and "upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains will or may reasonably be anticipated to cause death, disease ..." or problems with the organism or offspring. 42 USC § 9601(33).

The metals in the sediments outside the contaminant effects area have not been released (they are in the slag matrix), nor are they likely to be released. Moreover, the metals in sediments are not pollutants or contaminants because they are not causing effects. If there is neither a release nor a threatened release of hazardous substances, contaminants or pollutants, the agency cannot compel remedial or response action.

Source of capping material

The Proposed Plan specifies an upland source of capping material. There is no justification for specifying that the cap material be derived "from an upland source" and nothing that should preclude an aquatic source of material. Cap material from an aquatic source would be as suitable or more suitable than material from an upland source for biological colonization. There should be no difference in the effectiveness of contaminant isolation with either an upland or an aquatic source. Appropriate material may be available at a lower cost from a marine source. Asarco believes the location and selection of capping material is a Remedial Design task and that the Proposed Plan should not preclude aquatic sources of capping material.

Dredging depth in the marina
The Proposed Plan describes dredging to a depth of approximately 2 feet. This is an acceptable depth to use to develop a conservative estimate of dredging volume. However, it needs to be made clear that actual dredging depth will depend on the actual depth of contamination that is verified to be present during Remedial Design and during actual dredging. There is no evidence of sediments exceeding cleanup screening levels (CSLs) below a depth of 1 ft in the marina.

As part of the Phase 2 Expanded RI/FS, subsurface sediment chemistry core samples were collected by divers at stations 5-0 and 5.5-0 in the yacht basin (Parametrix 1996). The upper layer of sediment that contains metals higher than CSLs was visually distinctive from the deeper sediments that did not exceed CSLs. Cores were observed to contain black sand in the upper 0.4 ft and gray sand from 0.4 to 1.9 ft. Core samples from the upper 1.0 ft exceeded CSLs for arsenic, copper, and zinc. Samples from 1.0 to 1.9 ft were below CSLs.

Divers collected two additional core samples from the shallow, shoreward side of the basin in 1997. Rather than dividing the cores into 1-ft segments, these cores were sectioned according to visually distinctive changes in sediment type. The core from station 5-0.9 was described as a dark olive colored sandy gravel in the upper 17 cm (0.6 ft). The 17 to 18 cm section was gravel with shell debris. Copper exceeded the CSL in the upper section and all metals tested were below CSLs in the 17 to 18 cm section. The other core sample contained olive colored fine sand in the upper 21 cm (0.7 ft). The 21 to 37.5 cm section (0.7 to 1.2 ft) was silty sand with gravel and cobbles. The upper section exceeded CSLs for copper and mercury and the lower section was less than the CSLs for all metals analyzed.

Additional core samples will be collected in the spring of 2000 as part of the preliminary design analyses for yacht basin dredging. These analyses will help determine whether metals exceeding CSLs are limited to the upper 1 ft of sediments, or if deeper sediments exceed CSLs in any areas of the yacht basin.

Arsenic and Copper Remedial Action Objectives, Remediation Goals, and Compliance Points
Asarco strongly prefers that the Preferred Alternative and Proposed Plan result in attainment of Remedial Action Objectives and Remediation Goals (RGs). Asarco's primary concerns regarding the attainment of RAOs and RGs are:

1. The Remedial Action Objectives for groundwater do not match the RAOs of the Asarco Tacoma Smelter Facility Record of Decision ("Upland") ROD. Since the remedial action is being, and will continue to be, implemented as part of the Upland ROD, it appears that the remedial action must "serve two masters".
2. RAOs are overly broad and ignore site-specific information about the risk from arsenic.
3. The compliance point for attainment of RGs is not specified. Depending on location of groundwater compliance points the RGs may not be attainable.

To remedy these concerns, Asarco proposes that:

- the RAOs for groundwater in the Proposed Plan should complement the RAOs for groundwater in the Upland ROD;
- the RG for arsenic should be based on EPA's Site-specific risk assessment that indicates existing groundwater discharges to Commencement Bay do not cause unacceptable risks to human health and the environment; and
- the compliance point for groundwater discharges should be identified as the point of discharge (i.e., post-remedial action groundwater/seawater interface).

Specifically, Asarco proposes the following groundwater RAOs:

1. Prevent ingestion of potable groundwater containing concentrations above Federal MCLs and direct contact with groundwater containing contaminants in concentrations above risk-based goals.
2. Reduce discharge to Commencement Bay of groundwater that exceeds applicable marine surface water quality standards, risk-based levels protective of human health, or background concentrations (if background concentrations are higher than the standards).

Asarco proposes an arsenic remediation goal of 0.012 mg/L based on maintenance or improvement of groundwater arsenic concentration at the slag shoreline.

Asarco proposes a compliance point of surface water along the face of the post-RA slag shoreline.

Remedial Action Objectives

The Proposed Plan modifies the earlier RAOs in the Upland ROD for the Site making them overly broad and inappropriate. EPA's remedial action objectives (RAOs) for groundwater in the Proposed Plan are as follows:

1. Prevent ingestion of or direct contact with groundwater containing contaminants.
2. Prevent discharge (to Commencement Bay) of groundwater that exceeds applicable marine surface water quality standards or background concentrations (if background concentrations are higher than the standards).

