*Volume I*

# *Remedial Investigation Report*
# *Terminal 4, Slip 3 Sediments*
# *Port of Portland*
# *Portland, Oregon*

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*Port of Portland*

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**REMEDIAL INVESTIGATION REPORT**
**TERMINAL 4, SLIP 3 SEDIMENTS**
**PORT OF PORTLAND**
**PORTLAND, OREGON**

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# REMEDIAL INVESTIGATION REPORT
# TERMINAL 4, SLIP 3 SEDIMENTS
# PORT OF PORTLAND
# PORTLAND, OREGON

## EXECUTIVE SUMMARY

Hart Crowser, under contract with the Port of Portland (Port), conducted a Remedial Investigation (RI) of the sediments surrounding Terminal 4, Slip 3 (Slip 3). Terminal 4 (T-4) is a ship loading and unloading facility located at approximately River Mile 5 on the Willamette River. The RI study area consists of the sediments located upriver at Pier 5 Willamette River Dock (Pier 5), Slip 3, and Wheeler Bay, which is immediately downriver and adjacent to Slip 3.

The RI was conducted with Oregon Department of Environmental Quality (DEQ) oversight under the DEQ Voluntary Cleanup Program. RI activities included surface and subsurface sediment sampling, chemical and bioassay testing of sediments, and surface water sampling and chemical testing. The purpose of the sediments RI was to collect data to delineate the extent of contamination in the project area and to evaluate potential risks to human health and environment posed by the presence of chemicals of potential concern (COPCs) in riverine sediments at the site. Potential sources of contamination include: current and past diesel/oil seeps into the river; potential spills from bulk handling practices; discharges from storm water outfalls in the project area; and sediment transport from outside the study area.

Surface sediment samples (0 to 10 centimeters) were collected at 44 locations, including nine surface samples collocated with subsurface sediment sampling locations. As set forth in the DEQ-approved project work plans, sediment samples were analyzed for the following:

- Pencil pitch;
- Diesel;
- Total metals;
- Total organic carbon;
- Semivolatile organics;
- Volatile organics;
- Pesticides (for a limited subset of samples); and
- Grain size.

Detectable concentrations of pencil pitch were present throughout the study area. This is likely the result of storm water runoff events from upland handling activities at the berthing areas, discharge from storm water outfalls, and transport by propwash during ship movements.

Detectable concentrations of diesel in sediment were not found to be distributed throughout the study area, but were generally found in areas associated with known diesel pipeline leaks and seeps near the head of Slip 3 and along Berth 412.

The detected concentrations of chemical constituents in sediment were also compared against the Dredged Material Evaluation Framework - Lower Columbia River Management Area (LCRMA) Screening Levels (SLs) and Maximum Levels (MLs) (Corps. *et al.*, 1998). These screening levels were developed for characterizing dredged material for open-water disposal and were used to screen sediment chemical concentrations against available risk-based sediment quality criteria. The LCRMA screening criteria do not represent regulatory decision criteria for purposes of this RI; however, the LCRMA was utilized to assess the relative magnitude of sediment COPCs.

Concentrations of total high molecular weight polycylic aromatic hydrocarbons (HPAHs) and low molecular weight polycylic hydrocarbons (LPAHs) were detected throughout the study area and exceeded the corresponding LCRMA SLs and MLs. These elevated concentrations of HPAHs and LPAHs are likely a result of pencil pitch and/or diesel.

Metals in T-4 sediments that exceeded the LCRMA SLs were zinc, lead, and cadmium. The exceedence of SLs were collocated for these three metals detected at sample locations HC-S-19 and HC-S-25. The exceedence of LCRMA SLs for zinc and lead were also collocated in subsurface sediment samples HC-VC-7-S2 and HC-VC-11-S2.

An evaluation of the impacts of sediment contamination to ecological receptors in Slip 3 was conducted using sediment toxicity testing. A suite of three sediment bioassay tests (two acute tests and one chronic test) were conducted on 16 test sediments and on two reference sediments collected during this RI. The sediment samples failing biological interpretative criteria were distributed in the eastern half of Slip 3. The samples that failed biological criteria were generally associated with higher detected concentrations of organic (diesel and pencil pitch) and some inorganic (metals) COPCs. Additionally, the sediment samples that passed biological criteria were located in areas of the Slip that exhibit low to moderate concentrations of COPCs. These results suggest sediment toxicity in Slip 3 is associated with elevated concentrations of COPCs

rather than non-contaminant-related factors (e.g., grain size, total organic carbon).

The results of the sediment bioassays were evaluated with regard to the detected concentrations of pencil pitch and diesel – the primary sources of petroleum-related constituents to the Slip. For diesel, five out of six samples containing diesel concentrations greater than 100 mg/kg failed bioassay analysis, while, for all of the samples passing bioassay testing, diesel concentrations were less than 100 mg/kg or not detected at the sample quantitation limit. For pencil pitch, the relationship between detected concentrations and bioassay results were much more inconsistent. Some of the samples failing bioassay analyses contained elevated levels of pencil pitch (HC-S-01 at 7,730 mg/kg and HC-S-04 at 1,350 mg/kg), but others contained much lower pencil pitch concentrations (HC-S-22 at 449 mg/kg). Conversely, some of the samples passing sediment bioassays contained very high concentrations of pencil pitch (HC-S-19 at 8,650 mg/kg and HC-S-24 at 4,320 mg/kg). This inconsistency could be due to the presence (or absence) of other COPCs.

Surface water samples were collected from three locations to assess the contributions of various sources (both aquatic and upland) to the water quality in Slip 3. Metals, HPAHs, and phthalates were detected at these sampling locations; however, no exceedences of Oregon DEQ acute or chronic ambient water quality criteria (AWQC) were identified for the three water samples analyzed.

The next phase of this project is to conduct a feasibility study (FS) for sediments in the project area. This FS will be coordinated with the T-4 upland operable units' FS.

## 1.0 INTRODUCTION

This report presents the results of Remedial Investigation (RI) activities conducted at the Port of Portland (Port) Marine Terminal 4, Slip 3 (Slip 3) Sediments Operable Unit in Portland, Oregon. Terminal 4 (T-4) is a ship loading and unloading facility located at approximately River Mile 5 on the Willamette River (Figure 1). The RI study area consists of the sediments located upriver at Pier 5 Willamette River Dock (Pier 5), Slip 3, and Wheeler Bay, which is immediately downriver and adjacent to Slip 3 (Figure 2). These areas define the site for the sediments operable unit. The RI activities were conducted for the Port with Oregon Department of Environmental Quality (DEQ) oversight under the DEQ Voluntary Cleanup Program. This sediments RI is being conducted concurrently with the T-4, Slip 3 Upland Operable Unit RI (Hart Crowser, 1999).

## 1.1 Remedial Investigation Objectives

The purpose of the sediments RI was to collect data to delineate the extent of contamination in the project area and to evaluate potential risks to the Willamette River environment and to human health posed by the presence of chemicals of potential concern (COPCs) in riverine sediments at the site. The RI was completed in accordance with the scope of work presented in our August 17, 1998, "Remedial Investigation/Feasibility Study Work Plan, Marine Terminal 4, Slip 3 Sediments" (Hart Crowser, 1998a) and with the October 1, 1998, letter "Response to DEQ comments on the RI Work Plan" (Hart Crowser, 1998b).

The primary objectives of the RI were to:

- Conduct chemical testing of sediments present in the study area to delineate the horizontal and vertical extent of sediment contamination;
- Collect analytical chemistry data of sufficient quality to evaluate potential risks to human health and the environment; and
- Perform freshwater acute and chronic bioassays on surface sediment samples from the site to provide a definitive assessment of risks to benthic organisms.

Other tasks conducted as part of the RI included:

- Duplicate the previous (post-dredge) pencil pitch sediment sampling and analysis program performed under the Environmental Protection Agency (EPA) 1993 Consent Decree. This will enable the Port to determine the present pencil pitch concentrations and spatial (horizontal and vertical) extent of pencil pitch in harbor sediments at Slip 3. A formal report on the pencil pitch duplication study is briefly discussed in this RI and is presented in greater detail in a separate report.
- Perform limited human health and ecological risk assessments.

Following the completion of this RI, a Feasibility Study (FS) will be prepared to determine potential remedial alternatives for sediments at this site. The FS will be coordinated with upland FS activities.

## 1.2 Report Organization

The main text of the RI report: discusses the site location and physical setting; summarizes previous site investigations, remedial activities, and dredging history; reviews the 1998 RI field activities; discusses the chemical and bioassay testing programs and results; presents the results of a limited human health and ecological risk assessments based on an exposure pathway evaluation; and delineates the area of the site requiring an evaluation of remedial alternatives. The text portion of the report is followed by tables and figures. Tables and figures are presented in the order referenced in the text.

The RI report includes three volumes that contain the report and nine appendices, which provide supporting information and documentation:

- Volume I includes the main body of the report, tables, figures, and Appendices A through F. Appendix A describes the field investigation program. Appendix B includes copies of the sediment core logs. Appendix C presents the analytical chemistry results from the surface and subsurface sediment samples collected during this RI. Appendix D presents the sediment grain size data reports. Appendices E and F present the data quality reports for the chemical analyses and bioassay analyses, respectively.

- Volume II contains Appendices G and H. Appendix G contains copies of the analytical laboratory report and certifications. Appendix H presents the bioassay laboratory report and raw data.

- Volume III includes Appendix I, which presents the hydrocarbon differentiation study prepared by Columbia Analytical Services.

## 1.3 Limitations

The work Hart Crowser performed for this project was completed in accordance with generally accepted professional practices related to the nature of the work accomplished, in the same or similar localities, at the time the services were performed. This report is for the specific application to the referenced project and for the exclusive use of the Port. No other warranty, express or implied, is made.

## 2.0 PROJECT DESCRIPTION AND SITE HISTORY

### 2.1 *Project Description*

In May 1998, the DEQ conducted a Preliminary Assessment (PA) of T-4, which identified it as a "high priority" site for further investigation and cleanup (DEQ, 1998). The PA was based upon a review of historical environmental investigations encompassing soil, groundwater, and sediments at T-4. In response to this notification by DEQ, the Port agreed to perform a RI/FS at T-4 under the DEQ Voluntary Cleanup Program. The site was divided into two operable units, the upland operable unit and the sediments operable unit. This RI addresses only the sediments portion of the RI/FS.

Local potential sources of sediment contamination include current and past diesel/oil seeps into the river, potential spills from bulk handling practices, and runoff from storm water outfalls in the project area (Figure 3). In addition, sediment contamination may be present as a result of sediment transport to the site from other areas of the river.

### 2.2 *Site History*

T-4 consists of 16 berthing areas (Berths 401 through 416) located in two slips along the eastern edge of the Willamette River. T-4 lies within the St. Johns area of North Portland on land that has been zoned for industrial use. The areas north and south of T-4 are occupied by marine, industrial, and commercial operations. The berthing areas on the river are maintained to a mudline elevation of -40 feet Columbia River Datum (CRD).

Union Pacific Railroad owned and operated a fuel loading facility at this location as early as 1906. The City of Portland's Commission of Public Docks (Commission) purchased property (117 acres) from Union Pacific Railroad in 1917 and began the initial development of T-4. In 1920, the Commission acquired a 5-acre parcel adjoining Pier 5 from the railroad. The pipeline and fuel oil dock contained within the parcel were not included in the purchase. An easement was granted by the Commission to Union Pacific Railroad for the continued use of the pipeline and fuel oil dock.

In 1920, the quay and bulk handling facility at Pier 5 and Berth 412 were constructed. Berths 410 and 411 (Pier 4) were constructed in 1955 and were outfitted with Whirley cranes. The Whirley cranes were removed in 1984. The bulk outloader Dravo was commissioned at Berths 410 and 411 in 1961. The use of the Dravo ended in 1998. In 1962, the wharf at Pier 5 was removed, and

the bulk outloader was decommissioned in 1990. The wharf at Berth 412 was removed in 1997. Presently, only Berths 410 and 411 are in use in Slip 3.

The berthing areas at Slip 3 have historically been used for bulk cargo loading and unloading operations handling pencil pitch; diesel oil; soda ash; talc; iron, lead, zinc, and copper ores; bentonite clay; coke; and briquettes. Bulk off-loading (inbound bulks) no longer occurs at Berth 410 and 411. Handling of pencil pitch was discontinued in June, 1998. T-4 presently has facilities for the handling of autos, containers, logs, lumber, grain, dry and liquid bulks, steel products, and breakbulk cargo (Century West, 1994; Donovan, 1998).

**Pier 5 Willamette River Dock.** Pier 5 was historically used as a bulk loading facility that handled: diesel oil; coal; and iron, zinc, and copper ores. Diesel oil was handled by an underground pipeline that extended from the face of Pier 5 under Berth 412 and into above-ground storage tanks east of T-4. The bulk ore shipments were moved by conveyor to ship loaders at Pier 5 and Berth 412.

**Wheeler Bay.** Wheeler Bay has not been used as a ship loading or unloading facility; however, it is connected to Slip 3 via Berth 410 and to T-4 uplands by storm drains. Therefore, this area was included in the RI to determine whether runoff from bulk handling operations at Berths 410 and 411 or storm drains may have impacted the sediments within Wheeler Bay. DEQ has also expressed concern that sediments from Slip 3 could have been transported under Berth 410/411 and into Wheeler Bay.

## 2.3 Physical Characteristics of the Site

### 2.3.1 Bathymetry

Based on 1998 bathymetry data, the mudline elevation in Slip 3 ranges from -30 feet CRD at the head of the Slip to -50 feet CRD at the mouth. The bottom of Slip 3 is relatively uniform in elevation (-40 feet CRD), with a -49 feet CRD depression in front of Berth 411. The elevation -49 feet CRD hole is a remnant of pencil pitch removal efforts and scour holes due to prop wash.

### 2.3.2 Climate

The T-4 area has a temperate marine climate characterized by wet winters and dry summers. Precipitation, temperature, and wind data are summarized below.

Precipitation (Western Regional Climate Center, 1998)

| | |
|---|---|
| Average Annual | 37 inches (mostly rain) |
| Wettest Months | November through February (greater than 4 inches per month) |
| Driest Months | July and August (less than 1 inch per month) |

Temperature (Geological Survey, 1965; Oregon State University, 1996)

| | |
|---|---|
| Average Annual | 54°F |
| Coldest Month | January (Average 40°F) |
| Warmest Month | August (Average 69°F) |
| Lowest Recorded | -2°F (January 1888) |
| Highest Recorded | 107°F (July 1942) |

Wind (Geological Survey, 1965)

Minimum Monthly Mean (October): 6 mph
Maximum Monthly Mean (Dec./Jan.): 10 mph
Maximum Recorded: 88 mph (1962)
Direction: Generally from west, but east winds are common

### 2.3.3 Regional Geology and Hydrogeology

This section is based on information from U.S. Geological Survey (1965) and U.S. Geological Survey (1993) reports.

**Geology.** The T-4 area is located at the mouth of the Willamette Valley near the confluence of the Willamette and Columbia Rivers. The Willamette Valley is a broad structural basin bounded on the east by the Cascade Range and on the west by the Coast Range. The most recent geologic evaluation of the area has identified eight regional geologic units, four of which are present beneath the T-4 area. From the ground surface downward, these units are:

- *Unconsolidated Sedimentary Rocks.* Pleistocene catastrophic flood deposits ranging in size from gravel to silt; including fill placed on the site, this unit is about 80 feet thick.
- *Troutdale Gravel.* Composed of poorly to moderately cemented sandy conglomerate; estimated 100 feet thick beneath the site.
- *Undifferentiated Fine-grained Sediments.* Clay and silt with sand lenses that has not been specifically identified as one of the other units, usually because of lack of information.
- *Older Rocks.* Miocene and older volcanic (Columbia River Basalt) and marine sedimentary rocks (Sandy River Mudstone).

**Hydrogeology.** Aquifers in the unconsolidated sedimentary rocks are generally unconfined and localized because of heterogeneity of the deposits. Water quality and hydraulic conductivity are highly variable. The Troutdale Gravel is used regionally for water supply. Aquifers in the Troutdale Gravel are generally confined with interbedded claystones acting as aquitards.

### *2.3.4 Willamette River Hydrology*

The study area is located within the Portland Harbor section of the Willamette River, which represents the river's final reach prior to its confluence with the Columbia River. The Portland Harbor has been heavily developed with many docks and marine facilities designed to accommodate large, deep draft commercial ships in this section of the river. Deepening and widening of the main river channel have significantly altered the morphology of the lower Willamette River (Port of Portland, 1998).

Streamflow throughout the Willamette River basin is dominated by the seasonal rainfall patterns. The low-flow period runs from July through September, and the high-flow period runs from November to April (Anderson *et al.*, 1996).

Water surface elevations in Portland Harbor fluctuate on a daily basis, mainly due to daily tidal fluctuations in the Columbia River. Tidal fluctuations also result in the movement of Columbia River water into the Willamette River. These tidal fluctuations can also result in a reversal of water movement in the lower portion of Portland Harbor and in stagnation points where the water velocities in Portland Harbor are zero.

As water moves downstream through Portland Harbor, it slows as the river widens and as the hydraulic gradient flattens near the mouth of the Willamette River. Water velocities in Portland Harbor are low compared to those measured upstream and in major tributaries of the Willamette River.

## *2.4 Previous Investigations*

Previous sediment chemistry investigations at T-4 have focused on Slip 3 because of its historical and continued use as a bulk handling facility. Information about the sediment investigations based on the year the studies were performed are described below. In addition, Figure 4 identifies known sample locations from each sediment study since 1994.

**1988.** The Port conducted vertical and horizontal sediment sampling and analysis to delineate the areal extent of chemical concentrations at Slip 3

(Port of Portland, 1994). The study included obtaining 28 surface grabs that penetrated to a depth of 10 centimeters (cm) and six subsurface cores. The sediments were analyzed for concentrations of pencil pitch, PAHs, metals, pesticides, oil and grease, grain size, and polychlorinated biphenyls (PCBs).

Sediment chemistry results from this study indicated that pencil pitch ranged from <1 to 22.8 percent in Slip 3 near Berths 410/411 and was confined to the upper 10 to 15 cm of the sediment column. Trace metals were present in the samples analyzed with zinc and lead detected at the highest concentrations. PAHs were elevated in both surface and deeper sediments.

**1993 and 1994.** Historical bulk handling and dock cleanup activities at Berths 410 and 411 resulted in non-permitted discharges (spills) of pencil pitch to the sediments. The spills resulted in a Federal Consent Decree issued by the EPA, dated May 7, 1993, requiring that the Port cease all non-permitted discharges of pencil pitch and remediate the sediment concentration of pencil pitch to below 0.5 percent dry weight. In response to the Federal Consent Decree, the Port conducted a sediment investigation to better delineate the depth distribution of contaminants in Slip 3. Ten sediment cores (to a depth of 305 cm) were collected, and the sediment samples were tested for total metals, Toxicity Characteristic Leaching Procedure (TCLP) metals, and PAHs. In addition, SCUBA divers collected surface sediment samples for pencil pitch analysis (Port of Portland, 1994).

Results indicated that petroleum constituents were generally restricted to the top 30 cm; however, some contamination is present deeper in the sediment column. TCLP tests indicated that the sediment metal concentrations are not high enough for the sediments to be considered hazardous wastes. The Port used results of this study to design the dredging and disposal plan for remediation of the pencil pitch-contaminated sediments that was completed in 1995.

Sediments in Slip 3 containing greater than 0.5 percent pencil pitch were dredged in 1995. Dredging activities removed approximately 35,000 cubic yards of material.

**1997.** Four separate sampling events occurred in Slip 3 in 1997. Summaries for these studies are presented below.

- *Event 1.* A sediment characterization study was conducted as part of the Port's maintenance dredging requirements at Berth 410 (Hart Crowser, 1997a). Results of this study indicated that the PAHs and metals concentrations in sediments exceeded Puget Sound Dredge Disposal

Analysis (PSDDA) SLs and were not suitable for open water disposal. Sediment chemical concentrations were compared to PSDDA because the State of Oregon did not have sediment quality criteria at that time. Subsequently, the Port received an Army Corps of Engineers (Corps) permit for confined in-water disposal at Ross Island.

- *Event 2.* One Dravo bucketful of pencil pitch containing an estimated 50 to 1,000 pounds of pencil pitch was spilled in the vicinity of Berth 411 during a Hall Buck Marine unloading operation. A preliminary removal action was undertaken in July 1997, using a hydraulic dredge to remove pencil pitch from the area most likely contaminated by the spill (Hart Crowser, 1997b). However, surface sediment samples collected after the removal action revealed that pencil pitch concentrations in excess of 0.5 percent remained. A subsequent study was conducted to further delineate the horizontal extent of pencil pitch and to assess the need for future remedial activities at the site (Hart Crowser, 1997b). The study delineated the extent of pencil pitch contamination above 0.5 percent. The pencil pitch-contaminated sediments were dredged in August 1998 by Hall Buck Marine with DEQ oversight.

- *Event 3.* As part of the Portland Harbor Study, the DEQ and EPA conducted a port-wide sediment characterization study that included the T-4 study area (Roy F. Weston Inc., 1998). The Portland Harbor Study was designed to assess the overall chemical contamination of sediments in the lower Willamette River from River Mile 3.5 to 9.5. Seven surface sediment samples (25, 27, 29, 31, 32, 33, and 34) and one subsurface sample (31) were collected from the T-4 study area primarily within Slip 3 (Figure 4). Analytical results for these samples showed elevated concentrations of PAHs and zinc when compared to Washington State Freshwater Sediment Quality Criteria (FSQ). The Weston study compared samples to FSQ criteria because the State of Oregon did not have specific sediment quality criteria at that time.

- *Event 4.* In conjunction with the Portland Harbor Study, the Port took split samples from three locations (31, 32, and 33) in the T-4 study area. Results from the split samples also indicated that PAHs and zinc concentrations were elevated in Slip 3 when compared to Washington State FSQ Criteria.

## 2.5 Previous Remediation Activities

In response to the 1993 EPA Federal Consent Decree, remediation of pencil pitch-contaminated sediments along Berth 411 was accomplished by dredging and confined aquatic disposal of the dredged material at Ross Island.

Confirmatory sampling was conducted in each dredging unit after initial dredging and re-dredging was conducted if either sediment quality goals or project design depths were not met. Dredging and disposal began in December 1994 and completed in January 1995 (Hartman Associates, 1995).

Following a pencil pitch spill by Hall-Buck Marine in 1997, a hydraulic dredge and clamshell dredge were used to remove the pencil pitch. Confirmatory surface sediment tests revealed that pencil pitch was still present in the sediments at concentrations greater than 0.5 percent. In August 1998, pencil pitch-contaminated sediments in Slip 3 were removed to the satisfaction of the DEQ spill coordinator (DEQ, 1998).

## 2.6 *Dredging History of Slip 3*

The berthing areas at 410 and 411 must maintain a working draft of -40 feet CRD to safely berth vessels during loading/unloading operations. Maintenance dredging has been conducted three times since 1973. Dredging has also been conducted twice to remove contaminated sediments from pencil pitch spills, as described in Section 2.5. An area in front of Berth 411 was overdredged to elevation -49 feet CRD during the 1994 cleanup operations associated with the remediation of the pencil pitch spill. Based on projected future berthing requirements and sedimentation rates, the Port does not plan to conduct maintenance dredging at Slip 3 in the near future (Ogden Beeman and Hartman Associates, 1996).

## 2.7 *Potential Contaminant Sources*

Identified local potential contaminants include the following:

- Pencil pitch;
- Diesel; and
- Metals.

These potential contaminants may have entered the study area by one or more of several modes (sources), including:

- Pencil pitch handling procedures and spills that have occurred at Berth 411.
- Historical petroleum leaks and seeps from the former Union Pacific pipeline which passes near Berth 412 (Hart Crowser, 1999). An oil seep into the river at the head of Slip 3 (near Berth 412) originates from the

pipeline (the seep is currently being addressed by an interim remedial action).

- Metals that may have entered the sediments due to bulk handling practices while ships were being loaded or unloaded.
- Storm water runoff from bulk handling areas.
- Storm drains that discharge into the project area.
- Sediment/contaminants originating from upstream sources that deposit in Slip 3.

Once the contaminants reach the sediments, the contaminants can be dispersed throughout the study area primarily by propwash from ship movements and river currents.

## 3.0 REMEDIAL INVESTIGATION

Surface sediment, subsurface sediment, and surface water sampling were conducted as part of this RI and are described in detail in the following sections of this report. An overall objective of this RI was to collect data of a quality consistent with DEQ guidance for evaluating risk and appropriate remedial alternatives for this site. Surface sediment sampling and analyses (0 to 10 cm) were conducted to delineate the horizontal extent of chemical concentrations in the biologically active zone. Subsurface sediment sampling and analysis were conducted to assess the vertical extent of sediments that exceed sediment quality criteria. Sediment bioassays were conducted on a subset of the total collected samples to assess site-specific bioavailability and toxicity of surface sediments with varying degrees of contamination in the project areas. Surface water sampling and analysis were conducted to assess whether COPCs were present in surface waters of Slip 3 at concentrations exceeding DEQ AWQC risk-based SLs.

The chemical analyses conducted for this RI were limited to the COPCs identified in the RI/FS Work Plan for T-4 Slip 3 Sediments (Hart Crowser, 1998a). Limited analysis for pesticides was also conducted on a subset of surface sediment samples as detailed below.

### *3.1 Surface Sediment Sampling*

Surface sediment samples (0 to 10 centimeters) were collected at 44 locations, including nine surface samples collocated with subsurface sediment sampling locations (Figure 5). Table 1 presents the sediment sample identification,

chemical analysis conducted, and location of sediment samples. The surface sediment samples were analyzed for PAHs, VOCs, pencil pitch, diesel, and standard physical parameters, including grain size and total organic carbon. Additionally, 23 of the surface samples were submitted for metals analyses (Table 1 and Figure 6), and five of the surface samples (HC-S-16, HC-S-28, HC-S-36, HC-S-39, and HC-S-43) were submitted for pesticide analysis. Fifteen of these samples, plus two reference site samples, were also submitted for bioassay analyses, as described in Section 3.5. Surface sediment sampling was conducted in general accordance with the approved project Sampling and Analysis Plan (SAP). Refer to Appendix A and the RI/FS Work Plan (Hart Crowser, 1998a) for detailed descriptions of sampling methods, sample handling, decontamination, and custody protocols. Any modifications in the SAP are presented in Appendix A of this report.

A summary of surface sediment sample locations, sampling dates, and mudline elevations is presented in Table 2. The results of the surface sediment chemical analyses are presented in Appendix C and are summarized in Table 3. Section 4.0 discusses the results of the chemical analyses of surface sediments.

The overall data quality objectives for collection and chemical testing of surface sediment samples were met, as set forth in the Quality Assurance Project Plan (QAPP) of the Slip 3 RI/FS Work Plan, and the data for this project are acceptable for use as qualified. The Data Quality Review is presented in Appendix E, and the laboratory certificates of analysis from Columbia Analytical Services Laboratory are provided in Appendix G of Volume II.

## 3.2 Subsurface Sediment Core Sampling

Subsurface sediment samples were collected at nine locations as shown on Figure 5. Table 1 presents the sediment sample identification, chemical analysis conducted, and location of sediment samples. The subsurface sediment samples were analyzed for PAHs, VOCs, priority pollutant metals, and total organic carbon. Subsurface sediment sampling was conducted in general accordance with the approved project SAP. Refer to Appendix A and the RI/FS Work Plan (Hart Crowser, 1998a) for detailed descriptions of sampling methods, sample handling, decontamination, and custody protocols. Any modifications in the SAP are presented in Appendix A.

To obtain subsurface samples, sediment cores were collected using a vibracore with a 4-inch-diameter aluminum core tube deployed from the research vessel *R/V Nancy Anne*. Core positioning coordinates and mudline elevations are summarized in Table 2. Figure 7 displays the locations of the cross sections. A key to sediment log descriptions is presented on Figure B-1. Percent recoveries,

core logs, and geologic descriptions are compiled in Appendix B and are summarized in generalized cross sections presented on Figures 8 and 9. As shown on the subsurface cross sections, in Slip 3, the sediment stratigraphy indicates there are two distinct horizons present. The upper horizon, consisting of clayey to sandy silt (Table 4) represents recently deposited fine-grained sediments. Based on the core logging, the upper horizon appears to vary depending on the location within the Slip. The depth of this horizon has been affected by historical removal, dredging activities and physical disturbances within the Slip (e.g., propwash). In general, the lower sediment horizon (4 feet below mudline) consists of medium to fine sand and represents the native sediments that have not been impacted by dredging activities.

In accordance with the SAP, core samples were divided into three sections; top and bottom: top sediments represented sediments from 0 to -2 feet (labeled VC-XX-S1); bottom samples consisted of sediments from -2 to -4 feet in depth (labeled VC-XX-S2). A deeper layer, representing the -4 to -6 feet sediment column, was also sampled. These deeper sediment sections were archived for potential future chemical analyses. The results of the subsurface sediment chemical analyses are presented in Appendix C and summarized in Table 5. Section 4.0 discusses the results of the chemical analyses of the subsurface sediments.

The overall data quality objectives for collection and chemical testing of subsurface sediment samples were met, as set forth in the QAPP. Therefore, the data for this project are acceptable for use as qualified. The Data Quality Review are presented in Appendix E, and the laboratory certificates of analysis from Columbia Analytical Laboratories are provided in Appendix G of Volume II.

## 3.3 Surface Water Sampling

Water samples were collected from three locations to assess the contributions of various sources (both aquatic and upland) to the water quality in the Slip (Figure 5). Water samples were collected using a 2-liter Van Dorn Bottle deployed from the research vessel *R/V Nancy Anne* on October 15, 1998. Samples were collected in accordance with the procedures outlined in the Response to DEQ's Comments on the RI Work Plan (Hart Crowser, 1998b).

Water samples were collected midway between the water surface and sediment surface [middle water column (M)] and 1 meter above the sediment surface [bottom water column (B)] at each of the three water sampling locations; HC-WS-01, HC-WS-02, and HC-WS-03. Water samples were analyzed for: total suspended solids (TSS); benzene, toluene, ethylbenzene, and total xylenes

(BTEX); PAHs; and total and dissolved priority pollutant metals (Table 6). Surface water chemical analyses are presented in Table 7.

The overall data quality objectives for collection and chemical testing of surface water samples were met, as set forth in the QAPP, and the data for this project are acceptable for use as qualified. The Data Quality Review is presented in Appendix E, and the laboratory certificates of analysis from Columbia Analytical Laboratories are provided in Appendix G in Volume II.

### 3.4 Summary of Sediment Chemistry Methods

As set forth in the approved RI Work Plan, sediment samples were analyzed for the following:

- Pencil Pitch (NWTPH-Dx, EPA Method 3550B);
- Diesel (NWTPH-Dx, EPA Method 3550B);
- Total Metals (6000/7000 Series);
- Total Organic Carbon (EPA Method 9060);
- Semivolatile Organics (EPA Method 8270/GC-SIM);
- Volatile Organics (EPA Method 8260);
- Pesticides (EPA Method 8081); and
- Grain Size (PSEP).

During a review of the pencil pitch, diesel, and PAH results, it was deemed necessary to perform PAH differentiation analysis that expanded on the NWTPH-Dx and EPA 8270 methods. The differentiation study was conducted because NWTPH-Dx is a hydrocarbon screening method that measures total PAH concentrations in sediments for carbon ranges C10 to C40. This method provides a general understanding of the types of hydrocarbons present in the sediment, but also tends to overestimate the concentration of each compound (e.g., gasoline, lube oil, pencil pitch, and diesel) because the individual carbon ranges tend to overlap. Conversely, GC/MS SIM provides detailed analysis and concentrations of the individual HPAH and LPAH analytes present in each hydrocarbon product. Therefore, a differentiation study was necessary to further distinguish sediment pencil pitch and diesel concentrations and determine relative percentages of each compound.

Differentiation of pencil pitch versus diesel was performed using a series of analyses that included initial screening by GC/FID and subsequent confirmation

analyses on a selected subset of samples. Differentiation analyses included aliphatic and aromatic separation using silica gel, GC/FID analysis for alkane hydrocarbons, GC/FID analysis for pencil pitch, and GC/MS SIM analysis for PAHs. The data were evaluated against site specific pencil pitch and diesel standards to fingerprint the hydrocarbon content of each constituent in the sediment. Relative percentages of each constituent were calculated from the results of the differentiation study (Table 8). The study was successful in differentiating between diesel and pencil pitch contamination at the site. These results are discussed in Sections 4.4. For further discussion of the study and complete differentiation study report, see Appendix I presented in Volume III.

The PAH differentiation study indicated that the HPAH and LPAH concentrations detected in sediments are a combination of pencil pitch and diesel constituents. Total PAHs constitute approximately 10% of pencil pitch by weight. By comparison, total PAHs constitute only about 0.05% of T-4 diesel. Of the PAHs, LPAHs constitute less than 1% of pencil pitch, and HPAHs constitute almost 9% of pencil pitch. Conversely, for T-4 diesel, LPAHs are the dominant class of total PAHs, yet represent only 0.04% of the product by weight. The study indicated that small amounts of pencil pitch will contribute a PAH signature that will become the dominant fingerprinting characteristic of the PAH chromatogram. The study determined diesel contributions by the aromatic and aliphatic concentrations of the hydrocarbon extract (Appendix I).

As a result of the high percentage of pencil pitch in the sediments, a very small amount of pencil pitch in a sediment sample will create a fingerprint dominated by PAHs. The methylene chloride extraction of pencil pitch from sediment is an effective analytical tool for measuring total PAHs in the sample, but it vastly overstates the potential bioavailability of these PAHs because they are bound up in the insoluble, solid pencil pitch in the environment.

## 3.5 Bioassay Testing Program

To assess site-specific bioavailability and toxicity of sediments in the project areas, confirmatory sediment toxicity testing was conducted on 16 surface sediment samples collected at the site (Figure 10). Confirmatory bioassay testing was conducted to fulfill two objectives:

- Define the areas of the site that exhibit significant adverse ecological effects and require an evaluation of remedial options; and
- Determine the applicability of using the LCRMA SLs and MLs by testing a suite of sediment samples containing low to moderate concentrations of COPCs.

Bioassay testing of surface sediments was conducted in two phases to meet these two objectives.

**Phase 1.** Eight samples [HC-S-26, HC-S-28, HC-S-35, HC-S-36, HC-S-39, HC-S-42, Reference B (Ref-B), and Reference C (Ref-C)] were selected for Phase 1 bioassay testing based on historical analytical results (Hart Crowser, 1998b). These sample locations represented areas that have been minimally or moderately impacted by site-related activities or areas for which historical sediment quality data do not exist. The rationale for selection of these samples is that these data can be used to correlate bioassay responses associated with low to moderate concentrations of petroleum and inorganic constituents. These samples were also selected to be spatially distributed to maximize their use in identifying areas to be included or excluded from any evaluation of remedial alternatives. A secondary objective for selecting samples with low to moderate concentrations of chemical constituents was to assess the applicability of using the LCRMA SLs and MLs.

**Phase 2.** Twelve samples were selected for Phase 2 bioassay testing based on the sediment chemistry results from the project area. Phase 2 bioassay testing was conducted to further define the areas that exhibit significant adverse ecological effects and require evaluation of remedial options. These samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, HC-S-11, HC-S-16, HC-S-19, HC-S-22, HC-S-24, HC-S-30) were selected to represent areas of the site that exhibited elevated COPCs and were also spatially distributed within the project area. The results were compared against samples Ref-B and Ref-C. Distributing the sediment bioassay testing locations sought to maximize their use in defining areas, which may require the evaluation of remedial alternatives.

The following three sediment toxicity tests were used in this study:

- Acute 10-Day Amphipod Survival Test *(Hyalella azteca)*;
- Acute 10-Day Midge Survival Test *(Chironomus tentans)*; and
- Chronic 10-Day Midge Growth Test *(Chironomus tentans)*.

These freshwater sediment toxicity tests were conducted in accordance with available standard protocols (EPA, 1994; ASTM, 1995). Sediment toxicity test results are interpreted against the decision criteria provided in the LCRMA (Corps *et al.,* 1998). Decision criteria are discussed in detail in the RI/FS Work Plan (Hart Crowser, 1998a).

The three sediment toxicity tests used in this study incorporated standard quality assurance/quality check (QA/QC) procedures to ensure the test results are valid. Standard QA/QC procedures include the use of a negative control, a positive control, reference sediment samples, and measurements of water quality during testing. A data quality review was conducted to ensure the results of the sediment bioassays were of sufficient quality for use in dredged material disposal evaluations; the review is included in Appendix F of this report. The sediment bioassay report (including raw data) is presented in Appendix H of Volume II.

## 4.0 SEDIMENT CHEMICAL DETERMINATIONS

This section discusses chemical testing results for surface and subsurface sediment samples and for surface water samples collected as part of the RI. Fifty-three sediment samples and six surface water samples were collected during the RI effort at locations depicted on Figure 5. Samples were obtained using standard field procedures outlined in Appendix A. Validated chemical analytical results for these samples are presented in Appendix C. A brief review of laboratory data quality, a comparison of sample results to the LCRMA screening levels, and descriptions of the spatial distributions of key site contaminants are discussed below.

### *4.1 Sediment Sampling Objectives*

As stated in Section 1.1, the primary objective of the RI sediment sampling and chemical analysis was to characterize the vertical and horizontal extent of sediment contamination.

Together with the results of confirmatory biological testing discussed in Section 5.0 and the limited human health and ecological risk assessments presented in Section 6.0, these chemical data help define the extent of COPCs in site sediments. In addition, these data will enable an assessment of potential remedial alternatives.

### *4.2 Summary of Sediment Data Quality*

The overall data quality objectives for collection and chemical testing of sediment samples were met, as set forth in the QAPP, and the data for this project are acceptable for use as qualified. Summaries of validated chemical analytical results, organized by sample type for surface and subsurface sediment samples, are presented in Tables 3 and 5, respectively.

## 4.3 Identification of Key Constituents of Potential Concern

This section presents comparisons of chemical concentrations detected in T-4 site sediments with the LCRMA chemical criteria (SLs and MLs). These screening levels were developed to characterize dredged material for the suitability for open-water disposal. The more conservative SL values provide a regulatory benchmark by identifying surface sediments that are not predicted to result in unacceptable adverse effects on biological resources. The higher ML values identify sediments which are likely to cause adverse effects on biological resources.

Site sediments were compared to the LCRMA chemical criteria to assess the relative magnitude of chemical concentrations and to screen the sediment concentrations against available risk based sediment quality criteria. It is important to note that the LCRMA screening criteria have no regulatory authority for the purposes of this RI. The assessment of sediment quality at the site was based on chemical analysis of 44 surface sediment samples and nine subsurface sediment samples collected from the study area. Sampling locations are shown on Figure 5.

### 4.3.1 Surface Sediment Exceedences of LCRMA Criteria

As set forth in LCRMA and in the approved project plans, the surface sediment sampling interval was selected to represent the biologically active zone defined for this RI as the 0 to 10 cm depth interval. Tables listing the complete chemical data collected within this surface sediment layer are provided in Appendix C. Individual exceedences of SL and ML values are highlighted in the tables with dashed or solid outlines, respectively.

To aid data interpretation, a summary of the surface sediment chemical data, including detection frequencies, concentration ranges, maximum concentration location, and exceedence statistics relative to both the SL and ML values (frequency of exceedence and maximum enrichment ratio) for each constituent is presented in Table 3. The enrichment ratio (E-ratio) was defined as the ratio of a sample concentration to either the SL or ML value. Table 9 presents the individual chemical constituents from each sample location with an enrichment ratio greater than 1.0. No duplicate samples were included in the summary table.

Of the more than 80 chemicals analyzed, 20 were detected in surface sediments at concentrations exceeding SL values. In order of descending frequency of exceedence relative to SL values, the following analytes were enriched in surface sediments within the study area:

- Indeno(1,2,3-cd)pyrene (93% exceeding SL);
- Fluoranthene (83% exceeding SL);
- Benzo(g,h,i)perylene (79% exceeding SL);
- Chrysene and Pyrene (76% exceeding SL);
- Benzo(a)pyrene (74% exceeding SL);
- Benzo(a)anthracene (71% exceeding SL);
- Phenanthrene (64% exceeding SL);
- Dibenz(a,h)anthracene (57% exceeding SL);
- Total Benzofluoranthenes (52% exceeding SL);
- Acenapthene and Anthracene (36% exceeding SL);
- Zinc (25% exceeding SL);
- Fluorene (24% exceeding SL);
- Lead (13% exceeding SL);
- Cadmium (6% exceeding SL);
- Dibenzofuran (5% exceeding SL); and
- Acenapthylene, 2,4-Dimethylphenol, and Naphthalene (2% exceeding SL)

Based on the ML exceedence statistics in Table 3, the following chemicals, in order of descending frequency, were selected as key COPCs in surface sediments at the site:

- Benzo(a)pyrene and Indeno(1,2,3-cd)pyrene (64% exceeding ML);
- Benzo(g,h,i)perylene (57% exceeding ML);
- Benzo(a)anthracene (50% exceeding ML);
- Pyrene and total benzofluoranthenes (36% exceeding ML);
- Dibenz(a,h)anthracene (17% exceeding ML);
- Chrysene and fluoranthene (14% exceeding ML);
- Phenanthrene (10% exceeding ML);

- Acenapthene (7% exceeding ML); and
- Acenapthylene and fluorene (2% exceeding ML).

### 4.3.2 Subsurface Sediment Exceedences of LCRMA Criteria

Summaries of subsurface sediment chemical results are presented in Table 5. Listings of complete subsurface sample results that exceeded the SL and ML values are presented in Appendix C. Table 10 presents the individual chemical concentrations from each subsurface sample location with an enrichment ratio greater than 1.0.

The following analytes, in order of descending frequency, were enriched in subsurface sediments at concentrations above the LCRMA chemical criteria for SL values:

- Indeno(1,2,3-cd)pyrene (67% exceeding SL);
- Benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, total benzofluoranthenes, and fluoranthene (56% exceeding SL);
- Pyrene and phenanthrene (44% exceeding SL); and
- Zinc and lead (29% exceeding SL).

Based on the ML exceedence statistics (Table 5) and the LCRMA chemical criteria, the following chemicals, in order of descending frequency, were selected as key COPCS in subsurface sediments of the study area:

- Indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, and benzo(a)pyrene (44% exceeding ML);
- Benzo(a)anthracene and total benzofluoranthenes (33% exceeding ML); and
- Pyrene (22% exceeding ML).

### 4.3.3 Identification of Key Constituents of Potential Concern

Based on the above discussion and historical information regarding sources of contamination in this site, the following compounds were selected as key COPCs for further evaluation in this RI:

- Pencil pitch;
- Diesel;

- LPAH (Sum of acenapthene, acenaphthylene, anthracene, flourene, napthalene, and phenanthrene);
- HPAH (Sum of benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, benzo(g,h,I)perylene, benzo(k)flouranthene, chrysene, dibenz(a,h)anthrecene, flouranthene, indeno(1,2,3-cd)pyrene, and pyrene);
- Zinc;
- Lead; and
- Cadmium.

## 4.4 Spatial Distribution of Constituents of Potential Concern

The areal distributions of the surface sediment COPCs are presented on Figures 11 through 16. The surface sediment concentration contours presented in these figures were created using a surface mapping software (Surfer, Version 6.02) by Golden Software, Inc. This program uses a statistical technique called Kriging to generate concentration contours. Kriging provides a mean of interpolating values for points not physically sampled using knowledge about the underlying spatial relationships in the data set. Only the data collected from the surface sediment sampling program (0 to 10 cm in depth) were used to generate the concentration contours presented in these figures. The following presents a summary of these distributions by chemical groups.

Sediment subsurface concentrations were determined at nine sampling locations. Subsurface samples were divided into two sections, surface and bottom: surface sediments represented sediments from 0 to -2 feet (labeled VC-XX-S1); bottom samples consisted of sediments from -2 to -4 feet in depth (labeled VC-XX-S2). Subsurface analytical results are summarized in Table 5. Table 10 provides the locations and chemical analytes exceeding the LCRMA screening criterion. Table 11 presents analytical results as they are vertically distributed throughout collocated surface and subsurface core locations. Figures 17 through 25 represent the vertical distribution of selected analytes at collocated surface and subsurface locations.

### 4.4.1 Pencil Pitch

**Surface Results.** To assess the overall distribution of pencil pitch in the study area, sediment pencil pitch concentrations were determined for the 44 surface sampling locations (Table 12). These data indicate pencil pitch is dispersed throughout the study area, as pencil pitch was detected in all 44 surface sediment samples. No risk-based criteria are available for pencil pitch pertaining

to SLs and MLs. As shown on Figure 11, concentrations of pencil pitch were highest along Berth 411 at HC-S-01 and HC-S-19. Pencil pitch was also detected near Berth 412 (HC-S-24), in Wheeler Bay, and in the three samples collected along Pier 5. The highest pencil pitch concentration (8,650 mg/kg) was recorded at HC-S-19.

**Subsurface Results.** Pencil pitch is dispersed throughout subsurface sediments in the study area, as it was detected in 16 of 18 subsurface sediment samples. Sample locations HC-VC-13, HC-VC-18, HC-VC-22, HC-VC-32, and HC-VC-39 showed pencil pitch concentrations decreasing with core depth (Figures 19, 20, 21, 23, and 24). Bottom (-2 to -4 ft section) pencil pitch concentrations were higher at HC-VC-11-S2 and HC-VC-42-S2 than at their corresponding top samples (Figures 18 and 25). The elevated subsurface pencil pitch concentrations at HC-VC-11-S2 may be explained by the residual pencil pitch concentrations remaining after the 1995 remedial dredging. The explanation of elevated subsurface pencil pitch concentrations at HC-VC-42-S2 is uncertain due to lack of bathymetric information in Wheeler Bay; however, it could be due to historic discharge from the storm drain located near the location.