For comparison, the Upland ROD RAOs are:

1. Prevent ingestion of potable (Class IIB) groundwater … containing contaminants in concentrations above ARARs or above risk-based goals when ARARs are not protective or not available.
2. Reduce discharge to Commencement Bay of contaminated waters containing contaminants in concentrations above ARARs or risk-based goals when ARARs are not protective or not available.

As written, Proposed Plan RAO #1 is neither achievable nor necessary. EPA has substituted "groundwater" for "potable groundwater" and "groundwater containing contaminants" for "groundwater … containing concentrations above ARARs…" All groundwater, everywhere, contains "contaminants" but that is not a problem for human health or aquatic life unless concentrations are too high (i.e., above ARARs or risk-based goals). As written the RAO is so broad that it is nearly meaningless and gives no direction to the goals that are to be achieved.

Compared to the Upland ROD RAOs, Proposed Plan RAO #2:

- substitutes "prevent discharge to Commencement Bay of groundwater" for "reduce discharge of contaminated water"; and
- substitutes "background concentrations" for the phrase "risk-based goals when ARARs are not protective or not available".

Prevention of discharge of groundwater from the Site is not technically possible. However, the Preferred Alternative will reduce the discharge of groundwater from the Site to the extent practicable and will reduce the discharge of contaminants to levels that are clearly protective of human health and the environment.

Background concentrations are not appropriate substitutes for risk-based goals for arsenic since Site-specific risk information and protective risk-based goals are available. The Proposed Plan correctly points out that

> *"Neither the Maximum Contaminant Limits (MCLs) promulgated under the Federal Clean Water Act nor the State of Washington Model Toxics Cleanup Act (MTCA) groundwater cleanup levels are considered Applicable or Relevant and Appropriate Requirements (ARARs) for the shallow groundwater system at the Facility." page 15, Proposed Plan*

In this case, it is appropriate to use risk-based levels and EPA correctly notes that:

> *"Currently, the groundwater discharging to Commencement Bay will exceed human health risk based levels for fish consumption (0.14 µg/L for arsenic) (National Toxics Rule; CFR 40, § 131.36). However, past fish tissue sampling indicates low risk from Facility contaminants even to people consuming large quantities of fish from the Facility." page 15, Proposed Plan*

However, the RAO and RG for arsenic fail to acknowledge EPA's uncertainty in the National Toxics Rule (NTR) fish consumption limit and fails to acknowledge EPA's Site-specific data and risk assessment. The NTR does not reflect the current understanding of arsenic health risks. EPA has been reviewing the NTR arsenic criteria for several years with the intent to revise the criteria. EPA's risk assessment indicates that existing risk from fish consumption is acceptable and will be lowered further by implementation of the Preferred alternative.

CERCLA Section 121(d)(2)(B)(i) provides a standard for determining whether or not any water quality criteria under the Clean Water Act is relevant and appropriate. In making this determination, Section 121 directs that the Agency:

> "... shall consider the designated or potential use of the surface or groundwater, the environmental media affected, the purposes for which such criteria were developed, and the latest information available."

The existing human health criteria for arsenic in the NTR does not reflect the latest information available and does not consider Commencement Bay, the environmental media affected. EPA is currently in the process of revising the human health criteria for arsenic in the NTR. Recent information on arsenic risks in Commencement Bay are available in EPA's risk assessment entitled "EPA Ecological Risk Assessment and Seafood Consumption Screening Risk Assessment Asarco Sediment Site – October 1996." Given the uncertainty in the NTR arsenic level and the existence of more recent Site-specific data, Asarco believes that the NTR arsenic level should not be an ARAR for the Site in accordance with CERCLA Section 121(d)(2)(B)(i). In establishing the RAO for arsenic in groundwater, EPA should consider the latest information on the environmental media affected. The latest information available is EPA's risk assessment on Commencement Bay. Asarco proposes that the RAO be revised to include the use of risk-based limits for arsenic.

Remediation Goal for Arsenic in Groundwater

For current arsenic risks EPA's risk assessment (EPA, October 1996) concluded:

1. The potential for adverse non-cancer health effects associated with ingestion of fish caught near the site is low (i.e. at or below the hazard quotient benchmark value of 1.0).
2. For the reasonable maximally exposed individual, inorganic cancer risk estimates are close to but not greater than the upper end of the risk management range recommended in the NCP (1×10^{-6} to 1×10^{-4}) at fish ingestion rates greater than approximately 150 grams per day.
3. For the average case individual, inorganic cancer risk estimates are within or below the NCP risk management range at all fish ingestion rates considered.

Or as summarized by EPA in the Proposed Plan:

> *"... past fish tissue sampling indicates low risk from Facility contaminants even to people consuming large quantities of fish from the Facility." page 15, Proposed Plan*

In light of Site-specific data regarding the low arsenic risk from seafood ingestion, Asarco proposes that an appropriate RG for arsenic would be based on maintaining existing arsenic concentrations in groundwater discharging to Commencement Bay. Since the Preferred Alternative will result in a substantial decrease (to the extent practicable) in the amount of groundwater flow to Commencement Bay, maintaining groundwater arsenic concentrations would result in substantial decreases in the load (or mass) of arsenic discharged to Commencement Bay. Therefore, the Proposed Remedy with Asarco's proposed RG would result in further reduction to the maximum extent practicable of the already acceptable arsenic risk.