### *4.4.2 Diesel*

**Surface Results.** Diesel was detected in 10 of the 44 surface sediment samples. No criteria are available for diesel pertaining to SLs and MLs. As shown on Figure 12, concentrations of diesel were highest at samples HC-S-01, HC-S-25, and HC-S-34. Diesel was detected at lower concentrations in the head of the Slip near HC-S-04, HC-S-05, HC-S-06, and HC-S-07 and in the middle of the Slip HC-S-16, HC-S-33, and HC-S-36. The elevated diesel concentrations correlate with known diesel pipelines and seeps (Figure 3). Based on historical bathymetry data, HC-S-01 also appears to be a depositional area of the Slip. Diesel was not detected in surface sediments in Wheeler Bay, the areas along Berth 410 and 411, or Pier 5.

**Subsurface Results.** Diesel was not analyzed at the majority of subsurface locations. Where diesel was analyzed, it was below analytical detection limits (Table 12).

### *4.4.3 LPAHs*

**Surface Results.** Total LPAHs exceeded the SL of 5,200 µg/kg in 19 of 42 surface sediment samples; six of these samples also exceeded the ML of 29,000 µg/kg. As shown on Figure 13, concentrations of total LPAHs were highest near the head of the Slip. Total LPAHs exceeded the ML at HC-S-38 along Pier 5, and

SLs were exceeded at HC-S-41 and HC-S-42 in Wheeler Bay. SL exceedence was present throughout the inner portions of Slip 3.

**Subsurface Results.** Bottom (-2 to -4 ft section) LPAH concentrations were higher at HC-VC-7-S2, HC-VC-11-S2, and HC-VC-42-S2 than at their corresponding top samples (Figures 17, 18, and 25). Top (0 to -2 ft sections) LPAH concentrations were higher at HC-VC-13-S1, HC-VC-18-S1, HC-VC-22-S1, HC-VC-32-S1, and HC-VC-39-S1 than at their corresponding bottom samples (Figures 23 and 24). As explained in Section 3.4 and Section 4.4.2, the LPAH concentrations are likely a result of pencil pitch.

### *4.4.4 HPAHs*

**Surface Results.** Total HPAHs were elevated throughout the study area and exceeded the SL of 12,000 µg/kg in 33 of 42 surface sediment samples; 21 of these samples also exceeded ML of 69,000 µg/kg. As shown on Figure 14, concentrations of total HPAHs exceeded the SL throughout most of Slip 3, Wheeler Bay, and Pier 5. The highest HPAH concentrations were located along Berth 411. Total HPAHs exceeded the ML near the head of the Slip, at Pier 5, and in Wheeler Bay. Surface samples HC-S-13, HC-S-22, and HC-S-32 exceeded the SL for HPAHs as well as recording much higher concentrations than their corresponding subsurface samples (Table 11).

**Subsurface Results.** Bottom (-2 to -4 ft section) HPAH concentrations were higher at HC-VC-11-S2 and HC-VC-42-S2 than at their corresponding top samples (Figures 18 and 25). Top (0 to -2 ft sections) HPAH concentrations were higher at HC-VC-7-S1, HC-VC-13-S1, HC-VC-22-S1, HC-VC-32-S1, and HC-VC-39-S1 than at their corresponding bottom samples (Figures 17, 19, 21, 23, and 24). As explained in Section 3.4, the HPAH concentrations are likely a result of pencil pitch.

### *4.4.5 Metals*

**Zinc.** Zinc exceeded the SL of 410 mg/kg in 8 of 32 surface samples (0 to 10 cm). As shown on Figure 15, concentrations of zinc were highest along Berth 412 at HC-S-25 and HC-S-13. Concentrations of zinc above the SL were also located along Berth 411 at HC-S-19.

Bottom (-2 to -4 ft section) zinc concentrations were higher at HC-VC-7-S2, HC-VC-11-S2, HC-VC-39-S2, and HC-VC-42-S2 than at their corresponding top samples (Figures 17, 18, 24, and 25). Top (0 to -2 ft sections) zinc concentrations were higher at HC-VC-13-S1, HC-VC-22-S1, and HC-VC-27-S1 than at their corresponding bottom samples (Figures 19, 21, and 22).

**Lead.** Lead exceeded the SL of 450 mg/kg in 4 of 32 surface samples. As shown on Figure 16, concentrations of lead were highest along Berth 411. Concentrations of lead above the SL were also located along Berth 412 at HC-S-25. The ML for lead was not exceeded in any surface or subsurface sediment samples.

Bottom (-2 to -4 ft section) lead concentrations were higher at HC-VC-7-S2, HC-VC-11-S2, HC-VC-27-S2, and HC-VC-42-S2 than at their corresponding top samples (Figures 17, 18, 22, and 25). The lead concentration at sample location HC-VC-39-S2 was higher than its corresponding top (0 to -2 ft section) sample, but not at its corresponding surface (0 to 10 cm) sample (Figure 24). Top (0 to -2 ft sections) lead concentrations were higher at HC-VC-13-S1 and HC-VC-22-S1 than at their corresponding bottom samples (Figures 19 and 21).

**Cadmium.** Cadmium exceeded the SL of 5.1 mg/kg in 2 of 32 surface samples. The ML for cadmium was not exceeded in any surface sediment samples. Concentrations exceeded SL values at HC-S-19 and HC-S-25. HC-S-19 is located by Berth 411 (see Figure 5), which has been historically used as an inloading area of ores, clay, talc, and coal tar pitch. HC-S-25 is located by Berth 412, historically used for bulk loading and unloading of briquettes, coke, and sulfur.

Bottom (-2 to -4 ft section) cadmium concentrations were higher at HC-VC-7-S2, HC-VC-11-S2, and HC-VC-42-S2 than at their corresponding surface or top samples (Figures 17, 18, and 25). The SL or ML for cadmium was not exceeded in any subsurface sediment sample.

### *4.4.6 DDT*

The Portland Harbor Study indicated that elevated concentrations of DDT were found in sediments throughout the Portland Harbor area (Roy F. Weston Inc., 1998). In addition, the Port found elevated concentrations of DDT in the surface sediments of the Willamette River Navigation Channel and at other Port facilities that have historically never handled DDT (Port of Portland, 1999). In response to the results of these studies, five surface sediment samples (HC-S-16, HC-S-28, HC-S-36, HC-S-39, and HC-S-43) were analyzed for total DDT (summation of 4,4-DDD, 4,4-DDE, and 4,4-DDT). Sample locations were chosen from the middle of Slip 3 out to the mouth and near Pier 5 and Wheeler

Bay (Figure 5). Surface sediment DDT concentrations exceeded the LCRMA SL, but were below the ML at each of the five locations tested (Tables 3 and 9). Because the Port never handled DDT at the T-4 study area, DDT found in the surface sediments must be attributable to other upriver sources. Subsurface samples were not tested for DDT.

#### *4.4.7 Summary of Chemical Results*

**Pencil Pitch.** Chemical results show that pencil pitch is present throughout the study area. The highest pencil pitch concentrations were located near Berth 411 where pencil pitch was handled and where spills occurred. This area, along Berth 411, is also suspected of having a high sediment depositional rate, especially in the northeast corner of the Slip represented by HC-S-01. The elevated concentrations of pencil pitch detected in Wheeler Bay appear to be correlated with storm drain discharge as evidenced by pencil pitch concentrations at HC-S-41 and HC-S-42, which were located near the terminus of the storm drain (Figures 3 and 11).

**Diesel.** The detected concentrations of diesel in sediments correlate with known diesel handling areas at Berth 412 and with diesel pipeline leaks and seeps in Slip 3 (Figures 3 and 12). Diesel concentrations were elevated near the previously mentioned depositional area in the northeast corner of Slip 3 represented by sample HC-S-01.

**HPAHs and LPAHs.** Concentrations of total HPAHs and LPAHs were detected throughout the study area. For general comparison, the LCRMA SLs for HPAHs and LPAHs were exceeded at 32 and 19 of the sample locations, respectively.

**Metals.** Metals exceeding the LCRMA SLs were zinc, lead, and cadmium. The exceedence of SLs were collocated for these three metals detected at sample locations HC-S-19 and HC-S-25. Elevated subsurface concentrations of zinc and lead are generally collocated with elevated concentrations of pencil pitch.

**DDT.** Sediment total DDT concentrations exceeded the LCRMA SL at each of the five locations at which it was tested. Because the Port has never handled DDT at the T-4 study area, detected concentrations of DDT in the surface sediments must be attributable to other upriver sources.

### *4.5 Chemical Analysis of Water*

Water samples collected within Slip 3 (Figure 5) were compared to DEQ AWQC. Metals, HPAHs, and phthalates were detected at the three sampling

locations; however, no exceedences of AWQC were identified for any water sample analyzed (Table 7).

Metals detected below the AWQC were identified as having higher concentrations at HC-WS-01 and tended to decrease towards the mouth of Slip 3. HPAHs were detected in HC-WS-01 samples only. Of the HPAHs detected at HC-WS-01, samples collected in the middle of the water column were greater than the bottom samples. Low-level phthalate detections were comparable at the three sampling locations.

## 5.0 BIOASSAY RESULTS

This section summarizes the investigation of biological effects using confirmatory bioassay testing of sediments collected at the site and tested in accordance with the SAP and QAPP (Hart Crowser, 1998a). The following three bioassays were conducted on 16 test sediments and on two reference sediments collected during this RI (Figure 10):

- Acute 10-Day Amphipod Survival Test *(Hyalella azteca)*;
- Acute 10-Day Midge Survival Test *(Chironomus tentans)*; and
- Chronic 10-Day Midge Growth Test *(Chironomus tentans)*.

The sediment bioassay tests were conducted in two phases, as discussed in Section 3.5. The test sediment samples were collected by Hart Crowser on October 13 through 15, 1998, and were submitted for toxicity testing to Northwestern Aquatic Sciences (NAS) Laboratory in Newport, Oregon, on October 17, 1998. Reference sediments B (Ref-B) and C (Ref-C) were collected by Hart Crowser on October 15, 1998, and were submitted for toxicity testing to NAS Laboratory on October 17, 1998. Phase 1 of sediment bioassay testing was initiated on October 20, 1998, and Phase 2 was initiated on December 8, 1998.

The reference sediment selected for comparison with each test sediment was based on grain size characteristics of the sediment. The reference sediments are uncontaminated material collected from the vicinity of the site and are used as a point of comparison to identify potential contaminant effects of in the test sediments. The reference sediments were collected from two areas located on the Columbia River (Figure 26). These sediments were tested in both Phase 1 and Phase 2 rounds of bioassay testing. Reference sediments were submitted for chemical analyses, the results of which are provided in Appendix C of this

report. No compounds were detected in reference sediments at concentrations exceeding their corresponding LCRMA SLs.

The Phase 1 and Phase 2 negative control sediments were collected on October 19, 1998, and December 3, 1998, respectively, from an area adjacent to the Highway 101 bridge at Beaver Creek, approximately 8 miles south of Newport, Oregon. Negative control sediments are used to check laboratory performance. Negative control sediments are clean sediments in which the test organisms normally live. Separate negative control sediments were collected prior to the initiation of each phase of bioassay testing.

## 5.1 *Interpretative Criteria*

The sediment bioassay results were interpreted in accordance with the LCRMA guidance as presented in the DEQ-approved RI/FS Work Plan (Hart Crowser, 1998a). The response of bioassay organisms exposed to a test sediment is compared to the response of these organisms in both control and reference sediments. This comparison determines if the test sediment sample has passed or failed the sediment bioassays.

Biological test interpretation relies on two levels of observed response in the test organism. These are known as "one-hit" and "two-hit" criteria failures. The bioassay-specific guidelines for each of these response categories are listed below. In general, a one-hit failure is a marked response in any one biological test. A marked response in comparison to the reference sediment in any one of the three sediment bioassays will result in the test sediment failing bioassay analyses. A two-hit failure exhibits a lower intensity response which must be present in two or more biological tests for the test sediment to fail bioassay analyses.

### *One-Hit Criteria*

When any one of the three biological tests shows a test sediment response relative to the reference sediment that exceeds the bioassay-specific response guidelines (presented below), and if that response is "statistically different" from the reference, the test sediment is judged to have failed the bioassay. The method for determining statistical significance is presented below.

In accordance with the LCRMA, the bioassay-specific response guidelines for evaluating the "one hit criteria" are as follows:

**Amphipod Bioassay.** Mean test mortality is greater than 15 percent over the mean reference response and is statistically different from the reference (alpha = 0.05); and

**Midge Bioassay.** Mean mortality in the test sediment is 20 percent over reference and statistically different from reference (alpha = 0.05). For the growth test, a mean biomass is achieved that is less than 60 percent of the reference sediment response and statistically different from the reference (alpha = 0.05).

***Two-Hit Criteria***

When any two of the three biological tests show test sediment responses that are less than the bioassay specific guidelines noted above for a one-hit failure, but are significantly different statistically from the reference sediment, the test sediment is judged to have failed the bioassay.

## 5.2 Data Quality Review

A data quality review of the confirmatory sediment bioassays was conducted to ensure the results of the sediment bioassays were of sufficient quality for use in this RI. The bioassay data quality review is included as Appendix F of this report. The sediment bioassay report from NAS is included as Appendix H in Volume II of this report.

The following criteria were evaluated as part of this data quality review:

- Holding times;
- Bioassay performance in negative control and reference sediments;
- Bioassay performance in positive control tests; and
- Bioassay test conditions.

The grain size of the reference sediments collected for bioassay testing were representative of very fine grained (<63um) and coarse grained (>63um) material. Ref-B was characterized as 99.1% fines and Ref-C was characterized as 19.8% fines (Table 13). The test sediment grain size characteristics ranged from 23.1% to 92.9% fines. While it would have been preferable to include an additional reference sediment with grain size characteristics between those of Ref-B and Ref-C, the lack of established reference sediment collection areas in the Lower Willamette River has limited the availability of appropriate reference sediment. The reference sediments tested in both Phase 1 and Phase 2 of the

sediment bioassay testing program all met required performance criteria and were suitable for use in this RI.

The conclusion of the bioassay data quality review was that all bioassay data were of acceptable quality and fully usable for the purposes of the RI (Appendix F).

## 5.3 Interpretation of Bioassay Results

The results of the acute amphipod and acute and chronic midge bioassays are presented in Tables 14 through 16. These tables list the sediment samples tested in Phase 1 and Phase 2, the corresponding reference sediment samples (based on similar grain size), the test endpoint, comparison with the one-hit and two-hit interpretative criteria, and the overall results of whether the test sediment passed or failed the biological effects interpretive criteria. The comparative grain size data and the reference sediments that were compared against test sediments are provided in Table 13.

Selection of appropriate reference sediments for comparison with test sediments was based on the percent fines fraction. Percent fines are defined as the percentage of silts and clays in the sediment. The percent fines for Ref-B and Ref-C were 99.1 and 19.8 percent, respectively. The median value of the percent fines between reference sediments was used to determine the appropriate location for statistical comparison.

- Test sediments with % fines < 59.5% were compared to Ref-C; and
- Test sediments with % fines > 59.5% were compared to Ref-B.

The percent fines for test sediments ranged from 23.1 to 92.9 percent. Five test sediments contained percent fines less than 59.5 percent and were compared to Ref-C. Eleven test sediments contained percent fines greater than 59.5 percent and were compared to Ref-B.

The analytical chemistry results for the sediment samples included in both the Phase 1 and Phase 2 rounds of bioassay testing are presented in Table 17.

### 5.3.1 Amphipod Bioassay Results

The mean percent mortality in the test sediments for the 10-day amphipod bioassay (*H. azteca*) ranged from 3.8 to 16.3 percent in the Phase 1 bioassays (Table 14). In Phase 1, sediments passed the one-hit criteria, but two of six

samples (HC-S-26 and HC-S-28) were found to have statistically greater mortality than the corresponding reference sediment (two-hit criteria).

In the Phase 2 bioassays, the mean percent mortality in test sediments ranged from 12.5 to 37.5 percent (Table 14). Three of the ten samples (HC-S-01, HC-S-04, and HC-S-22) failed the one-hit criteria, and five of the ten samples (HC-S-01, HC-S-04, HC-S-05, HC-S-16, and HC-S-22) were determined to have statistically greater mortality than the corresponding reference sediment (two-hit criteria).

### 5.3.2 Midge Survival Bioassay Results

The mean percent mortality in the test sediments for the 10-day acute midge bioassay *(C. tentans)* ranged from 26.3 to 41.3 percent in the Phase 1 bioassays (Table 15). In Phase 1, sediments passed the one-hit criteria, but one of the six samples (HC-S-39) was determined to have statistically greater mortality than the corresponding reference sediment (two-hit criteria).

In the Phase 2 bioassays, the mean percent mortality in test sediments ranged from 8.6 to 47.5 percent (Table 15). Two of the ten samples (HC-S-01 and HC-S-22) failed the one-hit criteria, and four of the ten samples (HC-S-01, HC-S-04, HC-S-05, and HC-S-22) were determined to have statistically greater mortality than the corresponding reference sediment (two-hit criteria).

### 5.3.3 Midge Growth Bioassay Results

The mean test individual biomass for the 10-day chronic midge bioassay *(C. tentans)* ranged from 1.32 to 2.01 mg in the Phase 1 bioassays. In Phase 1, sediments passed both the one-hit criteria and two-hit criteria (Table 16). The mean test individual biomass ranged from 0.19 to 1.09 mg in the Phase 2 bioassays (Table 16).

In Phase 2, four of the ten samples (HC-S-01, HC–S-04, HC-S-05, and HC-S-07) failed the one-hit criteria, and eight of the ten samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, HC-S-11, HC-S-16, HC-S-24, and HC-S-30) were determined to have statistically less biomass than the corresponding reference sediment (two-hit criteria).

### 5.3.4 Summary of Bioassay Results

The biological effects interpretive criteria used in this RI are based on an analysis of bioassay results. This analysis segregates responses that are markedly different from reference responses (one-hit criteria) and responses that are less

than the one-hit criteria but nonetheless statistically different from reference sediment response (two-hit criteria). As described previously, any one-hit failure in any of the bioassays will result in the interpretation that the test sediment has failed the biological effects criteria. In the absence of a one-hit failure, two of the three bioassays tests must fail the two-hit criteria before a test sediment will be determined to have failed the biological effects criteria. The results of both phases of bioassay testing are presented on Figure 27 of this report.

In the Phase 1 bioassay testing, all of the test sediments were determined to have passed the biological effects criteria. An analysis of the concentrations of constituents detected in these samples revealed that low to moderate concentrations, in many cases above the LCRMA SLs, did not result in unacceptable ecological impacts (i.e., did not fail biological interpretive criteria) to benthic organisms at this site.

In the Phase 2 bioassay testing, six of the ten samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, HC-S-16, and HC-S-22) were determined to have failed the biological effects criteria. Of the six test sediments determined to have failed biological criteria, five samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, and HC-S-22) exhibited a marked response in one or more bioassay tests (one-hit failure), and one sample (HC-S-16) was determined to have failed biological criteria based on two tests exhibiting statistically different responses from the corresponding reference sediment (two-hit failure).

The spatial distribution of the sediment samples passing or failing biological interpretative criteria are presented on Figure 27. Additionally, the sediment bioassay results are presented along with the concentration contours of the key COPCs on Figures 11 through 16. Figure 11 presents the concentration contours for pencil pitch, Figure 12 presents the concentration contours for diesel, Figure 13 presents the concentration contours for LPAHs, Figure 14 presents the concentration contours for HPAHs, Figure 15 presents the concentration contours for zinc, and Figure 16 presents the contours for lead concentrations. For those constituents with corresponding LCRMA SLs and MLs, contours representing these concentrations are also presented in these figures.

In general, the samples that failed biological criteria are clustered in the eastern half of Slip 3, which is associated with higher concentrations of COPCs. However, some samples containing elevated concentrations of COPCs (i.e., HC-S-19 and HC-S-24) passed biological criteria. The sediment samples passing biological criteria are generally clustered in western areas of the Slip that exhibit low to moderate concentrations of COPCs. These results suggest that sediment

toxicity at this Slip is associated with elevated concentrations of COPCs rather than non-contaminant-related factors (e.g., grain size, total organic carbon).

### 5.3.5 Evaluation of Sediment Diesel and Pencil Pitch Concentrations

An evaluation of the relationship of concentrations of diesel and pencil pitch (the two main sources of petroleum related constituents to the Slip) to sediment bioassay results was conducted. The analytical results for sediment diesel concentrations in the bioassay samples (Table 17) reveals that five out of six samples that contained diesel concentrations greater than 100 mg/kg failed bioassay analysis. In contrast, all of the samples that passed bioassay testing had diesel concentrations less than 100 mg/kg or were not detected at the sample quantitation limit.

The relationship between sediment pencil pitch concentrations and bioassay results were much more inconsistent (Figure 11). Some of the samples that failed bioassay analyses contained elevated levels of pencil pitch (HC-S-01 at 7,730 mg/kg and HC-S-04 at 1,350 mg/kg), but others contained much lower pencil pitch concentrations (HC-S-22 at 449 mg/kg). Conversely, some of the samples that passed sediment bioassays contained very high concentrations of pencil pitch (HC-S-19 at 8,650 mg/kg and HC-S-24 at 4,320 mg/kg).

This discrepancy in relating detected concentrations of diesel and pencil pitch to bioassay results can be explained by the nature of these two petroleum mixtures. Diesel is a liquid mixture of as many as 500 individual compounds within the general carbon range of C10 to C20 and is primarily composed of aliphatics. The petroleum hydrocarbons that make up diesel are, in general, more mobile, water soluble, and bioavailable than the longer chained petroleum hydrocarbons that make up pencil pitch (API, 1996). Pencil pitch is a complex mixture of petroleum constituents within the carbon range of C12 and C36 that exists either as small or large solid particles scattered in the sediment. It has been reported in the literature that petroleum constituents present in sediment as pitch or coal particles can result in elevated detected concentrations of petroleum constituents (such as PAHs), but that bioavailability of this material is very limited (Paine et al., 1996). Bioavailability of pencil pitch is limited due to low water solubility (Appendix I). Therefore, while high pencil pitch and PAH concentrations may be present in sediment, these concentrations may not be associated with adverse effects to the environment.

This fact was particularly evident in the results from sample HC-S-19. This sample contained very elevated concentrations of pencil pitch (8,650 mg/kg pencil pitch), HPAHs (471 mg/kg), and LPAHs (41.9 mg/kg), but had low concentrations of diesel (not detected at a sample quantitation limit of 50

mg/kg). This sample passed the biological interpretation criteria for all three bioassays conducted on this sample. The petroleum constituents in diesel are much more mobile, water soluble, and bioavailable than those in pencil pitch and, as indicated in this study, are more correlated to the expression of sediment toxicity in the sediments of Slip 3 than are detected concentrations of pencil pitch. As previously discussed, the petroleum hydrocarbon mixture that comprises diesel is characterized by compounds with lower molecular weights and carbon molecules than the hydrocarbon mixture that characterizes pencil pitch.

## 6.0 LIMITED HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

A limited evaluation of human health and ecological risks was conducted for this RI because there are only a limited number of complete exposure pathways to Slip 3 sediment-associated constituents of concerns for the identified ecological and human receptors. The primary complete exposure pathways are quantitatively evaluated in Sections 6.5 and 6.6. The exposure pathway related to the bioaccumulation of constituents of concerns from sediments is discussed in Section 6.4. The limited human health and ecological risk assessments are sufficient to address the complete exposure pathways and delineate areas of the Slip requiring an evaluation of remedial alternatives based on the quantified risks to human health and the environment.

This section presents a discussion of current and future land use and a summary of the environmental setting at T-4, Slip 3. Additionally, a brief description of the ecological characteristics of the lower Willamette River is presented with a discussion of potential ecological receptors, including sensitive and/or protected species. An exposure pathway evaluation is provided, based on the exposure pathways originating from contaminated sediment in Slip 3. The section concludes with a quantitative evaluation of the identified complete exposure pathways. For this RI, the evaluation was limited to assessing risks associated with direct contact and incidental ingestion of sediment and surface water by aquatic organisms in the Slip. A delineation of areas within Slip 3 requiring an evaluation of remedial alternatives based on the results of the sediment bioassays and limited Risk Assessment is presented in Section 6.7.

T-4, Slip 3 is located within the Portland Harbor area of concern, which EPA has recommended for listing on the National Priorities List. The current DEQ work plan recommends that risk assessment issues be evaluated on a harbor-wide basis rather than at the individual site level. These include addressing risks due to exposure to bioaccumulative compounds. Because of the regulatory uncertainty of the Portland Harbor, the nature and scope of this assessment are

unknown. However, as the exposure pathway related to the food chain transfer of bioaccumulative compounds has not been identified as a primary pathway of concern at this site (see discussion in Section 6.4), the evaluation of risks associated with exposure to bioaccumulative compounds should not significantly impact the results of this assessment.

## 6.1 Current and Future Land Use

Hart Crowser performed a land use survey of T-4 by contacting the City of Portland Planning Bureau and nearby landowners and by reviewing the Port's Master Plan for this Marine Terminal to understand past, current, and potential future land uses within the locality of the facility. The locality of the facility is any point where a human or an ecological receptor contacts or is reasonably likely to come into contact with facility-related chemical contamination. The locality of the facility takes into account the likelihood of contamination migrating over time. Based on our current understanding of the site, the locality of the facility is limited to the study area presented in Figure 2.

This survey was conducted as part of the T-4 Upland RI (Hart Crowser, 1999), and relevant portions of that survey are reproduced in this section.

**Current Use.** The site and surrounding properties are zoned heavy industrial and are being used mostly for these purposes. The west side of the terminal has several berths that are parallel and perpendicular to the Willamette River. The area east of the terminal is used for industrial and commercial activities. The areas north and south of the terminal are occupied by marine, industrial, and commercial operations. The southern half of T-4 is leased to Toyota Logistics Services for vehicle offloading from ships and temporary storage at T-4.

As an active industrial facility, access to the T-4 property is regulated. The only access to the uplands area is via an occasionally manned gate. Public access from the river is limited to personal watercraft from the river. As Slip 3 is almost continuously used by vessels loading soda ash at Berth 410, recreational use of the Slip (e.g., swimming, boating, and fishing) is not permitted or expected. Access by trespassers or recreational uses of the piers, riverbanks, and near-shore areas is also prohibited and not expected. The industrial activities occurring at Slip 3, currently only involving the loading of soda ash, do not result in worker exposure to either the sediments or surface waters of the Slip. Additionally, there are some limited remedial activities associated with the T-4 upland investigation. These do not result in worker exposure to either the sediments or surface water of the Slip. The RI study area consists of the sediments located upriver at Pier 5, Slip 3, and Wheeler Bay, which is

immediately downriver and adjacent to Slip 3. Additional information on the uses of these areas is presented in Section 2.2.

**Future Use.** There are no planned changes to the present or future operational uses at the facilities in the study area. Berth 410 will continue to be used as a bulk handling facility. Because the pier has been removed at Berth 412, it is not currently being used as a berthing facility; however, the future use is planned for a bulk handling facility. Berth 411 is currently inactive but could be used for bulk handling in the future. There are no current plans for any future changes to the uses at Wheeler Bay and Pier 5. In addition, there are not any plans to handle petroleum-related bulk at any of these facilities in the future.

The water side use for Pier 5 is and will be nonexistent since there are no longer dock facilities. The upland area, including warehouses, is and will continue to be used. Two potential uses are: urea (unloaded at Berth 414 and storage/transfer to trucks in Warehouse 5), and steel slab (unloaded at Berth 414/415 and use of Warehouse 7).

**Summary of Land Use.** Land use in the locality of the facility has been heavy industrial. Reasonably likely future land use in this area is expected to be industrial due to current zoning, the City's comprehensive plan, the marine terminal master plan and recent updates, and existing/planned business developments.

## 6.2 *Environmental Setting and Ecological Receptor Characterization*

T-4 is located on the lower Willamette River in Portland, Oregon. The Willamette River is the tenth largest river in the conterminous United States (in total discharge). The lower Willamette consists of a freshwater tidal section with typical mid-channel depths of approximately 12 m from River Mile (RM) 0 to Willamette Falls. The Willamette River drains a 29,800-km$^2$ basin in which 70 percent of the human population and the three largest cities of Oregon are located (USGS, 1997).

The occurrence, abundance, and condition of aquatic organisms in an area is dependent on many factors, including habitat characteristics, water quality, and availability of food resources. As the Willamette River flows to Portland, the river becomes slower, warmer, more channeled, and incidences of water quality impacts increase due to the proximity of the urban center of Portland. The following sections summarize available information on the fish and macroinvertebrate communities present in the lower Willamette River.

**Fish.** The Willamette basin supports a diverse and extensive fish community. The Oregon Department of Fish and Wildlife (ODFW, 1988) listed 54 species of fish as being present within the Willamette basin, and an additional 7 species have been reported from other sources (USGS, 1997). Fish species richness tends to increase from the smaller, high elevation, steep gradient, cold water, headwater areas to the larger, low elevation, low gradient, warm water, main stem channel. The fish of the mid-to-high elevation tributaries in the basin tend to be dominated by a few cold water salmonid species, such as coho salmon and cutthroat trout as well as a few species of suckers, minnows, and sculpins, and the mountain whitefish *(Prosopium williamsoni).*

Species composition in the low elevation reaches of the major rivers of the Willamette Valley and foothills include numerous warm water fish such as bass *(Micropterus spp.),* catfish *(Ictalurus spp.),* and several species in the sunfish group. The fish fauna of the lower Willamette River is dominated by non-native, warm water, pollution-tolerant species (USGS, 1997). The United States Geological Survey (USGS, 1997) reports that fish assemblages in the Portland Harbor, from the confluence of the Willamette River with the Columbia River to RM 15, were dominated by the northern squawfish, followed by black crappie, white crappie, largemouth bass, smallmouth bass, and walleye.

The lower Willamette River is primarily used by anadromous salmonids, particularly chinook salmon and steelhead trout, as a passageway to tributaries where spawning grounds are located (USGS, 1997). Most salmonid spawning in the Willamette basin occurs in tributaries of the Willamette River, except for the reestablished runs of fall chinook salmon, which spawns from RM 50 (Newburg) through RM 187 (Springfield). ODFW (1992) conducted a study to determine when juvenile salmonids are in the Willamette River and how long they are in the Portland Harbor stretch of the river. The results indicate that the abundance of yearling chinook salmon peaks in mid-to-late March. Subyearling chinook salmon first appear in late April, peak in mid-May, and remain in decreasing numbers through June. Juvenile coho salmon and steelhead also begin to appear during late April; coho salmon are present in the harbor through May, and steelhead are present through June. It was reported that juvenile steelhead generally migrate through the Portland Harbor within 1 to 2 days, whereas yearling chinook generally migrate through the harbor within 2 to 3 days. A few yearling chinook salmon took as long as eight days to migrate through the harbor. Migration rates of these fish were not significantly correlated with river flow (ODFW, 1992).

**Macroinvertebrates.** There are numerous studies reported in the literature that describe the macroinvertebrate communities present in the Willamette basin. These studies have been conducted for a variety of objectives, and it is difficult

to synthesize the results to develop a comprehensive description of the distribution and abundance of macroinvertebrate populations because of the different sampling methodologies and varying taxonomic levels of identification used by these different studies (USGS, 1997).

In general, the upper reaches of the Willamette basin are characterized by streams and rivers with a high diversity of taxa and a high richness of pollution-intolerant species. Within the slow-current reaches of the lower Willamette River, the typical invertebrates are those that tolerate low dissolved oxygen concentrations, such as oligochaetes (segmented worms), cladocerans (water fleas), amphipods (scuds), odonates (dragonflies and damselflies), and chironomid midges (USGS, 1997).

Freshwater clams, mussels, crayfish, and snails have been identified as important components of the aquatic macroinvertebrate fauna of the basin. These species serve as prey items for fish, birds, and sometimes, recreational harvest for human consumption. No studies were found investigating the community characteristics of these species in the lower Willamette, though the habitat characteristics of this reach of river are not especially conducive to many of these species.

A recent benthic community survey conducted (Striplin Environmental Associates, 1999) at the Portland Shipyard (PSY) and adjacent lower Willamette River concluded that sediments in the Portland Harbor are dominated by two major taxonomic groups: oligochaetes and chironomids. The abundance and number of species found in Portland Harbor appear to be low in comparison to other similar river and lake systems. This report was not able to provide definitive reasons for the low abundance and diversity observed but suggested that contributing factors include: physical characteristics of the sediment (predominance of fine-grained soft sediment), industrial activity, and disturbance and channelization of the river.

**Species of Concern.** Species that have been selected by regulatory agencies for special protection and/or consideration were identified by contacting the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the Oregon Natural Heritage Program (ONHP). The following species are Federally listed as threatened pursuant to the Endangered Species Act:

- Steelhead trout (*Oncorhyncus mykiss*), Lower Columbia River Evolutionary Significant Unit (ESU); and

- Chinook salmon (*Oncorhyncus tshawytscha*), Lower Columbia River ESU.

In addition, coastal cutthroat trout (*Oncorhyncus clarki clarki*) are proposed as threatened for the Southwest Washington/Columbia River ESU. USFWS lists the following aquatic species as "Species of Concern" for this region: pacific lamprey *(Lampetra tridentata)*, river lamprey *(Lampetra ayresi)*, and the California floater *(Anodonta californiensis)*. The California floater (mussel) was not found on the macroinvertebrate species list provided by the USGS (1997); therefore, it is unknown whether this species is present in the lower Willamette River. The USFWS identifies species of concern as "those taxa whose conservation status is of concern to the Service but for which further information is still needed."

The ONHP conducted a data search of threatened and endangered species within a two-mile radius of the site. The ONHP identified the historical presence of the following:

- Tricolored blackbird *(Agelaius tricolor)* - reported south of Tomahawk Island on the NE Bridgeton Road, off of Marine Drive.
- Painted turtle *(Chrysemys picta)* - reported at the peninsular drainage canal; off of the Columbia Slough near the Portland International Airport.
- Columbia pebblesnail or spire snail *(Flumincola columbiana)* - reported in the Columbia River.
- Giant Columbia river limpet *(Fisherola nuttalli)* - reported in the Columbia River.

Based on the information gathered regarding the presence of species of concern in and around T-4, it is concluded that the species of concern that may be exposed to sediment-associated contaminants at this site would be limited to pacific lamprey, river lamprey, steelhead trout, coastal cutthroat trout, and chinook salmon. The other species mentioned above were observed at locations sufficiently distant (e.g., Columbia River, Columbia Slough) from T-4 to preclude exposure.

## 6.3 Exposure Pathway Evaluation

Based on the information on human use and ecological receptors present in and around T-4, an exposure pathway evaluation was conducted to identify potentially complete exposure pathways to the human and ecological receptors present at the site. The exposure pathway evaluation is based on an evaluation

of existing data and the presumed current and reasonably likely future conditions at the site.

To be considered complete, an exposure pathway must have: 1) an identified source of chemicals of potential concern; 2) a release/transport mechanism from the source; and 3) a receptor with which contact can occur.

**Potentially Exposed Populations.** Potential human receptors include industrial workers and construction/utility workers. As this site is an active industrial facility with controlled access, recreational use and trespassers are not expected at this site. The potential human exposure pathway involving exposure via off-site recreational or subsistence harvesting of fish that have been exposed to and have accumulated T-4 sediment-associated contaminants is discussed in Section 6.4.

Potential populations of ecological receptors include resident and anadromous fish species (including the species of concern presented above) and resident populations of benthic macroinvertebrates present in Slip 3. The potential ecological exposure pathway involving exposure to higher trophic level aquatic and terrestrial receptors via the ingestion of fish that have been exposed to and have accumulated T-4 sediment-associated contaminants is discussed in Section 6.4.

Figure 28 presents the preliminary exposure model for this site based on the above discussion. Check marks on the figure indicate potentially complete pathways to the indicated receptor. Question marks on the figure indicate uncertain exposure pathways related to ingestion by human and ecological receptors of aquatic organisms that may have taken up bioaccumulative contaminants from T-4 sediments.

**Complete Exposure Routes.** Exposure pathways for quantitative analysis were selected based on the exposure pathway evaluation developed for this site. As presented on Figure 28, the primary original sources of sediment contamination at this site were spills and leaks associated with the unloading of pencil pitch and ore, petroleum pipeline leaks and related seeps, and storm drain discharge. The secondary release mechanism for sediment-associated contaminants was the solubilization of contaminants to surface water. Additionally, uptake of bioaccumulative compounds from sediment and/or surface water by fish and subsequent ingestion by human and ecological receptors were considered. This evaluation is presented in the next section of this report.

Based on currently available information, complete exposure pathways for ecological receptors were limited to sediment and surface water as the exposure

medium. Exposure pathways identified as complete for ecological receptors were: 1) direct contact and incidental ingestion of sediment by aquatic organisms (fish and benthic invertebrates); and 2) direct contact and incidental ingestion of surface water by aquatic organisms (fish and benthic invertebrates). Additionally, the ingestion of fish that have taken up bioaccumulative compounds was identified as a potentially complete pathway.

Based on currently available information, the exposure pathways that were identified as complete for human receptors were limited to potential exposures related to off-site recreational and/or subsistence fishing and consumption of fish that have taken up bioaccumulative compounds from T-4 sediments or surface water. As previously discussed, industrial and construction worker exposure to T-4 sediments and surface water is not expected, and recreational use of the area, including fishing, is prohibited.

## 6.4 *Evaluation of Risks Associated with Exposure to Bioaccumulative Contaminants*

The exposure to bioaccumulative compounds from consumption of aquatic organisms that have taken up contaminants from sediments has been identified as a potentially complete exposure pathway for the human and ecological receptors at this site. A list of bioaccumulative contaminants of interest for the Portland Harbor (RM 3.5 to RM 6.5, including T-4, Slip 3) has been identified based on their presence in Portland Harbor sediments and fish tissues, and on their potential for bioaccumulation (DEQ, 1999a). The bioaccumulative contaminants of interest identified by the DEQ for the Portland Harbor are:

- Arsenic;
- Mercury;
- Butyltins;
- Pentachlorophenol;
- Bis(2-ethylhexyl)phthalate;
- Butylbenzyl pthalate;
- Di-n-butyl phthalate;
- Di-n-octyl phthalate;
- DDT and derivatives;
- Aldrin and dieldrin;

- PCBs; and
- Dioxins/furans.

The surface sediment chemistry results from this RI (Table 3) were evaluated with regard to the detection frequency and the detected concentrations of bioaccumulative contaminants of interest. The detected concentrations of bioaccumulative compounds of interest were compared against SLs and Bioaccumulation Trigger values (BT) provided in the LCRMA. BTs are screening values used to identify sediments that require bioaccumulation testing for determining appropriate disposal options for dredged material; they are based on identifying sediments that contain elevated concentrations of bioaccumulative compounds. All BT concentrations are higher than the corresponding SLs. The results are provided below:

- Arsenic; detected in 32 of 32 samples but no concentrations exceeded LCRMA SL or BT.
- Mercury; detected in 31 of 32 samples but no concentrations exceeded LCRMA SL or BT.
- Pentachlorophenol; not detected in 42 sediment samples.
- Bis(2-ethylhexyl)phthalate; detected in 29 of 42 samples but no concentrations exceeded LCRMA SL or BT.
- Butylbenzyl pthalate; detected in 7 of 42 samples but no concentrations exceeded LCRMA SL and no BT is available for this compound.
- Di-n-butyl phthalate; detected in only 1 of 42 samples which did not exceed the LCRMA SL or BT.
- Di-n-octyl phthalate; detected in 2 of 42 samples but no concentrations exceeded the LCRMA SL or BT.
- DDT and derivatives, detected in five of five samples, detected concentration exceeded LCRMA SL but not the BT.
- Aldrin and dieldrin, not detected in any of the five samples.

Two of the bioaccumulative contaminants of interest identified for the Portland Harbor (PCBs and butyltins) were not COPCs at this site and were not included in the analyte list for this RI. However, the concentrations of these compounds in sediment were evaluated in Slip 3 (by Berth 410) as part of a dredge material characterization study conducted at the Slip by Hart Crowser in 1997 (Hart Crowser, 1997a). Three sediment samples (composited from six sediment core samples) were submitted for chemical analysis. TBT was detected in only one of

the three sediment pore water samples, and the detected concentration was below the LCRMA SL and BT for TBT. Total PCBs were detected in two of the three samples; however, the detected concentrations were below the LCRMA SL and BT.

Therefore, while the bioaccumulative exposure pathway has been identified as potentially complete for higher trophic order aquatic and terrestrial ecological receptors and for off-site recreational and subsistence fishermen, the concentration of bioaccumulative contaminants of interest identified for the Portland Harbor are present at low or undetected concentrations in the sediments of this slip. Thus, the bioaccumulation exposure pathway is not considered to be a significant pathway of concern at this site.

The Portland Harbor Management Plan (DEQ, 1999a and 1999b) has identified the evaluation of risks associated with the bioaccumulation exposure pathways as an issue that should be addressed on a harbor-wide basis rather than at a site-specific level. While the regulatory status of the Portland Harbor is still uncertain, if and/or when a comprehensive assessment for bioaccumulative risk is conducted for the Portland Harbor, this remedial investigation may have to be revisited based on that risk assessment's results.

## 6.5 Summary of Surface Water Screening

The risk associated with direct contact and incidental ingestion of surface water by aquatic ecological receptors was assessed by comparing the surface water chemistry data to established risk-based water quality criteria. For this comparison, the analytical data for surface waters were compared against Oregon's AWQC established to protect the beneficial uses of the state's waterways. This comparison was conducted to provide a definitive assessment of risk to aquatic organisms from direct contact and ingestion of surface waters at the site. If the detected concentrations of constituents were below corresponding acute and chronic AWQC, no unacceptable risks to aquatic ecological receptors (including sensitive species) were predicted at this site.

Sampling locations were spatially distributed in the Slip to provide a comprehensive evaluation of potential exposure point concentrations to constituents of concern present in surface water (Figure 5). Samples were collected from just above the sediment-water interface to represent the potential worst-case conditions of contaminants solubilizing from sediment and also from the midpoint in the water column to represent the more likely exposure point for resident fish. As presented in Section 3.3, surface water samples were analyzed for TSS, BTEX, PAHs, and total and dissolved priority pollutant metals.

The analytical results and screening of the surface water data are presented in Table 7.

No concentrations of constituents were detected above corresponding acute or chronic AWQC in any of the surface water samples collected from the site. Therefore, no unacceptable risks to ecological receptors (including sensitive species) related to surface water exposure are expected in this slip.

## 6.6 Summary of Sediment Bioassay Results

The risk from direct contact and incidental ingestion of sediment by aquatic ecological receptors was assessed by sediment bioassay testing as described in Section 5.0. The results of the sediment bioassays are reported in Tables 14 through 16. These tables list the sediment samples, the corresponding reference sediment sample, the test endpoint, comparison with the "one-hit" and "two-hit" interpretative criteria, and the overall results of whether the test sediment passed or failed the biological effects interpretive criteria. As discussed in Section 5.0, bioassay testing was conducted in two phases during this RI.

In the Phase 1 bioassay testing, the test sediments were determined to have passed the biological effects criteria. In the Phase 2 bioassay testing, six of ten samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, HC-S-16, and HC-S-22) failed the biological effects criteria. Of the six test sediments that failed biological criteria, five samples (HC-S-01, HC-S-04, HC-S-05, HC-S-07, and HC-S-22) exhibited a marked response in one or more bioassay tests (one-hit failure), and one sample (HC-S-16) failed biological criteria based on two tests exhibiting statistically different responses from the corresponding reference sediment (two-hit failure).

The spatial distribution of the sediment samples failing biological interpretative criteria is presented on Figure 27 and, additionally, is shown along with the contours of constituents of concern on Figures 11 through 16.

As direct contact and incidental ingestion of sediment by aquatic organisms were the primary exposure pathways of concern at this site, the results of the sediment bioassays are considered definitive for delineating areas causing unacceptable ecological risks in the Slip. Bioaccumulation and food chain exposure were not identified as a concerns at this site because of the limited detection and the low concentrations of bioaccumulative compounds in sediments at this site. These sediment bioassays utilize pollution-sensitive organisms that reside within the biologically active zone in surface sediments and receive maximum exposure to sediment contaminants based on their life history characteristics. Additionally, bioassays are the best tool for evaluating the potential toxic effects of multiple contaminants present in sediments.

## 6.7 Delineation of Areas Requiring Evaluation of Remedial Alternatives

Areas of the site requiring an evaluation of remedial alternatives, as shown on Figure 29, were delineated using a combination of analytical chemistry results and the results of the confirmatory bioassays conducted for this RI. This delineation was conducted in accordance with the Washington State Sediment Management Standards established for Puget Sound and included in the DEQ-approved work plans for this investigation (Hart Crowser, 1998a). The Washington State Sediment Management Standard was used because the DEQ does not currently have promulgated sediment cleanup criteria. As presented in the Washington State Sediment Management Standard WAC Chapter 173-204 and PSDDA Program, sediments with concentrations of COPCs that exceed sediment quality standards or criteria (in the case of this RI, the LCRMA SLs and MLs) are designated as having ecological adverse effects, pending confirmation via biological testing. For the purpose of this RI, the LCRMA SLs and MLs are used only for comparison purposes and are not regulatory standards or criteria.

A suite of three bioassays are used as biological effects criteria to confirm or overturn initial designations based on chemical criteria. The results of the sediment bioassays are considered more definitive than chemical criteria for assessing risks to benthic organisms from direct contact and ingestion of surface sediments.

The sediment samples selected for bioassay testing for this RI were spatially distributed within the site to capture both a range of concentrations of constituents of concern and also to ensure sufficient spatial coverage within Slip 3 for delineating areas of the site requiring an evaluation of remedial alternatives.

Based on the exposure pathway analysis and the assessment of ecological risks associated with exposure to surface water, the ecological risks associated with direct contact and ingestion of surface sediments was the only complete exposure pathway present at this site on which to base decisions regarding areas of the site requiring an evaluation of remedial alternatives. The concentration of bioaccumulative contaminants of interest identified for the Portland Harbor are present at low or undetected concentrations in the sediments of this slip. Thus, the bioaccumulation exposure pathway is not considered to be a significant pathway of concern at this site. The area of the Slip requiring further evaluation is delineated by identifying areas that exhibit unacceptable ecological risks based on sediment bioassay failures. This area is presented on Figure 29.

The area delineated in Figure 29 serves as the starting point for the evaluation of remedial alternatives to be conducted as part of the Feasibility Study for this site.