Groundwater Compliance Point

The Proposed Plan does not specify a compliance point for groundwater discharging to Commencement Bay. Asarco proposes that the compliance point for groundwater discharges should be in the surface water as close as technically possible to the point or points where ground water flows into the surface water. After remediation, the point on the Site that is "as close as technically possible to the point or points where the ground water flows into the surface water" will be surface water along the face of the stabilized and protected slag shoreline. This compliance point of surface water along the face of the post-RA slag shoreline would protect the water resource at the point of possible human or aquatic life exposure and would comply with MTCA.

Under Washington's Model Toxics Control Act (MTCA), groundwater compliance monitoring points should be selected to be "as close as technically possible to the point or points where the ground water flows into the surface water." (WAC 173-340-720(3)(b)(v)). Furthermore, "At these sites [where the affected ground water flows into nearby surface water], the department may approve a conditional point of compliance that is located within the surface water as." (WAC 173-340-720(6)(d)). Presently, the point where groundwater flows into surface water on the Site is the face of the slag shoreline. During Upland remediation, the face of the slag shoreline will be armored to prevent erosion. After Upland remediation is completed, the point where groundwater flows into surface water on the Site will be the face of the armored shoreline. Therefore, the proposed groundwater compliance point is surface water at the face of the post-RA shoreline.

Additional groundwater capture

The Proposed Plan delays a final decision on the need for additional groundwater controls pending additional remedial design analysis. Asarco believes that the existing information demonstrates that additional groundwater controls are not appropriate and that ongoing evaluations during Remedial Design are unnecessary.

The hydrologic analyses of the feasibility of additional upgradient groundwater controls have been completed and draft reports have been submitted to EPA. These analyses demonstrate that additional groundwater controls would capture negligible amounts of additional groundwater and contaminants. Capture and treatment would reduce some, but not all metal concentrations in the captured groundwater and would eliminate the current reduction in arsenic concentrations provided by natural attenuation on the Site. Therefore, little or no environmental benefits would be realized by the additional groundwater capture. Costs associated with constructing an interception system and the additional treatment costs would be substantially and disproportionately expensive relative to the environmental benefit received.

Treatment of Captured Groundwater

The Proposed Plan presumes that treatment of groundwater will be necessary. The Proposed Plan should clearly state that treatment is not required unless treatment is necessary to meet Remediation Goals. Moreover, it is important to note that:

- Design of the stormwater treatment system is an Upland Remedial Design task.
- Design of the stormwater treatment system is based on treating stormwater, not groundwater.
- Design of the stormwater treatment system is ongoing.

Therefore, the Proposed Plan needs to be flexible regarding treatment of groundwater by the yet to be designed stormwater treatment system. One area in which the Proposed Plan may unduly constrain design of the surface water treatment system regards the treatment of groundwater during baseflow (i.e. non-stormwater flow) periods. The Proposed Plan needs to allow the potential for bypass of captured groundwater from treatment during baseflow periods if such bypass is consistent with stormwater treatment.

Specific Comments

Page 3, 5th bullet. This bullet states that Asarco will monitor the dredged area "...to ensure that it is not becoming recontaminated." Asarco is responsible for recontamination, if any that originates from the Site, but cannot ensure that the Yacht Basin will not become recontaminated from marina activities.

Page 4, 3rd bullet. The Refinement of the Proposed Remedy Report was revised and submitted to EPA on January 5, 1999. This document should be referenced instead of the August 1999 draft.

Page 4, document list. The Copper in Nearshore Marine Water Technical Memorandum submitted to EPA on June 23, 1999 should be included in the list of documents providing additional detailed information.

Page 6, first para. Sentence states "*The shallow aquifer system beneath the Facility is largely recharged by lateral flow of groundwater from the southwest (Ruston area) and infiltration of precipitation and surface water run-on.*"

It would be more accurate to say "*The shallow aquifer system beneath the Facility is largely recharged by infiltration of precipitation and surface water run-on and to a minor extent by lateral flow of groundwater from the southwest (Ruston area)*".

Pg. 9, 3rd full para. This paragraph compares site tissue concentrations to reference tissue concentrations and ignored the sections of the Phase 1 Data Report that showed "...the site station tissue chemistry was found to be indistinguishable from the reference station tissue chemistry in all cases (see Table 8-3)." In other words, the differences were not statistically significant. Further, it is not appropriate to state that tissue concentrations are elevated without providing any risk context. Anyone that only gets this far reading the document may not learn that these tissue concentrations are acceptable using EPA's risk criteria, as stated later in the Proposed Plan.

Page 9, last full para. This paragraph seems to state that copper exceeds the marine chronic criteria (MCC) at all locations in Commencement Bay near the Site. This is not true. The best data available to Asarco and EPA indicates that copper concentrations currently exceed the MCC at about half of the sampling locations along the shoreline and only in very close proximity to the slag shoreline. At most locations, seawater a few feet away from the slag meets all aquatic life criteria for copper and all other metals.

In conjunction with the Asarco Sediment/Groundwater Task Force (ASGTF) Asarco conducted two rounds of special seawater monitoring in 1999 to determine copper concentrations in seawater near the Site. This seawater monitoring employed ultraclean sampling and analytical techniques and yielded analytical sensitivities and accuracies several orders of magnitude better than techniques previously available. Results of this monitoring were submitted to EPA in a June 1999 Draft Technical Memorandum and in a November 16, 1999 data transmittal. The ultraclean monitoring data demonstrates that copper concentrations do not exceed criteria in all samples; only samples collected near the shoreline in some areas.

Page 13, The First Bullet is incorrect regarding Task Force findings related to arsenic. The Task Force found (see page 6-5 of the March 1999 ASGTF Group 5 Technical Memorandum) that groundwater discharges currently cause water column concentrations to exceed only the copper chronic aquatic life criterion. Current water column concentrations of arsenic and other metals are better than the chronic aquatic life criterion.

Page 14, 1st para. What does "nonminimally impacted" mean?

Page 15, Remediation Goals. At a minimum it would seem appropriate for EPA to acknowledge that the NTR arsenic criteria is under revision. It might also be appropriate to establish that if the arsenic RG can not be met, then the revised arsenic criteria would be considered in determining the need for additional groundwater controls/remediation.

Page 16, 2nd para. Deep groundwater does not presently exceed MCLs or MTCA standards for any parameters except possibly arsenic (see Summary and Interpretation of 1994, 1995, 1996, 1997 and 1998 Post-RI Long-Term Monitoring Results (Hydrometrics, 1999) and Table 4-3 in Summary and Interpretation of Production Well Abandonment Action-Specific Monitoring Results (Hydrometrics, June 1997).

Page 20, Table 7-3. The note for alternative S-2D states: "As a contingency, if all the contaminated material cannot be removed from the Yacht Basin, dredging in the Basin followed by placement of clean material may occur." EPA should acknowledge that slag will remain in the Yacht Basin following dredging and that this material, though it may exceed CSLs, has been shown to not exhibit contaminant effects at other areas of the Site. It would not be possible to remove all the slag exceeding CSLs from the basin without removing the entire breakwater peninsula, and dredging at the base of the peninsula will need to be designed so that it does not destabilize steep slopes. Placement of clean material over the slag will not be necessary because the metals in slag are bound in a rock-like form and are not necessarily available to the benthic community.

Page 23, last para. The Plan states "*Modeling performed by the Task Force indicates that state and federal laws applicable to protection of marine water quality may not be currently achieved within a few feet of the shoreline for all metals.*" Although model results did indicate some metal concentrations above marine chronic criteria, the Task Force placed more emphasis on empirical data rather than model predictions in concluding impacts from groundwater. The Task Force concluded that with the sole exception of copper, groundwater discharge currently does not cause metal concentrations to be higher than marine chronic criteria (see page 6-5 of the March 1999 ASGTF Group 5 Technical Memorandum).

Page 25, 2nd para. States "*The in situ treatment and seawater injection treatment alternatives would promote chemical precipitation (i.e., "settling out") of arsenic from groundwater, thereby reducing the arsenic load reaching Commencement Bay.*" Based on the Asarco Sediment/Groundwater Task Force evaluations, the effectiveness of in situ treatment is uncertain given that seawater already oxidizes and removes arsenic to the extent practical, with the exception of the Southeast Plant area.

Page 28, bottom of page. It states "*Additional groundwater interception is being considered at the Facility, and may also be considered by EPA at a later date. The need for additional groundwater interception would be based on the results of ongoing groundwater sampling.*" Earlier in the Proposed Plan (3rd paragraph, pg. 27) it is stated that additional diversions are disproportionately expensive and would only be considered if cleanup goals could not be met. Asarco agrees that additional interception is disproportionately expensive and believes that additional interception should only be considered if cleanup goals are not met.

Page 29, 3rd para. It states "*At a minimum, monitoring wells at the downgradient perimeter of the Facility (along the shoreline) will be monitored, including wells near source areas.*" Rather than "*wells near source areas*", it would be better to say, "wells near source areas if, and to the extent compatible with, protection and maintenance of the cap."

It further states "*In addition, should the groundwater indicate high concentrations of metals, contingency actions, such as additional groundwater diversions, may be considered.*" What is meant by high metal concentrations? Above cleanup goals? Where? It is expected that concentrations will remain above cleanup goals in and near source areas but this occurrence alone should not trigger additional diversions. Given EPA's broad authority under the five year review provisions of the Upland ROD, this last sentence is unnecessary and should be deleted. If the sentence is retained, then EPA should specify the trigger criteria of "high concentrations of metals". Asarco believes appropriate trigger criteria would be remedial action objectives and remediation goals (including Asarco's proposed changes) at a compliance point located in surface water along the armored slag shoreline.

WASHINGTON STATE DEPARTMENT OF
Natural Resources

JENNIFER M. BELCHER
Commissioner of Public Lands

March 27, 2000

Mr. Lee Marshall, Project Manager
Office of Environmental Cleanup
US EPA Region 10
1200 Sixth Avenue, MS ECL-111
Seattle, WA 98101

Subject: Comments on the *Proposed Plan, Asarco Sediments/Groundwater Operable Unit, Ruston and Tacoma, Washington*, January 2000

Dear Mr. Marshall,

Enclosed please find comments regarding the Asarco Sediments and Groundwater Proposed Plan. The comments are provided on behalf of the Washington State Department of Natural Resources (DNR) and are based on a summary review of the Proposed Plan document. We appreciate the opportunity to provide input and would like to thank the Environmental Protection Agency (EPA) for extending the comment deadline in response to our letter dated February 4, 2000. It is our understanding that the comments will be considered by EPA in the determination of a cleanup plan for the site.