## 7.0 REFERENCES


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# Tables

**Table 1 - Sediment Sample Identification and Analysis Summary**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | PAHs | Volatile Organic Compounds | Grain Size | Metals | Pesticides | Bioassays | Pencil Pitch | Diesel |
|---|---|---|---|---|---|---|---|---|
| HC-S-01 | X | X | X | | | X | X | X |
| HC-S-02 | X | X | X | X | | | X | X |
| HC-S-03 | X | X | | | | | X | X |
| HC-S-04 | X | X | X | X | | X | X | X |
| HC-S-05 | X | X | X | X | | X | X | X |
| HC-S-06 | | | | | | | X | X |
| HC-S-07 | X | X | X | X | | X | X | X |
| HC-VC-07-S1 | X | X | | X | | | X | |
| HC-VC-07-S2 | X | X | X | X | | | X | |
| HC-S-08 | X | X | X | | | | X | X |
| HC-S-09 | X | X | | X | | | X | X |
| HC-S-10 | | | | | | | X | X |
| HC-S-11 | X | X | X | X | | X | X | X |
| HC-VC-11-S1 | X | X | | X | | | X | X |
| HC-VC-11-S2 | X | X | X | X | | | X | X |
| HC-S-12 | | | | | | | X | X |
| HC-S-13 | X | X | X | X | | | X | X |
| HC-VC-13-S1 | X | X | | X | | | X | X |
| HC-VC-13-S2 | X | X | X | X | | | X | |
| HC-S-14 | X | X | | X | | | X | X |
| HC-S-15 | | | | | | | X | X |
| HC-S-16 | X | X | X | X | X | X | X | X |
| HC-S-17 | | | | | | | X | X |
| HC-S-18 | | | | | | | X | X |
| HC-VC-18-S1 | X | X | | | | | X | |
| HC-VC-18-S2 | X | X | X | | | | X | |
| HC-S-19 | X | X | X | X | | X | X | X |
| HC-S-20 | X | X | | | | | X | X |
| HC-S-21 | | | | | | | X | X |
| HC-S-22 | X | X | X | X | | X | X | X |
| HC-VC-22-S1 | X | X | | X | | | X | |
| HC-VC-22-S2 | X | X | | X | | | X | |
| HC-S-23 | | | | | | | X | X |
| HC-S-24 | X | X | X | X | | X | X | X |
| HC-S-25 | X | X | | X | | | X | X |
| HC-S-26 | X | X | X | X | | X | X | X |

**Table 1 - Sediment Sample Identification and Analysis Summary**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | PAHs | Volatile Organic Compounds | Grain Size | Metals | Pesticides | Bioassays | Pencil Pitch | Diesel |
|---|---|---|---|---|---|---|---|---|
| HC-S-27 | | | | | | | X | X |
| HC-VC-27-S1 | X | X | | X | | | X | |
| HC-VC-27-S2 | X | X | | X | | | X | |
| HC-S-28 | X | X | X | X | X | X | X | X |
| HC-S-29 | | | | | | | X | X |
| HC-S-30 | X | X | X | X | | X | X | X |
| HC-S-31 | | | | | | | X | X |
| HC-S-32 | X | X | X | | | | X | X |
| HC-VC-32-S1 | X | X | | | | | X | |
| HC-VC-32-S2 | X | X | X | | | | X | |
| HC-S-33 | | | | | | | X | X |
| HC-S-34 | X | X | X | X | | | X | X |
| HC-S-35 | X | X | X | X | | X | X | X |
| HC-S-36 | X | X | X | X | X | X | X | X |
| HC-S-37 | X | X | | | | | X | X |
| HC-S-38 | X | X | | | | | X | X |
| HC-S-39 | X | X | X | X | X | X | X | X |
| HC-VC-39-S1 | X | X | | X | | | X | |
| HC-VC-39-S2 | X | X | | X | | | X | |
| HC-S-40 | X | X | | | | | X | X |
| HC-S-41 | X | X | | X | | | X | X |
| HC-S-42 | X | X | X | X | | X | X | X |
| HC-VC-42-S1 | X | X | | X | | | X | |
| HC-VC-42-S2 | X | X | | X | | | X | |
| HC-S-43 | X | X | | | X | | X | X |
| HC-S-44 | X | X | X | | | | X | X |
| Reference B | X | X | X | X | | X | | |
| Reference C | X | X | X | X | | X | | |

**Table 2 - Sample Collection Dates, Locations, and Mudline Elevations**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Sampling Date | Latitude | Longitude | Sediment Elevation in CRD |
|---|---|---|---|---|
| HC-S-01 | 10/13/98 | 45° 36.06' | 122° 46.38' | -46 |
| HC-S-02 | 10/13/98 | 45° 36.05' | 122° 46.37' | -37.8 |
| HC-S-03 | 10/13/98 | 45° 36.03' | 122° 46.37' | -25.6 |
| HC-S-04 | 10/13/98 | 45° 36.02' | 122° 46.37' | -31.6 |
| HC-S-05 | 10/13/98 | 45° 36.01' | 122° 46.40' | -34.9 |
| HC-S-06 | 10/13/98 | 45° 36.02' | 122° 46.39' | -40.7 |
| HC-S-07 | 10/13/98 | 45° 36.03' | 122° 46.39' | -39.2 |
| HC-VC-07 | 10/12/98 | 45° 36.03' | 122° 46.39' | -40.2 |
| HC-S-08 | 10/13/98 | 45° 36.04' | 122° 46.39' | -43.6 |
| HC-S-09 | 10/13/98 | 45° 36.06' | 122° 46.38' | -46.1 |
| HC-S-10 | 10/14/98 | 45° 36.06' | 122° 46.41' | -48.1 |
| HC-S-11 | 10/12/98 | 45° 36.05' | 122° 46.41' | -44 |
| HC-VC-11 | 10/12/98 | 45° 36.05' | 122° 46.41' | -44 |
| HC-S-12 | 10/14/98 | 45° 36.03' | 122° 46.41' | -37.9 |
| HC-S-13 | 10/12/98 | 45° 36.02' | 122° 46.42' | -40.2 |
| HC-VC-13 | 10/12/98 | 45° 36.02' | 122° 46.42' | -40.2 |
| HC-S-14 | 10/14/98 | 45° 36.01' | 122° 46.45' | -35.4 |
| HC-S-15 | 10/14/98 | 45° 36.02' | 122° 46.44' | -39.9 |
| HC-S-16 | 10/14/98 | 45° 36.04' | 122° 46.44' | -37.4 |
| HC-S-17 | 10/14/98 | 45° 36.05' | 122° 46.44' | -43.5 |
| HC-S-18 | 10/12/98 | 45° 36.06' | 122° 46.43' | -47.8 |
| HC-VC-18 | 10/12/98 | 45° 36.06' | 122° 46.43' | -48.0 |
| HC-S-19 | 10/15/98 | 45° 36.06' | 122° 46.42' | -40 |
| HC-S-20 | 10/15/98 | 45° 36.06' | 122° 46.45' | -45.6 |
| HC-S-21 | 10/15/98 | 45° 36.07' | 122° 46.47' | -45.8 |
| HC-S-22 | 10/14/98 | 45° 36.05' | 122° 46.47' | -45.9 |
| HC-VC-22 | 10/12/98 | 45° 36.05' | 122° 46.47' | -46.7 |
| HC-S-23 | 10/14/98 | 45° 36.04' | 122° 46.47' | -41 |
| HC-S-24 | 10/14/98 | 45° 36.02' | 122° 46.48' | -42.7 |
| HC-S-25 | 10/14/98 | 45° 36.01' | 122° 46.50' | -36.5 |
| HC-S-26 | 10/14/98 | 45° 36.02' | 122° 46.51' | -36.4 |
| HC-S-27 | 10/14/98 | 45° 36.03' | 122° 46.52' | -42.3 |
| HC-VC-27 | 10/12/98 | 45° 36.03' | 122° 46.52' | -43.0 |
| HC-S-28 | 10/12/98 | 45° 36.04' | 122° 46.52' | -47.1 |
| HC-S-29 | 10/14/98 | 45° 36.05' | 122° 46.52' | -41.4 |
| HC-S-30 | 10/15/98 | 45° 36.07' | 122° 46.52' | -45.1 |
| HC-S-31 | 10/15/98 | 45° 36.07' | 122° 46.54' | -41.8 |
| HC-S-32 | 10/14/98 | 45° 36.06' | 122° 46.54' | -45.9 |

**Refer to notes at the end of this table.**

**Table 2 - Sample Collection Dates, Locations, and Mudline Elevations**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Sampling Date | Latitude | Longitude | Sediment Elevation in CRD |
|---|---|---|---|---|
| HC-VC-32 | 10/12/98 | 45° 36.06' | 122° 46.54' | -46.3 |
| HC-S-33 | 10/14/98 | 45° 36.04' | 122° 46.55' | -43.2 |
| HC-S-34 | 10/15/98 | 45° 36.01' | 122° 46.55' | -38 |
| HC-S-35 | 10/14/98 | 45° 36.07' | 122° 46.57' | -40.9 |
| HC-S-36 | 10/15/98 | 45° 36.05' | 122° 46.60' | -42.6 |
| HC-S-37 | 10/14/98 | 45° 36.08' | 122° 46.61' | -41.5 |
| HC-S-38 | 10/15/98 | 45° 35.97' | 122° 46.56' | -25.3 |
| HC-S-39 | 10/15/98 | 45° 35.94' | 122° 46.54' | -26.7 |
| HC-VC-39 | 10/12/98 | 45° 35.94' | 122° 46.54' | -27.1 |
| HC-S-40 | 10/15/98 | 45° 35.92' | 122° 46.53' | -32.9 |
| HC-S-41 | 10/15/98 | 45° 36.09' | 122° 46.54' | -10.8 |
| HC-S-42 | 10/15/98 | 45° 36.10' | 122° 46.56' | -11.2 |
| HC-VC-42 | 10/12/98 | 45° 36.10' | 122° 46.56' | -46.3 |
| HC-S-43 | 10/15/98 | 45° 36.12' | 122° 46.62' | -12.9 |
| HC-S-44 | 10/15/98 | 45° 36.10' | 122° 46.62' | -17.3 |
| Reference Site B | 10/15/98 | 45° 44.93' | 122° 46.25' | - - |
| Reference Site C | 10/15/98 | 45° 41.69' | 122° 45.75' | - - |
| HC-WS-01-B | 10/15/98 | 45° 36.03' | 122° 46.38' | - - |
| HC-WS-01-M | 10/15/98 | 45° 36.03' | 122° 46.38' | - - |
| HC-WS-02-B | 10/15/98 | 45° 36.04' | 122° 46.50' | - - |
| HC-WS-02-M | 10/15/98 | 45° 36.04' | 122° 46.50' | - - |
| HC-WS-03-B | 10/15/98 | 45° 36.05' | 122° 46.62' | - - |
| HC-WS-03-M | 10/15/98 | 45° 36.05' | 122° 46.62' | - - |

**Notes:**
Coordinates on NAD 83 Geographic Coordinates
- - = Not Applicable

**Table 3 - Summary of Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conventionals in mg/kg** | | | | | | | | | | |
| Ammonia as Nitrogen | 32/32 | 12.2 to 224 | 224 | HC-S-01 | | | | | | |
| Sulfide, Total | 32/32 | 1.6 to 1830 J | 1830 J | HC-S-25 | | | | | | |
| **Conventionals in %** | | | | | | | | | | |
| Carbon, Total Organic | 32/32 | .42 to 3.69 | 3.69 | HC-S-01 | | | | | | |
| Solids, Total | 44/44 | 30.1 to 78 | 78 | HC-S-19 | | | | | | |
| Solids, Total Volatile | 34/34 | 1.76 to 12.9 | 12.9 | HC-S-02 | | | | | | |
| **Metals in mg/kg** | | | | | | | | | | |
| Antimony, Total | 17/25 | .1 J to 4.4 J | 4.4 J | HC-S-19 | 150 | 0/25 | | 200 | 0/25 | |
| Arsenic, Total | 25/25 | 3 to 14 | 14 | HC-S-02 | 57 | 0/25 | | 700 | 0/25 | |
| Cadmium, Total | 25/25 | .2 to 6.6 J | 6.6 J | HC-S-25 | 5.1 | 2/25 | 1.29 | 14 | 0/25 | |
| Chromium, Total | 25/25 | 14.3 to 35.3 | 35.3 | HC-S-14 | | | | | | |
| Copper, Total | 25/25 | 15.3 to 90.1 | 90.1 | HC-S-02 | 390 | 0/25 | | 1300 | 0/25 | |
| Lead, Total | 25/25 | 15.2 to 1160 | 1160 | HC-S-19 | 450 | 4/25 | 2.58 | 1200 | 0/25 | |
| Mercury, Total | 24/25 | .02 U to .34 | 0.34 | HC-S-25 | 0.41 | 0/25 | | 2.3 | 0/25 | |
| Nickel, Total | 25/25 | 12 to 56 | 56 | HC-S-25 | 140 | 0/25 | | 370 | 0/25 | |
| Silver, Total | 25/25 | .1 to 2 | 2 | HC-S-02 | 6.1 | 0/25 | | 8.4 | 0/25 | |
| Zinc, Total | 25/25 | 82 J to 1330 J | 1330 J | HC-S-25 | 410 | 7/25 | 3.24 | 3800 | 0/25 | |
| **Volatiles in µg/kg** | | | | | | | | | | |
| 1,2-Dichlorobenzene | 0/32 | 5 U to 25 U | N/A | | 35 | 0/32 | | 110 | 0/32 | |
| 1,3-Dichlorobenzene | 0/32 | 5 U to 25 U | N/A | | 170 | 0/32 | | | | |
| 1,4-Dichlorobenzene | 0/32 | 5 U to 25 U | N/A | | 110 | 0/32 | | 120 | 0/32 | |
| Benzene | 0/32 | 5 U to 25 U | N/A | | | | | | | |
| Ethylbenzene | 0/32 | 5 U to 25 U | N/A | | 10 | 0/32 | | 50 | 0/32 | |
| Tetrachloroethene (PCE) | 0/32 | 5 U to 25 U | N/A | | 57 | 0/32 | | 210 | 0/32 | |
| Toluene | 0/32 | 5 U to 25 U | N/A | | | | | | | |
| Total Xylenes | 0/32 | 5 U to 25 U | N/A | | 40 | 0/32 | | 160 | 0/32 | |
| Trichloroethene (TCE) | 0/32 | 5 U to 25 U | N/A | | 160 | 0/32 | | 1600 | 0/32 | |

**Refer to notes at the end of this table.**

**Table 3 - Summary of Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **Volatiles in µg/kg** | | | | | | | | | | |
| m- & p-Xylenes | 0/32 | 5 U to 25 U | N/A | | | | | | | |
| o-Xylene | 0/32 | 5 U to 25 U | N/A | | | | | | | |
| **TPH in mg/kg** | | | | | | | | | | |
| Diesel | 14/44 | 25 UJ to 962 | 962 | HC-S-25 | | | | | | |
| Fluoranthene | 44/44 | .5 J to 180 J | 180 J | HC-S-19 | 2100 | 0/44 | | 2400 | 0/44 | |
| Lube Oil | 7/44 | 100 U to 1100 J | 1100 J | HC-S-25 | | | | | | |
| Pencil Pitch | 44/44 | 20.9 to 8430 | 8430 | HC-S-19 | | | | | | |
| Phytane | 11/44 | .5 to 6.1 | 6.1 | HC-S-25 | | | | | | |
| Pristane | 15/44 | .5 to 7 | 7 | HC-S-25 | | | | | | |
| **LPAHs in µg/kg** | | | | | | | | | | |
| Acenaphthene | 31/33 | 23 to 20000 U | 14000 | HC-S-02 | 500 | 14/33 | 28.00 | 2000 | 3/33 | 7 |
| Acenaphthylene | 18/33 | 20 to 20000 U | 3600 | HC-S-24 | 560 | 1/33 | 6.43 | 1300 | 1/33 | 2.77 |
| Anthracene | 31/33 | 27 to 20000 U | 12000 | HC-S-02 | 960 | 14/33 | 12.50 | 13000 | 0/33 | |
| Fluorene | 28/33 | 20 U to 20000 U | 14000 | HC-S-02 | 540 | 10/33 | 25.93 | 3600 | 1/33 | 3.89 |
| Naphthalene | 26/33 | 20 U to 20000 U | 2200 | HC-S-24 | 2100 | 1/33 | 1.05 | 2400 | 0/33 | |
| Phenanthrene | 33/33 | 150 to 74000 | 74000 | HC-S-02 | 1500 | 23/33 | 49.33 | 21000 | 4/33 | 3.52 |
| Total LPAHs (1/2 U) | 33/33 | 253 to 124000 | 124000 | HC-S-02 | 5200 | 17/33 | 23.85 | 29000 | 6/33 | 4.28 |
| **HPAHs in µg/kg** | | | | | | | | | | |
| Benz(a)anthracene | 33/33 | 170 to 81000 | 81000 | HC-S-02 | 1300 | 25/33 | 62.31 | 5100 | 18/33 | 15.88 |
| Benzo(a)pyrene | 33/33 | 180 to 86000 | 86000 | HC-S-01 | 1600 | 26/33 | 53.75 | 3600 | 22/33 | 23.89 |
| Benzo(b)fluoranthene | 33/33 | 150 to 83000 | 83000 | HC-S-01 | | | | | | |
| Benzo(g,h,i)perylene | 33/33 | 220 to 55000 | 55000 | HC-S-01 | 670 | 28/33 | 82.09 | 3200 | 21/33 | 17.19 |
| Benzo(k)fluoranthene | 33/33 | 98 to 63000 | 63000 | HC-S-02 | | | | | | |
| Chrysene | 33/33 | 170 to 78000 | 78000 | HC-S-02 | 1400 | 27/33 | 55.71 | 21000 | 6/33 | 3.71 |
| Dibenz(a,h)anthracene | 30/33 | 50 to 20000 U | 11000 | HC-S-19 | 230 | 24/33 | 47.83 | 1900 | 7/33 | 5.79 |
| Fluoranthene | 33/33 | 310 to 130000 | 130000 | HC-S-02 | 1700 | 30/33 | 76.47 | 30000 | 6/33 | 4.33 |
| Indeno(1,2,3-cd)pyrene | 33/33 | 340 to 110000 | 110000 | HC-S-01 | 600 | 32/33 | 183.33 | 4400 | 23/33 | 25.00 |

**Refer to notes at the end of this table.**

**Table 3 - Summary of Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | | | | | |
| Pyrene | 33/33 | 380 to 110000 | 110000 | HC-S-24 | 2600 | 27/33 | 42.31 | 16000 | 14/33 | 6.88 |
| Total Benzofluoranthenes | 33/33 | 248 to 144000 | 144000 | HC-S-01 | 3200 | 24/33 | 45.00 | 9900 | 18/33 | 14.55 |
| Total HPAHs (1/2 U) | 33/33 | 2068 to 775000 | 775000 | HC-S-01 | 12000 | 28/33 | 64.58 | 69000 | 18/33 | 11.23 |
| **Phenols in µg/kg** | | | | | | | | | | |
| 2,4-Dimethylphenol | 3/33 | 6 U to 6000 U | 31 | HC-S-19 | 29 | 1/33 | 1.07 | 210 | 0/33 | |
| 2-Methylphenol | 2/33 | 6 U to 6000 U | 51 | HC-S-19 | 63 | 0/33 | | 77 | 0/33 | |
| 4-Methylphenol | 4/33 | 20 U to 20000 U | 130 | HC-S-19 | 670 | 0/33 | | 3600 | 0/33 | |
| Pentachlorophenol (PCP) | 0/33 | 60 U to 60000 U | N/A | | 400 | 0/33 | | 690 | 0/33 | |
| Phenol | 2/33 | 20 U to 20000 U | 110 | HC-S-19 | 420 | 0/33 | | 1200 | 0/33 | |
| **Phthalates in µg/kg** | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 28/33 | 50 to 20000 U | 550 | HC-S-43 | 8300 | 0/33 | | | | |
| Butyl Benzyl Phthalate | 7/33 | 20 to 20000 U | 110 | HC-S-41 | 970 | 0/33 | | | | |
| Di-n-butyl Phthalate | 1/33 | 20 U to 20000 U | 43 | HC-S-20 | 5100 | 0/33 | | | | |
| Di-n-octyl Phthalate | 2/33 | 20 U to 20000 U | 100 | HC-S-42 | 6200 | 0/33 | | | | |
| Diethyl Phthalate | 1/33 | 20 U to 20000 U | 25 | HC-S-25 | 1200 | 0/33 | | | | |
| Dimethyl Phthalate | 0/33 | 20 U to 20000 U | N/A | | 1400 | 0/33 | | | | |
| **Semivolatiles in µg/kg** | | | | | | | | | | |
| Benzoic Acid | 1/33 | 100 U to 100000 U | 110 | HC-S-19 | 650 | 0/33 | | 760 | 0/33 | |
| Benzyl Alcohol | 0/33 | 6 U to 6000 U | N/A | | 57 | 0/33 | | 870 | 0/33 | |
| Dibenzofuran | 21/33 | 20 U to 20000 U | 860 | HC-S-38 | 540 | 2/33 | 1.59 | 1700 | 0/33 | |
| Hexachlorobenzene | 0/33 | 20 U to 20000 U | N/A | | 22 | 0/33 | | 230 | 0/33 | |
| Hexachlorobutadiene | 0/33 | 20 U to 20000 U | N/A | | 29 | 0/33 | | 290 | 0/33 | |
| N-Nitrosodiphenylamine | 0/33 | 12 U to 12000 U | N/A | | 28 | 0/33 | | 130 | 0/33 | |
| **Pesticide µg/kg** | | | | | | | | | | |
| 4,4'-DDD | 5/5 | 1 J to 8 J | 8 J | HC-S-16; S-28; S-43 | | | | | | |
| 4,4'-DDE | 4/5 | 2 J to 20 U | 5 J | HC-S-16; S-28 | | | | | | |
| 4,4'-DDT | 4/5 | 3 J to 26 | 26 | HC-S-16 | | | | | | |

**Refer to notes at the end of this table.**

**Table 3 - Summary of Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pesticide µg/kg** | | | | | | | | | | |
| Total DDT | 5/5 | 5 J to 39 J | 39 J | HC-S-16 | 6.9 | 5/5 | 5.65 | 69 | 0/5 | |
| Aldrin | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |
| Dieldrin | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |
| Endosulfan I | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Endosulfan II | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Endosulfan Sulfate | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Endrin | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Endrin Aldehyde | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Endrin Ketone | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Heptachlor | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |
| Heptachlor Epoxide | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Methoxychlor | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| Toxaphene | 0/5 | 300 U to 300 U | N/A | | | | | | | |
| alpha-BHC | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| alpha-Chlordane | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |
| beta-BHC | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| delta-BHC | 0/5 | 20 U to 20 U | N/A | | | | | | | |
| gamma-BHC | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |
| gamma-Chlordane | 0/5 | 20 U to 20 U | N/A | | 10 | 0/5 | | | | |