As trustee and land manager for public aquatic lands at the site, we rely on clear standards for use of public aquatic lands - standards that are defined in state laws and the state Constitution, in long-standing policies and strategies for implementing these laws, and in guidance developed to ensure we effectively and permanently solve current contamination and avoid future contamination.

Based on the information provided in the Proposed Plan, we believe that additional evaluation is necessary to ensure that we can meet the management standards for public aquatic lands at this site and in the bay. Specifically, we are concerned about restoration and sustainability of natural resources at the site as a component of the overall function and productivity of Commencement Bay. We are also concerned about appropriate short- and long-term land use, source control, and risk and responsibility management. The following discussion identifies a number of issues that we request receive further consideration.

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Endangered Species Act (ESA)

We anticipated that the extension to the comment period would provide the opportunity to review the Proposed Plan in the context of the Commencement Bay Biological Assessment (BA). We view the BA as critical to decision-making at all scales in the bay, including site-specific cleanup actions. Without consideration of the BA, we do not believe that our common goal of achieving cleanup in a broader ecosystem management context can be ensured. We also cannot evaluate the adequacy of the proposed site-specific remedial action in achieving ESA compliance without review by and discussion with EPA and National Marine Fisheries Service of the BA and the biological opinion. Until this information and analysis is available, we remain concerned that the effects of the proposed remedial action on critical habitats for chinook salmon are not resolved at either a site or baywide scale.

For example, we are concerned with the lack of information and guidance on the functional linkages between deep water (>-10 MLLW) epibenthic habitats and the foodweb for young-of-year and immature resident chinook salmon. Recent studies of the polychlorinated biphenyls body burdens for Puget Sound chinook and herring stocks indicate an exposure pathway link between the benthic community and the pelagic foodwebs of these species. This information argues for a very conservative approach to remediating chemicals of concern for bioaccumulation, such as arsenic and mercury.

We are also concerned that the proposal does not restore the healthy nearshore habitats, both as salmonid migration corridors and as intertidal feeding areas, that once existed at the site. In addition, we believe that decisions regarding cleanup objectives are based on incomplete information. We encourage incorporation of the latest information from the federal services - particularly results of current NMFS efforts - on cleanup standards that are protective of trust resources.

Available information suggests that numerous individuals from the White River chinook stock are expected to rear nearshore at the Asarco site for extended periods. The proposed plan does not provide sufficient information to determine the degree to which chinook salmon will be restored and protected. We encourage EPA to more actively integrate the numerous cleanup decisions necessary throughout Commencement Bay within the context of the Commencement Bay BA and biological opinion. We are interested in working with EPA on a management plan for the entire bay that defines both site-specific and baywide implementation actions, with net gain in habitat area and function being one of the primary plan objectives.

Land Use

The current proposal includes the permanent capping of contaminated sediments in place. Siting such permanent caps within the City of Tacoma Harbor Area - as the proposal currently does - is problematic in that the caps may be inconsistent with constitutional, statutory and regulatory directives.
The main issues are:

- Capping as a mechanism for contaminated sediment storage is a non water-dependent use. Non water-dependent uses in harbor areas are considered interim uses and can only be allowed if defined criteria are met (e.g., compatibility and exceptional circumstance analyses and other factors, Washington Administrative Code (WAC) 332-30-137);

- Institutional controls (i.e., Regulated Navigation Area) likely necessary to maintain the integrity of the capped areas will limit commerce and navigation in a Harbor Area. However, Harbor Areas are reserved for commerce and navigation in the Washington State Constitution; and

- Caps displace navigation and increase present navigational hazards.

In addition, some of the proposed cap appears to extend beyond the outer harbor line. This is especially problematic because Article XV Section 1 of the Washington State Constitution establishes that "the state shall never give, sell, or lease to any private person, corporation, or association any rights whatever in the waters beyond such harbor lines."

If the proposed caps are authorized, the City of Tacoma's Harbor Area will have to be adjusted, a time-consuming process subject to rules detailed in WAC 332-30-116. A Harbor Area relocation should maintain or enhance the type and amount of harbor area needed to meet long-term needs of water dependent commerce. The relocation should also maintain adequate space for navigation beyond the outer harbor line. After these findings are made, there are other issues to be considered (see WAC 332-30-116(2)).

We have identified to EPA the value of the Asarco area as an important functional component to the overall Harbor Area in Commencement Bay. We continue to encourage EPA to define a plan that recognizes this important land use role and that allows a balance between commerce/navigation and habitat functional needs. The cleanup plan should not impact the existing deep draft capability at the site or lessen the current and future capacity for structures associated with navigation and commerce.

Permanence of Proposed Remedy

The proposed plan does not define the design life for the remedy. It is uncertain how long monitoring will occur, under what conditions monitoring will be enhanced or curtailed, and what will trigger contingency actions now and in the future. These and other concerns lead to uncertainty regarding the permanence of the remedy and to questions regarding how exhaustively more permanent solutions were explored.

For example, the proposal to cap the north nearshore unit is not supported by the information and analysis. The costs shown demonstrate that dredging and upland disposal, a more permanent remedy, is less expensive. Costs associated with mitigation for habitat impacts due to cap design, as well as a number of additional costs - including potential compensation for use of public aquatic lands - not included in the existing analysis, will increase the costs associated with the capping alternative. We therefore do not support capping of this unit.

We also believe that permanent solutions such as treatment are viable. Vendors are providing treatment rates of around $29 per cubic yard. We encourage EPA to further evaluate treatment as part of the decision-making process.

For public aquatic lands, the state laws, the state Constitution, and the existing policies, strategies, and guidance for implementing these laws do not support the use of public aquatic lands for permanent storage of contaminated material. If contamination is to be temporarily stored on public aquatic lands, the worst of the contamination must be removed for treatment or upland disposal, and the remaining storage site must be designed to allow future removal for treatment or upland disposal once technology makes it feasible to do so. Neither the alternatives analysis nor the resulting proposal to cap recognizes or incorporates these standards for use of public aquatic lands.

Source Control

The proposal for the sediments unit does not adequately provide for long-term isolation of materials. For example, the porous slag slopes and incomplete armoring will result in continued release of fine-grained slag particulates to the nearshore sediments. More innovative alternatives to reduce the slopes to allow more effective armoring or to isolate the peninsula in some other way need to be more thoroughly analyzed. The benefits and total costs (including on-going source control, long-term operation and maintenance, and contingency actions) associated with all potential alternatives need to be fully evaluated in order to make well-informed decisions.

We strongly support alternatives to actively remove and treat contaminated groundwater, and we encourage a commitment to long-term, intensive monitoring to determine effectiveness of the remedy. We also encourage removal of any leaking, unused and/or abandoned pipes and any other debris or unnecessary structures along the shoreline. Finally, we would like to discuss the potential reuse of the treated groundwater as a resource for restoration of a stream delta estuary. Such a delta existed on-site prior to development. The value of these small estuaries as nodes of productivity is becoming more widely recognized. Salmonid species such as chinook, chum, and cutthroat have been documented to preferentially target these areas in their utilization of nearshore corridors. The potential for creation of a stream delta estuary appears to exist on the southeast portion of the site. Integration of planning for such a project with the remedial and damage assessment actions may provide opportunities for an improved, less expensive, more comprehensive project.

Natural Resource Damages

The facility's operations have filled and/or degraded a substantial acreage of aquatic lands. The values of the public aquatic lands for a broad range of functions and services are damaged. The proposed remedy does not restore those values, and Asarco has not proposed to compensate the State of Washington as a natural resource trustee for past and on-going losses. We will seek natural resource damages for functions and services that are not restored in order to compensate the citizens' natural resource trust values.

The extent of damages will be highly-dependent on the degree to which the functions of aquatic lands have been and will continue to be injured by slag deposition/deposits, groundwater, runoff, point discharges, and other releases of injurious contaminants. We encourage the resolution of natural resource damages claims in conjunction with the remedial action processes at the site.

Text-Specific Comments

- (Section 5.2) It is unclear how healthy biological communities are being defined. How was this determined? Diversity, abundance, both?
- (Section 6.1) What happens in the future if and when background concentrations and laboratory detection limits drop? Will cleanup goals track these drops, if they occur, until it reaches the National Toxics Rule standard of 0.14 μg/l for arsenic. Likewise for copper.
- (Section 7) What is the term of the OMMP?

- (Table 7.2 and 7.3) Alternative S-1E: Dredge and Upland Disposal has a present worth cost of $26.2 million for 88,000 cy. This is $298/cy. Alternative S-2D: Dredging and Upland Disposal has a present worth cost of $3.6 million for 55,000 cy of Yacht Basin sediment. This is $65/cy. Why is one over 4.5 times more than the other?
- (Section 8.1) Do you understand why fish tissue remained below risk thresholds even though groundwater exceeds human health risk based levels for fish consumption? If not, how can you be sure that the environmental conditions which allow this to happen will remain constant?
- (Section 8.1) Were the full range of potential organisms considered when determining the thickness of cap necessary to prevent recontamination due to bioturbation?
- (Section 8.2) The plan should require that institutional controls, maintenance and monitoring results be shared and coordinated with DNR.
- (Section 8.6) Since the following sentence claims that pump and treat is reliable and available, by "difficult" do you mean costly?
- (Section 8.7) The sentence "For all sediment areas, upland disposal is less costly than nearshore confinement" is not consistent with Table 7.2.
- (Section 9.1.1) What will be the final quality of treated groundwater?
- (Section 9.2.1) The likely static and dynamic slope stability risks indicate the need for a more permanent solution.
- (Section 9.2.4) What is the contingency for heavy erosion of the cap?

We appreciate the opportunity to provide input to EPA. We also appreciate EPA's effort to address issues. In particular, we applaud the recent discussions with local citizens about their concerns, many of which we share. We look forward to active involvement with the interested parties to resolve issues as the process moves forward. If you have any questions or concerns, please feel free to contact me at 360-902-1148, **chuck.turley@wadnr.gov** or Amy Kurtenbach at 360-902-1029, **amy.kurtenbach@wadnr.gov.**

Sincerely,

Tamara Allen for

Charles W. Turley
Assistant Division Manager
Aquatic Resources Division

c: Maria Victoria Peeler, Division Manager, DNR Aquatics
Mark Mauren, ADM, DNR Aquatics
Amy Kurtenbach, DNR Aquatics
Tammy Allen, DNR Aquatics
Kathy Marshall, DNR SPS Region
Bill Graeber, DNR Aquatics
Lee Stilson, DNR Aquatics
Tim Goodman, DNR Aquatics
Michelle Wilcox, Ecology, TCP

CITIZENS FOR A HEALTHY BAY

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March 27, 2000

Mr. Lee Marshall, Project Manager
US EPA Region 10
1200 Sixth Avenue
MS/ECL-111
Seattle, WA 98101

marshall.lee@epamail.epa.gov

Re: Former Asarco Smelter Facility
Sediment and Groundwater Remediation
Ruston/North Tacoma, Washington

Dear Mr. Marshall:

On behalf of Citizens for a Healthy Bay (CHB), an organization representing 850 members of the Tacoma and Greater Commencement Bay community, thank you for the opportunity to comment on the proposed remedial plan for Asarco Smelter site groundwater and sediments. Except as discussed below, CHB generally agrees with the remedial actions proposed for site sediments and groundwater.