**Notes:**
N/A = Not Applicable
U = Not detected at the detection limit indicated
J = Estimated concentration

## Table 4 - Sediment Grain Size Summary
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon

| Sample Identification | %Gravel | %Sand | %Silt | %Clay | Material Description |
|---|---|---|---|---|---|
| HC-S-01 | 0.1 | 19.1 | 65 | 15.8 | Clayey, sandy SILT |
| HC-S-02 | 0.3 | 54.5 | 33.1 | 12.1 | Clayey, very silty SAND |
| HC-S-04 | 0.7 | 17.7 | 66.6 | 15 | Clayey, sandy SILT |
| HC-S-05 | 0 | 39.6 | 45.8 | 14.6 | Clayey, very sandy SILT |
| HC-S-07 | 0 | 12.9 | 68.3 | 18.8 | Sandy, clayey SILT |
| HC-VC-7-S2 | 0.1 | 47.8 | 36.3 | 15.8 | Clayey, very silty SAND |
| HC-S-08 | 0 | 5.6 | 73.7 | 20.7 | Slightly sandy, clayey SILT |
| HC-S-11 | 0 | 13.4 | 69.8 | 16.8 | Sandy, clayey, SILT |
| HC-VC-11-S2 | 0 | 47.8 | 39.7 | 12.5 | Clayey, very silty SAND |
| HC-S-13 | 0.1 | 39.1 | 46.4 | 14.4 | Clayey, very sandy SILT |
| HC-VC-13-S2 | 0.1 | 96.9 | 2.1 | 0.9 | SAND |
| HC-S-16 | 0 | 29.6 | 55.3 | 15.1 | Clayey, sandy SILT |
| HC-VC-18-S2 | 0 | 96.8 | 2.3 | 0.9 | SAND |
| HC-S-19 | 3.7 | 64.4 | 24.4 | 7.5 | Slightly clayey, silty SAND |
| HC-S-22 | 0 | 39 | 46.9 | 14.1 | Clayey, very sandy SILT |
| HC-S-24 | 0.7 | 58.5 | 30.4 | 10.4 | Slightly clayey, silty SAND |
| HC-S-26 | 0 | 76.9 | 17.4 | 5.7 | Slightly clayey, silty SAND |
| HC-S-28 | 0 | 16 | 65 | 19 | Sandy, clayey SILT |
| HC-S-30 | 0 | 59.2 | 30.6 | 10.2 | Slightly clayey, silty SAND |
| HC-S-32 | 0 | 43.8 | 38.6 | 17.6 | Clayey, very silty SAND |
| HC-VC-32-S2 | 0 | 96.5 | 2.6 | 0.9 | SAND |
| HC-S-34 | 0.1 | 38.2 | 47.2 | 14.5 | Clayey, very sandy SILT |
| HC-S-35 | 0 | 35.5 | 50.2 | 14.3 | Clayey, very sandy SILT |
| HC-S-36 | 0.2 | 76.4 | 17.1 | 6.3 | Slightly clayey, silty SAND |
| HC-S-39 | 0 | 14.9 | 69.4 | 15.7 | Sandy, clayey SILT |
| HC-S-42 | 0 | 7.1 | 78.3 | 14.6 | Slightly sandy, clayey SILT |
| HC-S-44 | 0 | 11.2 | 72 | 16.8 | Slightly sandy, clayey SILT |
| HC-Ref-B | 0 | 0.9 | 73.6 | 25.5 | Clayey SILT |
| HC-Ref-C | 1.1 | 79.1 | 16.6 | 3.2 | Silty SAND |

**Table 5 - Summary of Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **Conventionals in mg/kg** | | | | | | | | | | |
| Ammonia as Nitrogen | 18/18 | 1.4 to 327 | 327 | HC-VC-39-S2 | | | | | | |
| Sulfide, Total | 12/12 | 2 J to 796 J | 796 J | HC-VC-7-S2 | | | | | | |
| **Conventionals in %** | | | | | | | | | | |
| Carbon, Total Organic | 18/18 | .03 to 2.95 | 2.95 | HC-VC-42-S2 | | | | | | |
| Solids, Total | 18/18 | 49 to 81.4 | 81.4 | HC-VC-32-S2 | | | | | | |
| Solids, Total Volatile | 18/18 | 1.73 to 10.5 | 10.5 | HC-VC-11-S1 | | | | | | |
| **Metals in mg/kg** | | | | | | | | | | |
| Antimony, Total | 7/14 | .1 UJ to 1.4 J | 1.4 J | HC-VC-7-S2 | 150 | 0/14 | | 200 | 0/14 | |
| Arsenic, Total | 14/14 | 2 to 15 | 15 | HC-VC-7-S2 | 57 | 0/14 | | 700 | 0/14 | |
| Cadmium, Total | 13/14 | .1 to 3.3 | 3.3 | HC-VC-7-S2 | 5.1 | 0/14 | | 14 | 0/14 | |
| Chromium, Total | 14/14 | 9 to 29.4 | 29.4 | HC-VC-42-S2 | | | | | | |
| Copper, Total | 14/14 | 13.3 to 83.2 | 83.2 | HC-VC-7-S2 | 390 | 0/14 | | 1300 | 0/14 | |
| Lead, Total | 14/14 | 3 to 576 | 576 | HC-VC-7-S2 | 450 | 2/14 | 1.28 | 1200 | 0/14 | |
| Mercury, Total | 12/14 | .02 to .18 | 0.18 | HC-VC-7-S2 | 0.41 | 0/14 | | 2.3 | 0/14 | |
| Nickel, Total | 14/14 | 15 to 26 | 26 | HC-VC-7-S1 | 140 | 0/14 | | 370 | 0/14 | |
| Silver, Total | 10/14 | .1 U to 1.4 | 1.4 | HC-VC-7-S2 | 6.1 | 0/14 | | 8.4 | 0/14 | |
| Zinc, Total | 14/14 | 37 to 656 | 656 | HC-VC-11-S2 | 410 | 3/14 | 1.6 | 3800 | 0/14 | |
| **Volatiles in µg/kg** | | | | | | | | | | |
| 1,2-Dichlorobenzene | 0/18 | 5 U to 10 U | N/A | | 35 | 0/18 | | 110 | 0/18 | |
| 1,3-Dichlorobenzene | 0/18 | 5 U to 10 U | N/A | | 170 | 0/18 | | | | |
| 1,4-Dichlorobenzene | 0/18 | 5 U to 10 U | N/A | | 110 | 0/18 | | 120 | 0/18 | |
| Benzene | 0/18 | 5 U to 10 U | N/A | | | | | | | |
| Ethylbenzene | 0/18 | 5 U to 10 U | N/A | | 10 | 0/18 | | 50 | 0/18 | |
| Tetrachloroethene (PCE) | 0/18 | 5 U to 10 U | N/A | | 57 | 0/18 | | 210 | 0/18 | |
| Toluene | 0/18 | 5 U to 10 U | N/A | | | | | | | |
| Total Xylenes | 0/18 | 5 U to 10 U | N/A | | 40 | 0/18 | | 160 | 0/18 | |
| Trichloroethene (TCE) | 0/18 | 5 U to 10 U | N/A | | 160 | 0/18 | | 1600 | 0/18 | |

**Refer to notes at the end of this table.**

**Table 5 - Summary of Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **Volatiles in µg/kg** | | | | | | | | | | |
| m- & p-Xylenes | 0/18 | 5 U to 10 U | N/A | | | | | | | |
| o-Xylene | 0/18 | 5 U to 10 U | N/A | | | | | | | |
| **TPH in mg/kg** | | | | | | | | | | |
| Diesel | 0/3 | 25 U to 100 U | N/A | | | | | | | |
| Fluoranthene | 2/3 | .5 U to 24 | 24 | HC-VC-11-S2 | 2100 | 0/3 | | 2400 | 0/3 | |
| Lube Oil | 0/3 | 100 U to 100 U | N/A | | | | | | | |
| Pencil Pitch | 16/18 | 21 to 2000 | 2000 | HC-VC-42-S2 | | | | | | |
| Phytane | 0/3 | .5 U to .5 U | N/A | | | | | | | |
| Pristane | 0/3 | .5 U to .5 U | N/A | | | | | | | |
| **LPAHs in µg/kg** | | | | | | | | | | |
| Acenaphthene | 2/18 | 20 U to 4000 U | 510 | HC-VC-18-S1 | 500 | 1/18 | 1.02 | 2000 | 0/18 | |
| Acenaphthylene | 0/18 | 20 U to 4000 U | N/A | | 560 | 0/18 | | 1300 | 0/18 | |
| Anthracene | 5/18 | 20 U to 4000 U | 1000 | HC-VC-11-S1 | 960 | 1/18 | 1.04 | 13000 | 0/18 | |
| Fluorene | 0/18 | 20 U to 4000 U | N/A | | 540 | 0/18 | | 3600 | 0/18 | |
| Naphthalene | 0/18 | 20 U to 4000 U | N/A | | 2100 | 0/18 | | 2400 | 0/18 | |
| Phenanthrene | 15/18 | 20 U to 10000 | 10000 | HC-VC-42-S2 | 1500 | 8/18 | 6.67 | 21000 | 0/18 | |
| Total LPAHs (1/2 U) | 15/18 | 60 U to 20000 | 20000 | HC-VC-42-S2 | 5200 | 5/18 | 3.85 | 29000 | 0/18 | |
| **HPAHs in µg/kg** | | | | | | | | | | |
| Benz(a)anthracene | 16/18 | 20 U to 20000 | 20000 | HC-VC-42-S2<br>HC-VC-7-S1 | 1300 | 10/18 | 15.38 | 5100 | 6/18 | 3.92 |
| Benzo(a)pyrene | 16/18 | 20 U to 24000 | 24000 | HC-VC-42-S2 | 1600 | 10/18 | 15.00 | 3600 | 9/18 | 6.67 |
| Benzo(b)fluoranthene | 16/18 | 20 U to 21000 | 21000 | HC-VC-42-S2 | | | | | | |
| Benzo(g,h,i)perylene | 16/18 | 20 U to 16000 | 16000 | HC-VC-42-S2 | 670 | 10/18 | 23.88 | 3200 | 7/18 | 5.00 |
| Benzo(k)fluoranthene | 16/18 | 20 U to 17000 | 17000 | HC-VC-7-S1 | | | | | | |
| Chrysene | 16/18 | 20 U to 20000 | 20000 | HC-VC-7-S1 | 1400 | 10/18 | 14.29 | 21000 | 0/18 | |
| Dibenz(a,h)anthracene | 3/18 | 20 U to 4000 U | 43 | HC-VC-13-S2 | 230 | 0/18 | | 1900 | 0/18 | |
| Fluoranthene | 16/18 | 20 U to 28000 | 28000 | HC-VC-7-S1 | 1700 | 10/18 | 16.47 | 30000 | 0/18 | |

**Refer to notes at the end of this table.**

**Table 5 - Summary of Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| | Detection Frequency | Range | Maximum Detection | Location of Max. Detect. | SL | Exceedence Frequency | E-Ratio | ML | Exceedence Frequency | E-Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Indeno(1,2,3-cd)pyrene | 16/18 | 20 U to 32000 | 32000 | HC-VC-42-S2 | 600 | 13/18 | 53.33 | 4400 | 8/18 | 7.27 |
| Pyrene | 16/18 | 20 U to 24000 | 24000 | HC-VC-7-S1; HC-VC-42-S2 | 2600 | 9/18 | 9.23 | 16000 | 3/18 | 1.50 |
| Total Benzofluoranthenes | 16/18 | 20 U to 36000 | 36000 | HC-VC-7-S1; HC-VC-42-S2 | 3200 | 10/18 | 11.25 | 9900 | 6/18 | 3.64 |
| Total HPAHs (1/2 U) | 16/18 | 100 U to 200000 | 200000 | HC-VC-42-S2 | 12000 | 10/18 | 16.67 | 69000 | 6/18 | 2.90 |
| **Phenols in µg/kg** | | | | | | | | | | |
| 2,4-Dimethylphenol | 0/17 | 6 U to 1200 U | N/A | | 29 | 0/17 | | 210 | 0/17 | |
| 2-Methylphenol | 0/17 | 6 U to 1200 U | N/A | | 63 | 0/17 | | 77 | 0/17 | |
| 4-Methylphenol | 0/17 | 20 U to 4000 U | N/A | | 670 | 0/17 | | 3600 | 0/17 | |
| Pentachlorophenol (PCP) | 0/17 | 60 U to 12000 U | N/A | | 400 | 0/17 | | 690 | 0/17 | |
| Phenol | 0/17 | 20 U to 4000 U | N/A | | 420 | 0/17 | | 1200 | 0/17 | |
| **Phthalates in µg/kg** | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 2/18 | 20 U to 4000 U | 180 | HC-VC-39-S2 | 8300 | 0/18 | | | | |
| Butyl Benzyl Phthalate | 0/18 | 20 U to 4000 U | N/A | | 970 | 0/18 | | | | |
| Di-n-butyl Phthalate | 0/18 | 20 U to 4000 U | N/A | | 5100 | 0/18 | | | | |
| Di-n-octyl Phthalate | 0/18 | 20 U to 4000 U | N/A | | 6200 | 0/18 | | | | |
| Diethyl Phthalate | 0/18 | 20 U to 4000 U | N/A | | 1200 | 0/18 | | | | |
| Dimethyl Phthalate | 0/18 | 20 U to 4000 U | N/A | | 1400 | 0/18 | | | | |
| **Semivolatiles in µg/kg** | | | | | | | | | | |
| Benzoic Acid | 0/18 | 100 U to 20000 U | N/A | | 650 | 0/18 | | 760 | 0/18 | |
| Benzyl Alcohol | 0/18 | 6 U to 1200 U | N/A | | 57 | 0/18 | | 870 | 0/18 | |
| Dibenzofuran | 0/18 | 20 U to 4000 U | N/A | | 540 | 0/18 | | 1700 | 0/18 | |
| Hexachlorobenzene | 0/18 | 20 U to 4000 U | N/A | | 22 | 0/18 | | 230 | 0/18 | |
| Hexachlorobutadiene | 0/18 | 20 U to 4000 U | N/A | | 29 | 0/18 | | 290 | 0/18 | |
| N-Nitrosodiphenylamine | 0/18 | 12 U to 2400 U | N/A | | 28 | 0/18 | | 130 | 0/18 | |

**Notes:**
N/A = Not Applicable
U = Not detected at the detection limit indicated
J = Estimated concentration

**Table 6 - Surface Water Sample Identification and Analysis Summary**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Priority Pollutant Metals[1] | Volatile Organics | PAHs | Semivolatile Organics |
|---|---|---|---|---|
| HC-WS-01-B | X | X | X | X |
| HC-WS-01-M | X | X | X | X |
| HC-WS-02-B | X | X | X | X |
| HC-WS-02-M | X | X | X | X |
| HC-WS-03-B | X | X | X | X |
| HC-WS-03-M | X | X | X | X |

**Note:**

[1] Priority Pollutants Include: Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Th, and Zn

**Table 7 - Summary of Surface Water Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Lab ID<br>Sample ID | Fresh<br>Acute | Fresh<br>Chronic | K9807169-019<br>HC-WS-01-B | K9807169-018<br>HC-WS-01-M | K9807169-021<br>HC-WS-02-B | K9807169-020<br>HC-WS-02-M |
|---|---|---|---|---|---|---|
| **Metals in µg/L** | | | | | | |
| Antimony, Total | 9000 | 1600 | 0.09 | 0.05 | 0.04 | 0.05 |
| Arsenic, Total | 360 | 190 | 0.6 | 0.6 | 0.6 | 0.6 |
| Cadmium, Total | 3.7 | 1.03 | 0.02 | 0.02 U | 0.02 U | 0.02 |
| Chromium, Total | 549 | 178 | 0.4 | 0.5 | 0.2 | 0.2 U |
| Copper, Total | 17 | 11.4 | 1.7 | 2 | 1.4 | 2.7 |
| Lead, Total | 64.6 | 2.52 | 2.68 | 2.85 | 0.71 | 0.61 |
| Mercury, Total | 2.4 | 0.012 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Nickel, Total | 1415 | 157 | 0.7 | 0.7 | 0.6 | 0.5 |
| Silver, Total | 1.19 | 0.12 | 0.02 U | 0.02 U | 0.02 U | 0.04 |
| Thallium, Total | 1400 | 40 | 0.02 | 0.03 | 0.02 | 0.02 U |
| Zinc, Total | 114.4 | 104.5 | 5 | 5.2 | 3.2 | 3.2 |
| **Volatiles in µg/L** | | | | | | |
| 1,2-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Benzene | 5300 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Ethylbenzene | 32000 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetrachloroethene (PCE) | 5280 | 840 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toluene | 17500 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene (TCE) | 45000 | 21900 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| m- & p-Xylenes | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| o-Xylene | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Total Xylenes | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| **LPAHs in µg/L** | | | | | | |
| Acenaphthene | 1700 | 520 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Acenaphthylene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Anthracene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Fluorene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Naphthalene | 2300 | 620 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Phenanthrene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Total LPAHs | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| **HPAHs in µg/L** | | | | | | |
| Benz(a)anthracene | | | 0.1 U | 0.1 | 0.1 U | 0.1 U |
| Benzo(a)pyrene | | | 0.1 U | 0.2 | 0.1 U | 0.1 U |
| Benzo(b)fluoranthene | | | 0.1 U | 0.2 | 0.1 U | 0.1 U |
| Benzo(k)fluoranthene | | | 0.1 U | 0.1 | 0.1 U | 0.1 U |
| Total Benzofluoranthenes | | | 0.1 U | 0.3 | 0.1 U | 0.1 U |
| Benzo(g,h,i)perylene | | | 0.1 U | 0.1 | 0.1 U | 0.1 U |
| Chrysene | | | 0.1 U | 0.1 | 0.1 U | 0.1 U |
| Dibenz(a,h)anthracene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Fluoranthene | 3980 | | 0.1 | 0.2 | 0.1 U | 0.1 U |
| Indeno(1,2,3-cd)pyrene | | | 0.2 | 0.3 | 0.1 U | 0.1 U |
| Pyrene | | | 0.1 | 0.2 | 0.1 U | 0.1 U |
| Total HPAHs | | | 0.4 | 1.8 | 0.1 U | 0.1 U |

**Note:**
U = Undetected at or above the MRL

**Table 7 - Summary of Surface Water Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Lab ID<br>Sample ID | Fresh<br>Acute | Fresh<br>Chronic | K9807169-019<br>HC-WS-01-B | K9807169-018<br>HC-WS-01-M | K9807169-021<br>HC-WS-02-B | K9807169-020<br>HC-WS-02-M |
|---|---|---|---|---|---|---|
| **Phenols in µg/L** | | | | | | |
| 2,4-Dimethylphenol | 2120 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Methylphenol | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 4-Methylphenol | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Pentachlorophenol (PCP) | 20 | 13 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Phenol | 10200 | 2560 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| **Phthalates in µg/L** | | | | | | |
| Bis(2-ethylhexyl) Phthalate | | | 0.2 U | 0.4 U | 0.3 U | 0.2 U |
| Butyl Benzyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Di-n-butyl Phthalate | | | 0.2 | 0.2 | 0.2 | 0.2 |
| Di-n-octyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Diethyl Phthalate | | | 0.1 U | 0.2 | 0.1 | 0.1 |
| Dimethyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| **Semivolatiles in µg/L** | | | | | | |
| Benzoic Acid | | | 5 U | 5 U | 5 U | 5 U |
| Benzyl Alcohol | | | 1 U | 1 U | 1 U | 1 U |
| Dibenzofuran | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Hexachlorobenzene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Hexachlorobutadiene | 90 | 9.3 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| N-Nitrosodiphenylamine | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |

**Note:**
U = Undetected at or above the MRL

**Table 7 - Summary of Surface Water Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Lab ID<br>Sample ID | Fresh<br>Acute | Fresh<br>Chronic | K9807169-023<br>HC-WS-03-B | K9807169-022<br>HC-WS-03-M | K9807169-024<br>HC-RB-100 | K9807169-025<br>HC-RB-101 |
|---|---|---|---|---|---|---|
| **Metals in µg/L** | | | | | | |
| Antimony, Total | 9000 | 1600 | 0.05 | 0.04 | 0.02 U | 0.02 U |
| Arsenic, Total | 360 | 190 | 0.6 | 0.6 | 0.5 U | 0.5 U |
| Cadmium, Total | 3.7 | 1.03 | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Chromium, Total | 549 | 178 | 0.3 | 0.3 | 0.2 U | 0.2 U |
| Copper, Total | 17 | 11.4 | 1.9 | 1.6 | 1.5 | 1 |
| Lead, Total | 64.6 | 2.52 | 0.76 | 0.87 | 0.02 | 0.02 U |
| Mercury, Total | 2.4 | 0.012 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Nickel, Total | 1415 | 157 | 0.6 | 0.6 | 0.2 U | 0.2 U |
| Silver, Total | 1.19 | 0.12 | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Thallium, Total | 1400 | 40 | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Zinc, Total | 114.4 | 104.5 | 3.6 | 4.4 | 0.5 | 0.8 |
| **Volatiles in µg/L** | | | | | | |
| 1,2-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,3-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 1,4-Dichlorobenzene | 1120 | 763 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Benzene | 5300 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Ethylbenzene | 32000 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetrachloroethene (PCE) | 5280 | 840 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Toluene | 17500 | | 0.5 U | 0.5 U | 0.9 | 0.8 |
| Trichloroethene (TCE) | 45000 | 21900 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| m- & p-Xylenes | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| o-Xylene | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Total Xylenes | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| **LPAHs in µg/L** | | | | | | |
| Acenaphthene | 1700 | 520 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Acenaphthylene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Anthracene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Fluorene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Naphthalene | 2300 | 620 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Phenanthrene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Total LPAHs | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| **HPAHs in µg/L** | | | | | | |
| Benz(a)anthracene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Benzo(a)pyrene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Benzo(b)fluoranthene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Benzo(k)fluoranthene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Total Benzofluoranthenes | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Benzo(g,h,i)perylene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Chrysene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Dibenz(a,h)anthracene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Fluoranthene | 3980 | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Indeno(1,2,3-cd)pyrene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Pyrene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Total HPAHs | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |

**Note:**
U = Undetected at or above the MRL

**Table 7 - Summary of Surface Water Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Lab ID<br>Sample ID | Fresh<br>Acute | Fresh<br>Chronic | K9807169-023<br>HC-WS-03-B | K9807169-022<br>HC-WS-03-M | K9807169-024<br>HC-RB-100 | K9807169-025<br>HC-RB-101 |
|---|---|---|---|---|---|---|
| **Phenols in µg/L** | | | | | | |
| 2,4-Dimethylphenol | 2120 | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 2-Methylphenol | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| 4-Methylphenol | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Pentachlorophenol (PCP) | 20 | 13 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Phenol | 10200 | 2560 | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| **Phthalates in µg/L** | | | | | | |
| Bis(2-ethylhexyl) Phthalate | | | 0.2 U | 0.7 U | 0.6 U | 5 U |
| Butyl Benzyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Di-n-butyl Phthalate | | | 0.1 | 0.2 | 0.2 | 0.1 U |
| Di-n-octyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Diethyl Phthalate | | | 0.1 U | 0.1 U | 13 | 10 |
| Dimethyl Phthalate | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| **Semivolatiles in µg/L** | | | | | | |
| Benzoic Acid | | | 5 U | 5 U | 5 U | 5 U |
| Benzyl Alcohol | | | 1 U | 1 U | 1 U | 1 U |
| Dibenzofuran | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Hexachlorobenzene | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Hexachlorobutadiene | 90 | 9.3 | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| N-Nitrosodiphenylamine | | | 0.1 U | 0.1 U | 0.1 U | 0.1 U |

Note:
U = Undetected at or above the MRL

**Table 8 - Percent Pencil Pitch and Diesel in Sediments**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample Name | Lab Code | Concentration (PPM) | | | | % of TPH | | |
|---|---|---|---|---|---|---|---|---|
| | | Pencil Pitch1 | Diesel2 | TPH Background3 | TPH4 | Pencil Pitch | Diesel | TPH Background |
| HC-S-01 | K9807097-031 | 5020 | 779 | 97 | 5896 | 85 | 13 | 2 |
| HC-S-02 | K9807097-032 | 3060 | 87 | <50 | 3147 | 97 | 3 | <5 |
| HC-S-03 | K9807097-033 | 2060 | <50 | <50 | 2060 | 100 | <5 | <5 |
| HC-S-04 | K9807097-034 | 979 | 183 | 88 | 1250 | 78 | 15 | 7 |
| HC-S-05 | K9807097-035 | 772 | 115 | 81 | 968 | 80 | 12 | 8 |
| HC-S-06 | K9807097-036 | 678 | 135 | 94 | 907 | 75 | 15 | 10 |
| HC-S-07 | K9807097-037 | 779 | 106 | 77 | 962 | 81 | 11 | 8 |
| HC-S-12 | K9807115-003 | 647 | 77 | 81 | 805 | 80 | 10 | 10 |
| HC-S-16 | K9807115-007 | 1070 | 115 | 108 | 1293 | 83 | 9 | 8 |
| HC-S-23 | K9807115-010 | 572 | 58 | 107 | 737 | 78 | 8 | 15 |
| HC-S-24 | K9807115-011 | 3200 | 77 | 67 | 3344 | 96 | 2 | 2 |
| HC-S-25 | K9807115-013 | <50 | 962 | <50 | 962 | <5 | 100 | <5 |
| HC-S-33 | K9807115-021 | 131 | 121 | 82 | 334 | 39 | 36 | 25 |
| HC-S-36 | K9807169-001 | <50 | 96 | 22 | 118 | <15 | 81 | 19 |
| HC-S-34 | K9807169-002 | 74.7 | 375 | <50 | 450 | 17 | 83 | <5 |
| HC-S-40 | K9807169-003 | 195 | <50 | 85 | 280 | 70 | <5 | 30 |
| HC-S-39 | K9807169-004 | 459 | <50 | 122 | 581 | 79 | <5 | 21 |
| HC-S-38 | K9807169-005 | 1300 | <50 | 106 | 1406 | 92 | <5 | 8 |
| HC-S-19 | K9807169-013 | 8430 | <50 | <50 | 8430 | 100 | <5 | <5 |
| HC-S-31 | K9807169-016 | 57.6 | <50 | 79 | 137 | 42 | <5 | 58 |
| HC-S-30 | K9807169-017 | 311 | <50 | 62 | 373 | 83 | <5 | 17 |

**Notes:**

[1] Calculated from the sum of LCRMA HPAHs.

[2] Calculated from the sum of Pristane + Phytane.

[3] Calculated from the sum of nC25 - nC31 odd alkanes.

[4] Total Petroleum Hydrocarbons (TPH) calculated as the sum of Pencil Pitch, Diesel and TPH Background.

NC = Not Calculated because the TPH concentration was too low to accurately differentiate Diesel from the TPH Background.

## Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon



| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **Metals in mg/kg** | | | | | | |
| HC-S-19 | Cadmium, Total | 5.6 | 5.1 | 1.10 | | |
| HC-S-25 | Cadmium, Total | 6.6 J | 5.1 | 1.29 | | |
| HC-S-02 | Lead, Total | 837 | 450 | 1.86 | | |
| HC-S-09 | Lead, Total | 626 | 450 | 1.39 | | |
| HC-S-19 | Lead, Total | 1160 | 450 | 2.58 | | |
| HC-S-25 | Lead, Total | 644 J | 450 | 1.43 | | |
| HC-S-02 | Zinc, Total | 855 | 410 | 2.09 | | |
| HC-S-04 | Zinc, Total | 450 | 410 | 1.10 | | |
| HC-S-09 | Zinc, Total | 563 | 410 | 1.37 | | |
| HC-S-13 | Zinc, Total | 798 J | 410 | 1.95 | | |
| HC-S-19 | Zinc, Total | 1020 J | 410 | 2.49 | | |
| HC-S-25 | Zinc, Total | 1330 J | 410 | 3.24 | | |
| HC-S-26 | Zinc, Total | 435 J | 410 | 1.06 | | |
| **LPAHs in µg/kg** | | | | | | |
| HC-S-02 | Acenaphthene | 14000 | 500 | 28.00 | 2000 | 7.00 |
| HC-S-04 | Acenaphthene | 1100 | 500 | 2.20 | | |
| HC-S-05 | Acenaphthene | 560 | 500 | 1.12 | | |
| HC-S-07 | Acenaphthene | 990 | 500 | 1.98 | | |
| HC-S-08 | Acenaphthene | 810 | 500 | 1.62 | | |
| HC-S-09 | Acenaphthene | 960 | 500 | 1.92 | | |
| HC-S-11 | Acenaphthene | 940 | 500 | 1.88 | | |
| HC-S-16 | Acenaphthene | 630 | 500 | 1.26 | | |
| HC-S-19 | Acenaphthene | 6100 | 500 | 12.20 | 2000 | 3.05 |
| HC-S-20 | Acenaphthene | 1500 | 500 | 3.00 | | |
| HC-S-38 | Acenaphthene | 4000 | 500 | 8.00 | 2000 | 2.00 |
| HC-S-41 | Acenaphthene | 1600 | 500 | 3.20 | | |
| HC-S-42 | Acenaphthene | 920 | 500 | 1.84 | | |
| HC-S-24 | Acenaphthylene | 3600 | 560 | 6.43 | 2000 | 1.80 |
| HC-S-02 | Anthracene | 12000 | 960 | 12.50 | | |
| HC-S-04 | Anthracene | 1700 | 960 | 1.77 | | |
| HC-S-05 | Anthracene | 1400 | 960 | 1.46 | | |
| HC-S-07 | Anthracene | 1700 | 960 | 1.77 | | |
| HC-S-08 | Anthracene | 1200 | 960 | 1.25 | | |
| HC-S-09 | Anthracene | 1300 | 960 | 1.35 | | |
| HC-S-11 | Anthracene | 1700 | 960 | 1.77 | | |
| HC-S-16 | Anthracene | 1900 | 960 | 1.98 | | |
| HC-S-19 | Anthracene | 5900 | 960 | 6.15 | | |
| HC-S-20 | Anthracene | 2000 | 960 | 2.08 | | |
| HC-S-24 | Anthracene | 6600 | 960 | 6.88 | | |
| HC-S-38 | Anthracene | 4100 | 960 | 4.27 | | |
| HC-S-41 | Anthracene | 2000 | 960 | 2.08 | | |
| HC-S-42 | Anthracene | 1500 | 960 | 1.56 | | |
| HC-S-02 | Fluorene | 14000 | 540 | 25.93 | 3600 | 3.89 |
| HC-S-04 | Fluorene | 670 | 540 | 1.24 | | |
| HC-S-05 | Fluorene | 570 | 540 | 1.06 | | |
| HC-S-07 | Fluorene | 730 | 540 | 1.35 | | |
| HC-S-11 | Fluorene | 590 | 540 | 1.09 | | |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **LPAHs in µg/kg** | | | | | | |
| HC-S-16 | Fluorene | 620 | 540 | 1.15 | | |
| HC-S-19 | Fluorene | 2500 | 540 | 4.63 | | |
| HC-S-20 | Fluorene | 700 | 540 | 1.30 | | |
| HC-S-24 | Fluorene | 1200 | 540 | 2.22 | | |
| HC-S-41 | Fluorene | 650 | 540 | 1.20 | | |
| HC-S-24 | Naphthalene | 2200 | 2100 | 1.05 | | |
| HC-S-01 | Phenanthrene | 49000 | 1500 | 32.67 | 21000 | 2.33 |
| HC-S-02 | Phenanthrene | 74000 | 1500 | 49.33 | 21000 | 3.52 |
| HC-S-03 | Phenanthrene | 16000 | 1500 | 10.67 | | |
| HC-S-04 | Phenanthrene | 6400 | 1500 | 4.27 | | |
| HC-S-05 | Phenanthrene | 4700 | 1500 | 3.13 | | |
| HC-S-06 | Phenanthrene | 3100 | 1500 | 2.07 | | |
| HC-S-07 | Phenanthrene | 6100 | 1500 | 4.07 | | |
| HC-S-08 | Phenanthrene | 4300 | 1500 | 2.87 | | |
| HC-S-09 | Phenanthrene | 5000 | 1500 | 3.33 | | |
| HC-S-11 | Phenanthrene | 5700 | 1500 | 3.80 | | |
| HC-S-13 | Phenanthrene | 2100 | 1500 | 1.40 | | |
| HC-S-14 | Phenanthrene | 2700 | 1500 | 1.80 | | |
| HC-S-16 | Phenanthrene | 4900 | 1500 | 3.27 | | |
| HC-S-19 | Phenanthrene | 26000 | 1500 | 17.33 | 21000 | 1.24 |
| HC-S-20 | Phenanthrene | 7900 | 1500 | 5.27 | | |
| HC-S-22 | Phenanthrene | 1900 | 1500 | 1.27 | | |
| HC-S-24 | Phenanthrene | 15000 | 1500 | 10.00 | | |
| HC-S-28 | Phenanthrene | 1700 | 1500 | 1.13 | | |
| HC-S-30 | Phenanthrene | 1600 | 1500 | 1.07 | | |
| HC-S-38 | Phenanthrene | 23000 | 1500 | 15.33 | 21000 | 1.10 |
| HC-S-39 | Phenanthrene | 4700 | 1500 | 3.13 | | |
| HC-S-41 | Phenanthrene | 7800 | 1500 | 5.20 | | |
| HC-S-42 | Phenanthrene | 5300 | 1500 | 3.53 | | |
| HC-S-01 | Total LPAHs | 99000 | 5200 | 19.04 | 29000 | 3.41 |
| HC-S-02 | Total LPAHs | 124000 | 5200 | 23.85 | 29000 | 4.28 |
| HC-S-03 | Total LPAHs | 41000 | 5200 | 7.88 | | |
| HC-S-04 | Total LPAHs (1/2 U) | 10470 | 5200 | 2.01 | | |
| HC-S-05 | Total LPAHs (1/2 U) | 8130 | 5200 | 1.56 | | |
| HC-S-07 | Total LPAHs (1/2 U) | 9920 | 5200 | 1.91 | | |
| HC-S-08 | Total LPAHs (1/2 U) | 7120 | 5200 | 1.37 | | |
| HC-S-09 | Total LPAHs (1/2 U) | 8110 | 5200 | 1.56 | | |
| HC-S-11 | Total LPAHs (1/2 U) | 9380 | 5200 | 1.80 | | |
| HC-S-16 | Total LPAHs (1/2 U) | 8980 | 5200 | 1.73 | | |
| HC-S-24 | Total LPAHs (1/2 U) | 29010 | 5200 | 5.58 | 29000 | 1.00 |
| **HPAHs in µg/kg** | | | | | | |
| HC-S-01 | Benz(a)anthracene | 77000 | 1300 | 59.23 | 5100 | 15.10 |
| HC-S-02 | Benz(a)anthracene | 81000 | 1300 | 62.31 | 5100 | 15.88 |
| HC-S-03 | Benz(a)anthracene | 28000 | 1300 | 21.54 | 5100 | 5.49 |
| HC-S-04 | Benz(a)anthracene | 13000 | 1300 | 10.00 | 5100 | 2.55 |
| HC-S-05 | Benz(a)anthracene | 8600 | 1300 | 6.62 | 5100 | 1.69 |
| HC-S-06 | Benz(a)anthracene | 7000 | 1300 | 5.38 | 5100 | 1.37 |
| HC-S-07 | Benz(a)anthracene | 12000 | 1300 | 9.23 | 5100 | 2.35 |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-08 | Benz(a)anthracene | 8200 | 1300 | 6.31 | 5100 | 1.61 |
| HC-S-09 | Benz(a)anthracene | 11000 | 1300 | 8.46 | 5100 | 2.16 |
| HC-S-11 | Benz(a)anthracene | 11000 | 1300 | 8.46 | 5100 | 2.16 |
| HC-S-13 | Benz(a)anthracene | 4600 | 1300 | 3.54 | | |
| HC-S-14 | Benz(a)anthracene | 4800 | 1300 | 3.69 | | |
| HC-S-16 | Benz(a)anthracene | 9000 | 1300 | 6.92 | 5100 | 1.76 |
| HC-S-19 | Benz(a)anthracene | 44000 | 1300 | 33.85 | 5100 | 8.63 |
| HC-S-20 | Benz(a)anthracene | 14000 | 1300 | 10.77 | 5100 | 2.75 |
| HC-S-22 | Benz(a)anthracene | 4000 | 1300 | 3.08 | | |
| HC-S-24 | Benz(a)anthracene | 37000 | 1300 | 28.46 | 5100 | 7.25 |
| HC-S-26 | Benz(a)anthracene | 2300 | 1300 | 1.77 | | |
| HC-S-28 | Benz(a)anthracene | 3200 | 1300 | 2.46 | | |
| HC-S-30 | Benz(a)anthracene | 2700 | 1300 | 2.08 | | |
| HC-S-35 | Benz(a)anthracene | 1500 | 1300 | 1.15 | | |
| HC-S-38 | Benz(a)anthracene | 29000 | 1300 | 22.31 | 5100 | 5.69 |
| Hc-S-39 | Benz(a)anthracene | 6200 | 1300 | 4.77 | 5100 | 1.22 |
| HC-S-41 | Benz(a)anthracene | 15000 | 1300 | 11.54 | 5100 | 2.94 |
| HC-S-42 | Benz(a)anthracene | 11000 | 1300 | 8.46 | 5100 | 2.16 |
| HC-S-01 | Benzo(a)pyrene | 86000 | 1600 | 53.75 | 3600 | 23.89 |
| HC-S-02 | Benzo(a)pyrene | 82000 | 1600 | 51.25 | 3600 | 22.78 |
| HC-S-03 | Benzo(a)pyrene | 33000 | 1600 | 20.63 | 3600 | 9.17 |
| HC-S-04 | Benzo(a)pyrene | 15000 | 1600 | 9.38 | 3600 | 4.17 |
| HC-S-05 | Benzo(a)pyrene | 9600 | 1600 | 6.00 | 3600 | 2.67 |
| HC-S-06 | Benzo(a)pyrene | 9100 | 1600 | 5.69 | 3600 | 2.53 |
| HC-S-07 | Benzo(a)pyrene | 13000 | 1600 | 8.13 | 3600 | 3.61 |
| HC-S-08 | Benzo(a)pyrene | 11000 | 1600 | 6.88 | 3600 | 3.06 |
| HC-S-09 | Benzo(a)pyrene | 12000 | 1600 | 7.50 | 3600 | 3.33 |
| HC-S-11 | Benzo(a)pyrene | 13000 | 1600 | 8.13 | 3600 | 3.61 |
| HC-S-13 | Benzo(a)pyrene | 5500 | 1600 | 3.44 | 3600 | 1.53 |
| HC-S-14 | Benzo(a)pyrene | 5400 | 1600 | 3.38 | 3600 | 1.50 |
| HC-S-16 | Benzo(a)pyrene | 11000 | 1600 | 6.88 | 3600 | 3.06 |
| HC-S-19 | Benzo(a)pyrene | 55000 | 1600 | 34.38 | 3600 | 15.28 |
| HC-S-20 | Benzo(a)pyrene | 18000 | 1600 | 11.25 | 3600 | 5.00 |
| HC-S-22 | Benzo(a)pyrene | 4900 | 1600 | 3.06 | 3600 | 1.36 |
| HC-S-24 | Benzo(a)pyrene | 39000 | 1600 | 24.38 | 3600 | 10.83 |
| HC-S-26 | Benzo(a)pyrene | 2700 | 1600 | 1.69 | | |
| HC-S-28 | Benzo(a)pyrene | 4000 | 1600 | 2.50 | 3600 | 1.11 |
| HC-S-30 | Benzo(a)pyrene | 3300 | 1600 | 2.06 | | |
| HC-S-35 | Benzo(a)pyrene | 1800 | 1600 | 1.13 | | |
| HC-S-38 | Benzo(a)pyrene | 31000 | 1600 | 19.38 | 3600 | 8.61 |
| HC-S-39 | Benzo(a)pyrene | 6700 | 1600 | 4.19 | 3600 | 1.86 |
| HC-S-40 | Benzo(a)pyrene | 1700 | 1600 | 1.06 | | |
| HC-S-41 | Benzo(a)pyrene | 20000 | 1600 | 12.50 | 3600 | 5.56 |
| HC-S-42 | Benzo(a)pyrene | 14000 | 1600 | 8.75 | 3600 | 3.89 |
| HC-S-01 | Benzo(g,h,I)perylene | 55000 | 670 | 82.09 | 3200 | 17.19 |
| HC-S-02 | Benzo(g,h,I)perylene | 50000 | 670 | 74.63 | 3200 | 15.63 |
| HC-S-03 | Benzo(g,h,I)perylene | 22000 | 670 | 32.84 | 3200 | 6.88 |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-04 | Benzo(g,h,i)perylene | 11000 | 670 | 16.42 | 3200 | 3.44 |
| HC-S-05 | Benzo(g,h,i)perylene | 7100 | 670 | 10.60 | 3200 | 2.22 |
| HC-S-06 | Benzo(g,h,i)perylene | 5100 | 670 | 7.61 | 3200 | 1.59 |
| HC-S-07 | Benzo(g,h,i)perylene | 9400 | 670 | 14.03 | 3200 | 2.94 |
| HC-S-08 | Benzo(g,h,i)perylene | 6800 | 670 | 10.15 | 3200 | 2.13 |
| HC-S-09 | Benzo(g,h,i)perylene | 8600 | 670 | 12.84 | 3200 | 2.69 |
| HC-S-11 | Benzo(g,h,i)perylene | 8900 | 670 | 13.28 | 3200 | 2.78 |
| HC-S-13 | Benzo(g,h,i)perylene | 3900 | 670 | 5.82 | 3200 | 1.22 |
| HC-S-14 | Benzo(g,h,i)perylene | 4000 | 670 | 5.97 | 3200 | 1.25 |
| HC-S-16 | Benzo(g,h,i)perylene | 7600 | 670 | 11.34 | 3200 | 2.38 |
| HC-S-19 | Benzo(g,h,i)perylene | 38000 | 670 | 56.72 | 3200 | 11.88 |
| HC-S-20 | Benzo(g,h,i)perylene | 13000 | 670 | 19.40 | 3200 | 4.06 |
| HC-S-22 | Benzo(g,h,i)perylene | 3300 | 670 | 4.93 | 3200 | 1.03 |
| HC-S-24 | Benzo(g,h,i)perylene | 27000 | 670 | 40.30 | 3200 | 8.44 |
| HC-S-25 | Benzo(g,h,i)perylene | 1000 | 670 | 1.49 | | |
| HC-S-26 | Benzo(g,h,i)perylene | 1900 | 670 | 2.84 | | |
| HC-S-28 | Benzo(g,h,i)perylene | 2800 | 670 | 4.18 | | |
| HC-S-30 | Benzo(g,h,i)perylene | 2500 | 670 | 3.73 | | |
| HC-S-32 | Benzo(g,h,i)perylene | 1200 | 670 | 1.79 | | |
| HC-S-35 | Benzo(g,h,i)perylene | 1200 | 670 | 1.79 | | |
| HC-S-38 | Benzo(g,h,i)perylene | 23000 | 670 | 34.33 | 3200 | 7.19 |
| HC-S-39 | Benzo(g,h,i)perylene | 5400 | 670 | 8.06 | 3200 | 1.69 |
| HC-S-40 | Benzo(g,h,i)perylene | 1300 | 670 | 1.94 | | |
| HC-S-41 | Benzo(g,h,i)perylene | 16000 | 670 | 23.88 | 3200 | 5.00 |
| HC-S-42 | Benzo(g,h,i)perylene | 11000 | 670 | 16.42 | 3200 | 3.44 |
| HC-S-01 | Chrysene | 75000 | 1400 | 53.57 | 21000 | 3.57 |
| HC-S-02 | Chrysene | 78000 | 1400 | 55.71 | 21000 | 3.71 |
| HC-S-03 | Chrysene | 30000 | 1400 | 21.43 | 21000 | 1.43 |
| HC-S-04 | Chrysene | 11000 | 1400 | 7.86 | | |
| HC-S-05 | Chrysene | 7800 | 1400 | 5.57 | | |
| HC-S-06 | Chrysene | 6300 | 1400 | 4.50 | | |
| HC-S-07 | Chrysene | 10000 | 1400 | 7.14 | | |
| HC-S-08 | Chrysene | 8600 | 1400 | 6.14 | | |
| HC-S-09 | Chrysene | 11000 | 1400 | 7.86 | | |
| HC-S-11 | Chrysene | 11000 | 1400 | 7.86 | | |
| HC-S-13 | Chrysene | 4500 | 1400 | 3.21 | | |
| HC-S-14 | Chrysene | 4500 | 1400 | 3.21 | | |
| HC-S-16 | Chrysene | 8900 | 1400 | 6.36 | | |
| HC-S-19 | Chrysene | 46000 | 1400 | 32.86 | 21000 | 2.19 |
| HC-S-20 | Chrysene | 14000 | 1400 | 10.00 | | |
| HC-S-22 | Chrysene | 3800 | 1400 | 2.71 | | |
| HC-S-24 | Chrysene | 38000 | 1400 | 27.14 | 21000 | 1.81 |
| HC-S-25 | Chrysene | 1500 | 1400 | 1.07 | | |
| HC-S-26 | Chrysene | 2200 | 1400 | 1.57 | | |
| HC-S-28 | Chrysene | 3200 | 1400 | 2.29 | | |
| HC-S-30 | Chrysene | 3000 | 1400 | 2.14 | | |
| HC-S-32 | Chrysene | 1200 | 1400 | 0.86 | | |
| HC-S-38 | Chrysene | 31000 | 1400 | 22.14 | 21000 | 1.48 |