Of greatest concern is that EPA defer to and enforce all Washington State cleanup standards for groundwater and sediments. As was recently proved in the findings for Asarco at the Asarco Everett facility, failure to enforce Washington State standards on one site can have adverse impacts to another site cleanup. As Asarco is a PRP for another Commencement Bay Superfund sediment cleanup action in the Hylebos Waterway, it is imperative that uniform cleanup standards be employed throughout the entire Commencement Bay cleanup area.

5.1 Human Health Screening Risk Assessment

Sediments: In determining human health risks associated with eating fish caught within the site, the low end range (1 gram per day of fish) was selected to represent the consumption of an infrequent sports fisherperson who might eat fish from the waters off the facility a few times each year. The greater Commencement Bay area hosts a number of ethnic communities who routinely fish for subsistence. Because of easy access, the waters along Ruston Way/Asarco/Point Defiance are a popular fishing spot for members of these communities. We believe that the assumption of 1 gram per day of fish does not consider the subsistence harvest practiced by members of these communities and needs to be increased accordingly.

5.2 Ecological Risk Assessment

<u>Sediment:</u>

Non-Impacted/Minimally Impacted Stations

Stations that have chemical concentrations greater than the state standards must be cleaned up to meet Washington State standards. Additionally, those areas with minor biological CSL exceedances must be remediated as well.

Moderately Impacted Stations

Stations falling within this category need to be remediated to meet Washington State cleanup standards.

6.1 Groundwater Cleanup Objectives

Background contamination levels for copper in the remedial area are held to be 40 ug/L and a question is raised as to whether groundwater cleanup levels of 3.1 ug/L can be met. However, no mention is made as to what the background levels for copper in groundwater are for the Commencement Bay area outside of the Asarco site. Presumably, the higher copper background contaminant level is directly attributable to past smelter operations, and therefore subject to remedial action to correct the problem.

6.2 Sediment Cleanup Objectives

EPA's stated cleanup objective for sediments is to restore and preserve aquatic habitats by limiting or preventing the exposure of environmental receptors to sediments with contaminant above Washington State Sediment Management Standards.

7.1 Groundwater

We agree with the stated preferred alternative GW-B involving intercepting and treating site groundwater prior to discharging into Commencement Bay. We are concerned that the remedy be scaled to handle large magnitude storm events and associated increases to groundwater.

Also, use of an on-site cap to limit infiltration of precipitation into the soil will increase the amount of stormwater runoff and contaminants commonly associated with stormwater runoff.

How will recontamination of the sediments by toxins such as PAHs, BEPs, fertilizers, herbicides, insecticides, etc. be avoided? We do not wish to see one set of problems exchanged for another.

7.2 Sediment

In addition to the remedial alternatives presented in the proposed cleanup plan, additional actions are required in the *Non-Impacted/Minimally Impacted Stations* and *Moderately Impacted Stations* to ensure that these stations are remediated to meet all State of Washington Criteria. (see 5.2 above)

9.2.4 Long-term Monitoring

Components of the long-term remedial monitoring plan must include action plans for earthquakes, high-intensity storm events, severe tide/wind storms, etc.

Citizens for a Healthy Bay urges you to consider that private citizens, aquatic communities and the improved health of Commencement Bay are the largest stakeholders in the cleanup and disposal of contaminated sediments and groundwater at the former Asarco Smelter site. As a citizen-based representative of that community, Citizens for a Healthy Bay is concerned about the decisions EPA will make regarding remediation at the Asarco site. We urge the Environmental Protection Agency to make decisions that will positively affect the primary stakeholders in the cleanup of Asarco sediments and groundwater.

We appreciate your attention to our concerns regarding this document.

Sincerely:

Leslie Ann Rose
Senior Policy Analyst
Citizens for a Healthy Bay

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Environmental Cleanup Office

Lee Marshall
EPA Project Manager
1200 Sixth Avenue
MS/ECL-111
Seattle, WA. 98101

February 17, 2000

Dear Mr. Marshall:

As a long-time resident of North Tacoma, I would like to take this opportunity to comment on the EPA cleanup of the Asarco smelter. I would like to voice my concerns about the long- term effectiveness of the proposed disposal alternatives. I can not see how capping contaminated sediments on-site with 1 meter of clean material represents a safe and reliable solution. Humans have been burying garbage for thousands of years, surely we can do better than this by now? I would like to encourage the EPA to support the development and use of improved treatment methods. I believe the government has an obligation to the future health and well being of humans and the environment to forward progressive solutions. In addition, I am concerned about the storage of contaminated sediments so near the water. Earthquakes and slides could yield potentially disastrous results. Furthermore, there is the corrosive, erosive capacity of the salt air and water to consider. Hopefully, the EPA will continue to re-evaluate conditions at the site and apply improved treatment measures as they become available. Thank you for your thoughtful consideration.

Sincerely,

Valerie Anderson

Valerie Anderson
4121 North Gove Street
Tacoma, WA. 98407

FORMAL COMMENT PERIOD
JANUARY 26 THROUGH FEBRUARY 24, 2000
FOR
Asarco Sediments and Groundwater Proposed Plan

COMMENTS BY JOSEPH A. LUCAS LONG RANGE PLANNING COMMITTEE - TACOMA YACHT CLUB

1. TACOMA YACHT CLUB SHOULD BE FORMALLY DESIGNATED AS A STAKE HOLDER IN THE DESIGN AND IMPLEMENTATION OF THE REMEDIATION PLAN FOR THE YACHT BASIN. THE CLUB WILL FORMALLY DESIGNATE A COMMITTEE TO LAISON WITH E.P.A., ASARCO AND OTHER ACTIVE PARTIES

2. EPA + ASARCO SHOULD CONSIDER DEEPER DREDGING BETWEEN THE ROAD AND A DOCK TO REMOVE CONTAMINANTS AND TO FACILITATE PASSAGE OF DEEPER DRAUGHT BOATS - CONTAMINATED SEDIMANTS HAVE ACCUMULATED FROM ASARCO PROPERTY TO FILL THIS AREA IN TO A DISADVANTAGEOUS DEGREE.

PLEASE: - Fold the page in half so that EPA's address is showing
-Tape or Staple closed
-Put on a 33 cent stamp
-Drop in the mail!

OR - Leave with us tonight

3. MAKE SURE ANY DREDGING PLAN FOR THE YACHT BASIN INCLUDES INDEMNIFICATION FOR DAMAGE TO BOATS + HOUSES AND DOCKAGE. MAKE SURE PROVISION FOR TEMPORARY MOORAGE FOR DISPLACED BOATS IS MADE AVAILABLE.

Lee Marshall, EPA Project Manager
1200 Sixth Ave, MS/ECL-111
Seattle, Wa. 98101

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Environmental Cleanup C

Going through the Fact Sheet on the Former Asarco Smelter Cleanup from Jan. 2000, I wish to enter the following written comments on the clean up.

I am a boater and live and have lived in the Yacht Basin for the last 15 yrs. from just before the Smelter shut down. I have seen the Basin so dead and hot you could almost power a light bulb, to today, where electroylsis is almost gone and sea life has come back. Years back we never had much growth on boat bottoms, now we have barnacles and mussels and growth of seaweed. What you are doing, I have faith it is a good job and see nothing to change. I only want to push 2 points that relate to me.

Re: Yacht Basin Area. The bottom is deep mud gunk. In spite of the returned sea life, this life cannot be safe do to the bottom it lives over.

And in some cases on and in.
I wish to strongly push for the dredgeing of the Basin to at least 2 ft. Absolutely no less and possibly more. I know what this stuff looks like and is.
My only other concern is the slow speed that all of the cleanup is going at. Please no more extentions. Lets just get it done!
Thank You for reading this and for your consideration.

Dave Goughnour
PO Box 7504
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MAR 13 2000
Environmental Cleanup Office

Thu;09.Mar.2000

EPA Project Manager
1200-Sixth Avenue
Seattle, WA 98101

ATTN: Lee Marshall

I recently saw an item in the Tacoma News Tribune concerning the cleanup of the old ASARCO site in Ruston. I would like to add written comments toward the process of cleaning up the wastes.

My standpoint, you must understand, comes from a metallurgical engineer who had an opportunity to tour the ASARCO smelter while a young college student. It is unfortunate to the community and the area as a whole that so much toxic substances were released into the environment in the name of progress and the almighty dollar. It should also be remembered that the plant offered employment to numerous workers during its lifetime. It was a monument to the ingenuity of metallurgists while now becoming a bane to those of us in the profession. It is demoralizing to think that the metals industry has had to cope with changes that sometimes make my training obselete.

Just as a passing thought; there are plans to remove and store in a landfill, the contaminated soils around the Ruston plant. And the Seattle-Taocma airport is looking for fill for their third proposed runway. Abra-cadabra! Why not use this soil for their fill and kill two birds with one stone? I had heard some statistics about the amount of fill needed for the SEA-TAC airport and the time needed to complete their plans, much to the consternation of the local residents.

Another thought; why not sell, for refining, the waste products from the ASARCO plant? It used to be that tailings piles from older mines would be reprocessed again and again to remove the smallest traces of valuable metals. Arsenic still has used in rodenticides. Lead is used in storage batteries. Cadmium is used in low-melting point alloys. What other treasures could be gleaned from all the waste?

The EPA plan to cover the site with non-permeable material does not take into account one thing; water seeping UP through the covering layer. This is something that must be considered in our wet Washington weather.

Men have torn down mountains to get to precious metals for a long time. If the material at Ruston is offending, why not dig out a big hole and put it back into those torn-down mountains?

These are my thoughts and suggestions concerning the treatment of the wastesite at ASARCO's Ruston plant. I hope they are doing a better job of not polluting in their new location in the southwestern USA. It was a kick in the butt to see them leave town. That was one less place I could have sought gainful employment from.

Thank you for the opportunity to comment on your proposals.

Sincerely,

Wayne C.R. Taylor, Jr.

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former President; Metalchemy, Inc.
"The Metalchemist"

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