**Refer to notes at the end of this table.**

## Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon



| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-39 | Chrysene | 7000 | 1400 | 5.00 | | |
| HC-S-40 | Chrysene | 1700 | 1400 | 1.21 | | |
| HC-S-41 | Chrysene | 16000 | 1400 | 11.43 | | |
| HC-S-42 | Chrysene | 11000 | 1400 | 7.86 | | |
| HC-S-04 | Dibenz(a,h)anthracene | 1200 | 230 | 5.22 | | |
| HC-S-05 | Dibenz(a,h)anthracene | 730 | 230 | 3.17 | | |
| HC-S-06 | Dibenz(a,h)anthracene | 670 | 230 | 2.91 | | |
| HC-S-07 | Dibenz(a,h)anthracene | 1200 | 230 | 5.22 | | |
| HC-S-08 | Dibenz(a,h)anthracene | 1100 | 230 | 4.78 | | |
| HC-S-09 | Dibenz(a,h)anthracene | 1300 | 230 | 5.65 | | |
| HC-S-11 | Dibenz(a,h)anthracene | 2200 | 230 | 9.57 | 1900 | 1.16 |
| HC-S-13 | Dibenz(a,h)anthracene | 870 | 230 | 3.78 | | |
| HC-S-14 | Dibenz(a,h)anthracene | 570 | 230 | 2.48 | | |
| HC-S-16 | Dibenz(a,h)anthracene | 1700 | 230 | 7.39 | | |
| HC-S-19 | Dibenz(a,h)anthracene | 11000 | 230 | 47.83 | 1900 | 5.79 |
| HC-S-20 | Dibenz(a,h)anthracene | 3100 | 230 | 13.48 | 1900 | 1.63 |
| HC-S-22 | Dibenz(a,h)anthracene | 800 | 230 | 3.48 | 1900 | |
| HC-S-24 | Dibenz(a,h)anthracene | 4700 | 230 | 20.43 | 1900 | 2.47 |
| HC-S-26 | Dibenz(a,h)anthracene | 350 | 230 | 1.52 | | |
| HC-S-28 | Dibenz(a,h)anthracene | 630 | 230 | 2.74 | | |
| HC-S-30 | Dibenz(a,h)anthracene | 540 | 230 | 2.35 | | |
| HC-S-32 | Dibenz(a,h)anthracene | 290 | 230 | 1.26 | | |
| HC-S-35 | Dibenz(a,h)anthracene | 280 | 230 | 1.22 | | |
| HC-S-38 | Dibenz(a,h)anthracene | 7200 | 230 | 31.30 | 1900 | 3.79 |
| HC-S-39 | Dibenz(a,h)anthracene | 1700 | 230 | 7.39 | | |
| HC-S-40 | Dibenz(a,h)anthracene | 290 | 230 | 1.26 | | |
| HC-S-41 | Dibenz(a,h)anthracene | 3900 | 230 | 16.96 | 1900 | 2.05 |
| HC-S-42 | Dibenz(a,h)anthracene | 2600 | 230 | 11.30 | 1900 | 1.37 |
| HC-S-01 | Fluoranthene | 120000 | 1700 | 70.59 | 30000 | 4.00 |
| HC-S-02 | Fluoranthene | 130000 | 1700 | 76.47 | 30000 | 4.33 |
| HC-S-03 | Fluoranthene | 42000 | 1700 | 24.71 | 30000 | 1.40 |
| HC-S-04 | Fluoranthene | 21000 | 1700 | 12.35 | | |
| HC-S-05 | Fluoranthene | 18000 | 1700 | 10.59 | | |
| HC-S-06 | Fluoranthene | 13000 | 1700 | 7.65 | | |
| HC-S-07 | Fluoranthene | 19000 | 1700 | 11.18 | | |
| HC-S-08 | Fluoranthene | 13000 | 1700 | 7.65 | | |
| HC-S-09 | Fluoranthene | 16000 | 1700 | 9.41 | | |
| HC-S-11 | Fluoranthene | 21000 | 1700 | 12.35 | | |
| HC-S-13 | Fluoranthene | 9600 | 1700 | 5.65 | | |
| HC-S-14 | Fluoranthene | 13000 | 1700 | 7.65 | | |
| HC-S-16 | Fluoranthene | 21000 | 1700 | 12.35 | | |
| HC-S-19 | Fluoranthene | 70000 J | 1700 | 41.18 | 30000 | 2.33 |
| HC-S-20 | Fluoranthene | 26000 | 1700 | 15.29 | | |
| HC-S-22 | Fluoranthene | 7200 | 1700 | 4.24 | | |
| HC-S-24 | Fluoranthene | 84000 | 1700 | 49.41 | 30000 | 2.80 |
| HC-S-25 | Fluoranthene | 3100 | 1700 | 1.82 | | |
| HC-S-26 | Fluoranthene | 5500 | 1700 | 3.24 | | |
| HC-S-28 | Fluoranthene | 6500 | 1700 | 3.82 | | |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-30 | Fluoranthene | 5200 | 1700 | 3.06 | | |
| HC-S-32 | Fluoranthene | 2000 | 1700 | 1.18 | | |
| HC-S-34 | Fluoranthene | 2300 | 1700 | 1.35 | | |
| HC-S-35 | Fluoranthene | 2700 | 1700 | 1.59 | | |
| HC-S-38 | Fluoranthene | 58000 | 1700 | 34.12 | 30000 | 1.93 |
| HC-S-39 | Fluoranthene | 13000 | 1700 | 7.65 | | |
| HC-S-40 | Fluoranthene | 3000 | 1700 | 1.76 | | |
| HC-S-41 | Fluoranthene | 24000 | 1700 | 14.12 | | |
| HC-S-42 | Fluoranthene | 17000 | 1700 | 10.00 | | |
| HC-S-44 | Fluoranthene | 1800 | 1700 | 1.06 | | |
| HC-S-01 | Indeno(1,2,3-cd)pyrene | 110000 | 600 | 183.33 | 4400 | 25.00 |
| HC-S-02 | Indeno(1,2,3-cd)pyrene | 92000 | 600 | 153.33 | 4400 | 20.91 |
| HC-S-03 | Indeno(1,2,3-cd)pyrene | 40000 | 600 | 66.67 | 4400 | 9.09 |
| HC-S-04 | Indeno(1,2,3-cd)pyrene | 19000 | 600 | 31.67 | 4400 | 4.32 |
| HC-S-05 | Indeno(1,2,3-cd)pyrene | 10000 | 600 | 16.67 | 4400 | 2.27 |
| HC-S-06 | Indeno(1,2,3-cd)pyrene | 10000 | 600 | 16.67 | 4400 | 2.27 |
| HC-S-07 | Indeno(1,2,3-cd)pyrene | 17000 | 600 | 28.33 | 4400 | 3.86 |
| HC-S-08 | Indeno(1,2,3-cd)pyrene | 12000 | 600 | 20.00 | 4400 | 2.73 |
| HC-S-09 | Indeno(1,2,3-cd)pyrene | 15000 | 600 | 25.00 | 4400 | 3.41 |
| HC-S-11 | Indeno(1,2,3-cd)pyrene | 14000 | 600 | 23.33 | 4400 | 3.18 |
| HC-S-13 | Indeno(1,2,3-cd)pyrene | 7100 | 600 | 11.83 | 4400 | 1.61 |
| HC-S-14 | Indeno(1,2,3-cd)pyrene | 6600 | 600 | 11.00 | 4400 | 1.50 |
| HC-S-16 | Indeno(1,2,3-cd)pyrene | 13000 | 600 | 21.67 | 4400 | 2.95 |
| HC-S-19 | Indeno(1,2,3-cd)pyrene | 60000 | 600 | 100.00 | 4400 | 13.64 |
| HC-S-20 | Indeno(1,2,3-cd)pyrene | 21000 | 600 | 35.00 | 4400 | 4.77 |
| HC-S-22 | Indeno(1,2,3-cd)pyrene | 6000 | 600 | 10.00 | 4400 | 1.36 |
| HC-S-24 | Indeno(1,2,3-cd)pyrene | 41000 | 600 | 68.33 | 4400 | 9.32 |
| HC-S-25 | Indeno(1,2,3-cd)pyrene | 1800 | 600 | 3.00 | | |
| HC-S-26 | Indeno(1,2,3-cd)pyrene | 3400 | 600 | 5.67 | 4400 | 0.77 |
| HC-S-28 | Indeno(1,2,3-cd)pyrene | 5100 | 600 | 8.50 | 4400 | 1.16 |
| HC-S-30 | Indeno(1,2,3-cd)pyrene | 4600 | 600 | 41.18 | 4400 | 1.05 |
| HC-S-32 | Indeno(1,2,3-cd)pyrene | 1300 | 600 | 2.17 | | |
| HC-S-34 | Indeno(1,2,3-cd)pyrene | 1300 | 600 | 2.17 | | |
| HC-S-35 | Indeno(1,2,3-cd)pyrene | 2300 | 600 | 3.83 | | |
| HC-S-37 | Indeno(1,2,3-cd)pyrene | 900 | 600 | 1.50 | | |
| HC-S-38 | Indeno(1,2,3-cd)pyrene | 53000 | 600 | 88.33 | 4400 | 12.05 |
| HC-S-39 | Indeno(1,2,3-cd)pyrene | 10000 | 600 | 16.67 | 4400 | 2.27 |
| HC-S-40 | Indeno(1,2,3-cd)pyrene | 2600 | 600 | 4.33 | | |
| HC-S-41 | Indeno(1,2,3-cd)pyrene | 25000 | 600 | 41.67 | 4400 | 5.68 |
| HC-S-42 | Indeno(1,2,3-cd)pyrene | 18000 | 600 | 30.00 | 4400 | 4.09 |
| HC-S-43 | Indeno(1,2,3-cd)pyrene | 1700 | 600 | 2.83 | | |
| HC-S-44 | Indeno(1,2,3-cd)pyrene | 1400 | 600 | 2.33 | | |
| HC-S-01 | Pyrene | 98000 | 2600 | 37.69 | 16000 | 6.13 |
| HC-S-02 | Pyrene | 100000 | 2600 | 38.46 | 16000 | 6.25 |
| HC-S-03 | Pyrene | 40000 | 2600 | 15.38 | 16000 | 2.50 |
| HC-S-04 | Pyrene | 21000 | 2600 | 8.08 | 16000 | 1.31 |
| HC-S-05 | Pyrene | 20000 | 2600 | 7.69 | 16000 | 1.25 |
| HC-S-05 | Pyrene | 20000 | 2600 | 7.69 | 16000 | 1.25 |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-06 | Pyrene | 13000 | 2600 | 5.00 | | |
| HC-S-07 | Pyrene | 21000 | 2600 | 8.08 | 16000 | 1.31 |
| HC-S-08 | Pyrene | 14000 | 2600 | 5.38 | | |
| HC-S-09 | Pyrene | 16000 | 2600 | 6.15 | 16000 | 1.00 |
| HC-S-11 | Pyrene | 22000 | 2600 | 8.46 | 16000 | 1.38 |
| HC-S-13 | Pyrene | 11000 | 2600 | 4.23 | | |
| HC-S-14 | Pyrene | 17000 | 2600 | 6.54 | 16000 | 1.06 |
| HC-S-16 | Pyrene | 25000 | 2600 | 9.62 | 16000 | 1.56 |
| HC-S-19 | Pyrene | 68000 | 2600 | 26.15 | 16000 | 4.25 |
| HC-S-20 | Pyrene | 25000 | 2600 | 9.62 | 16000 | 1.56 |
| HC-S-22 | Pyrene | 7500 | 2600 | 2.88 | | |
| HC-S-24 | Pyrene | 110000 | 2600 | 42.31 | 16000 | 6.88 |
| HC-S-25 | Pyrene | 3700 | 2600 | 1.42 | | |
| HC-S-26 | Pyrene | 6800 | 2600 | 2.62 | | |
| HC-S-28 | Pyrene | 7000 | 2600 | 2.69 | | |
| HC-S-30 | Pyrene | 5000 | 2600 | 1.92 | | |
| HC-S-34 | Pyrene | 2800 | 2600 | 41.18 | | |
| HC-S-35 | Pyrene | 2700 | 2600 | 1.04 | | |
| HC-S-38 | Pyrene | 46000 | 2600 | 17.69 | 16000 | 2.88 |
| HC-S-39 | Pyrene | 10000 | 2600 | 3.85 | | |
| HC-S-41 | Pyrene | 22000 | 2600 | 8.46 | 16000 | 1.38 |
| HC-S-42 | Pyrene | 16000 | 2600 | 6.15 | 16000 | 1.00 |
| HC-S-01 | Total Benzofluoranthenes | 144000 | 3200 | 45.00 | 9900 | 14.55 |
| HC-S-02 | Total Benzofluoranthenes | 141000 | 3200 | 44.06 | 9900 | 14.24 |
| HC-S-03 | Total Benzofluoranthenes | 5600 | 3200 | 1.75 | | |
| HC-S-04 | Total Benzofluoranthenes | 22100 | 3200 | 6.91 | 9900 | 2.23 |
| HC-S-05 | Total Benzofluoranthenes | 13500 | 3200 | 4.22 | 9900 | 1.36 |
| HC-S-06 | Total Benzofluoranthenes | 11300 | 3200 | 3.53 | 9900 | 1.14 |
| HC-S-07 | Total Benzofluoranthenes | 20100 | 3200 | 6.28 | 9900 | 2.03 |
| HC-S-08 | Total Benzofluoranthenes | 13800 | 3200 | 4.31 | 9900 | 1.39 |
| HC-S-09 | Total Benzofluoranthenes | 16000 | 3200 | 5.00 | 9900 | 1.62 |
| HC-S-11 | Total Benzofluoranthenes | 18400 | 3200 | 5.75 | 9900 | 1.86 |
| HC-S-13 | Total Benzofluoranthenes | 7500 | 3200 | 2.34 | | |
| HC-S-14 | Total Benzofluoranthenes | 6500 | 3200 | 2.03 | | |
| HC-S-16 | Total Benzofluoranthenes | 14600 | 3200 | 4.56 | 9900 | 1.47 |
| HC-S-22 | Total Benzofluoranthenes | 7000 | 3200 | 2.19 | | |
| HC-S-24 | Total Benzofluoranthenes | 47000 | 3200 | 14.69 | 9900 | 4.75 |
| HC-S-26 | Total Benzofluoranthenes | 3400 | 3200 | 1.06 | | |
| HC-S-28 | Total Benzofluoranthenes | 5600 | 3200 | 1.75 | | |
| HC-S-01 | Total HPAHs | 775000 | 12000 | 64.58 | 69000 | 11.23 |
| HC-S-02 | Total HPAHs | 759000 | 12000 | 63.25 | 69000 | 11.00 |
| HC-S-03 | Total HPAHs | 296000 | 12000 | 24.67 | 69000 | 4.29 |
| HC-S-04 | Total HPAHs | 134300 | 12000 | 11.19 | 69000 | 1.95 |
| HC-S-05 | Total HPAHs | 95330 | 12000 | 7.94 | 69000 | 1.38 |
| HC-S-06 | Total HPAHs | 75470 | 12000 | 41.18 | 69000 | 1.09 |
| HC-S-07 | Total HPAHs | 122700 | 12000 | 10.23 | 69000 | 1.78 |
| HC-S-08 | Total HPAHs | 88500 | 12000 | 7.38 | 69000 | 1.28 |
| HC-S-09 | Total HPAHs | 106900 | 12000 | 8.91 | 69000 | 1.55 |

**Refer to notes at the end of this table.**

**Table 9 - Surface Sediment Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **HPAHs in µg/kg** | | | | | | |
| HC-S-11 | Total HPAHs | 121500 | 12000 | 10.13 | 69000 | 1.76 |
| HC-S-13 | Total HPAHs | 54570 | 12000 | 4.55 | | |
| HC-S-14 | Total HPAHs | 62370 | 12000 | 5.20 | | |
| HC-S-16 | Total HPAHs | 111800 | 12000 | 9.32 | 69000 | 1.62 |
| HC-S-22 | Total HPAHs | 44500 | 12000 | 3.71 | | |
| HC-S-24 | Total HPAHs | 427700 | 12000 | 35.64 | 69000 | 6.20 |
| HC-S-25 | Total HPAHs | 15450 | 12000 | 1.29 | | |
| HC-S-26 | Total HPAHs | 28550 | 12000 | 2.38 | | |
| HC-S-28 | Total HPAHs | 38030 | 12000 | 3.17 | | |
| HC-S-32 | Total HPAHs | 12890 | 12000 | 1.07 | | |
| HC-S-35 | Total HPAHs | 16780 | 12000 | 1.40 | | |
| **Phenols in µg/kg** | | | | | | |
| HC-S-19 | 2,4-Dimethylphenol | 31 | 29 | 1.07 | | |
| **Semivolatiles in µg/kg** | | | | | | |
| HC-S-19 | Dibenzofuran | 660 | 540 | 1.22 | | |
| HC-S-38 | Dibenzofuran | 860 | 540 | 1.59 | | |
| **Pesticides/PCBs µg/kg** | | | | | | |
| HC-S-16 | Total DDT | 39 J | 6.9 | 5.65 | | |
| HC-S-28 | Total DDT | 23 J | 6.9 | 3.33 | | |
| HC-S-36 | Total DDT | 15 J | 6.9 | 2.17 | | |
| HC-S-39 | Total DDT | 7 J | 6.9 | 1.01 | | |
| HC-S-43 | Total DDT | 28 J | 6.9 | 4.06 | | |

**Notes:**

J = Estimated concentration. Value is less than Method Reporting Limit, but greater than Method Detection Limit.

SL = Screening Level from LCRMA.

ML = Maximum Level from LCRMA.

## Table 10 - Subsurface Locations that Exceeded LCRMA SLs or MLs
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon



| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| **Metals in mg/kg** | | | | | | |
| HC-VC-11-S2 | Lead, Total | 527 | 450 | 1.17 | | |
| HC-VC-7-S2 | Lead, Total | 576 | 450 | 1.28 | | |
| HC-VC-11-S2 | Zinc, Total | 656 | 410 | 1.60 | | |
| HC-VC-7-S1 | Zinc, Total | 469 | 410 | 1.14 | | |
| HC-VC-7-S2 | Zinc, Total | 650 | 410 | 1.59 | | |
| **LPAHs in µg/kg** | | | | | | |
| HC-VC-18-S1 | Acenaphthene | 510 | 500 | 1.02 | | |
| HC-VC-11-S1 | Anthracene | 1000 | 960 | 1.04 | | |
| HC-VC-11-S1 | Phenanthrene | 4300 | 1500 | 2.87 | | |
| HC-VC-11-S2 | Phenanthrene | 8400 | 1500 | 5.60 | | |
| HC-VC-18-S1 | Phenanthrene | 2200 | 1500 | 1.47 | | |
| HC-VC-27-S1 | Phenanthrene | 2200 | 1500 | 1.47 | | |
| HC-VC-27-S2 | Phenanthrene | 2400 | 1500 | 1.60 | | |
| HC-VC-42-S1 | Phenanthrene | 4500 | 1500 | 3.00 | | |
| HC-VC-42-S2 | Phenanthrene | 10000 | 1500 | 6.67 | | |
| HC-VC-7-S2 | Phenanthrene | 6100 | 1500 | 4.07 | | |
| HC-VC-11-S1 | Total LPAHs (1/2 U) | 7300 | 5200 | 1.40 | | |
| HC-VC-11-S2 | Total LPAHs (1/2 U) | 18400 | 5200 | 3.54 | | |
| HC-VC-42-S2 | Total LPAHs (1/2 U) | 20000 | 5200 | 3.85 | | |
| HC-VC-7-S2 | Total LPAHs (1/2 U) | 16100 | 5200 | 3.10 | | |
| **HPAHs in µg/kg** | | | | | | |
| HC-VC-11-S1 | Benz(a)anthracene | 7500 | 1300 | 5.77 | 1300 | 5.77 |
| HC-VC-11-S2 | Benz(a)anthracene | 15000 | 1300 | 11.54 | 5100 | 2.94 |
| HC-VC-18-S1 | Benz(a)anthracene | 4100 | 1300 | 3.15 | | |
| HC-VC-18-S2 | Benz(a)anthracene | 1600 | 1300 | 1.23 | | |
| HC-VC-27-S1 | Benz(a)anthracene | 3900 | 1300 | 3.00 | | |
| HC-VC-27-S2 | Benz(a)anthracene | 4400 | 1300 | 3.38 | | |
| HC-VC-42-S1 | Benz(a)anthracene | 9400 | 1300 | 7.23 | 5100 | 1.84 |
| HC-VC-42-S2 | Benz(a)anthracene | 20000 | 1300 | 15.38 | 5100 | 3.92 |
| HC-VC-7-S1 | Benz(a)anthracene | 20000 | 1300 | 15.38 | 5100 | 3.92 |
| HC-VC-7-S2 | Benz(a)anthracene | 9300 | 1300 | 7.15 | 5100 | 1.82 |
| HC-VC-11-S1 | Benzo(a)pyrene | 8200 | 1600 | 5.13 | 3600 | 2.28 |
| HC-VC-11-S2 | Benzo(a)pyrene | 18000 | 1600 | 11.25 | 3600 | 5.00 |
| HC-VC-18-S1 | Benzo(a)pyrene | 4800 | 1600 | 3.00 | 3600 | 1.33 |
| HC-VC-18-S2 | Benzo(a)pyrene | 1900 | 1600 | 1.19 | | |
| HC-VC-27-S1 | Benzo(a)pyrene | 4300 | 1600 | 2.69 | 3600 | 1.19 |
| HC-VC-27-S2 | Benzo(a)pyrene | 4800 | 1600 | 3.00 | 3600 | 1.33 |
| HC-VC-42-S1 | Benzo(a)pyrene | 11000 | 1600 | 6.88 | 3600 | 3.06 |
| HC-VC-42-S2 | Benzo(a)pyrene | 24000 | 1600 | 15.00 | 3600 | 6.67 |
| HC-VC-7-S1 | Benzo(a)pyrene | 23000 | 1600 | 14.38 | 3600 | 6.39 |
| HC-VC-7-S2 | Benzo(a)pyrene | 11000 | 1600 | 6.88 | 3600 | 3.06 |
| HC-VC-11-S1 | Benzo(g,h,i)perylene | 5200 | 670 | 7.76 | 3200 | 1.63 |
| HC-VC-11-S2 | Benzo(g,h,i)perylene | 9600 | 670 | 14.33 | 3200 | 3.00 |
| HC-VC-18-S1 | Benzo(g,h,i)perylene | 2600 | 670 | 3.88 | | |
| HC-VC-18-S2 | Benzo(g,h,i)perylene | 1300 | 670 | 1.94 | | |
| HC-VC-27-S1 | Benzo(g,h,i)perylene | 3000 | 670 | 4.48 | | |

**Refer to notes at the end of this table.**

**Table 10 - Subsurface Locations that Exceeded LCRMA SLs or MLs**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| HC-VC-27-S2 | Benzo(g,h,i)perylene | 3300 | 670 | 4.93 | 3200 | 1.03 |
| HC-VC-42-S1 | Benzo(g,h,i)perylene | 7300 | 670 | 10.90 | 3200 | 2.28 |
| HC-VC-42-S2 | Benzo(g,h,i)perylene | 16000 | 670 | 23.88 | 3200 | 5.00 |
| HC-VC-7-S1 | Benzo(g,h,i)perylene | 14000 | 670 | 20.90 | 3200 | 4.38 |
| HC-VC-7-S2 | Benzo(g,h,i)perylene | 6800 | 670 | 10.15 | 3200 | 2.13 |
| HC-VC-11-S1 | Chrysene | 7300 | 1400 | 5.21 | | |
| HC-VC-11-S2 | Chrysene | 14000 | 1400 | 10.00 | | |
| HC-VC-18-S1 | Chrysene | 4000 | 1400 | 2.86 | | |
| HC-VC-18-S2 | Chrysene | 1800 | 1400 | 1.29 | | |
| HC-VC-27-S1 | Chrysene | 3800 | 1400 | 2.71 | | |
| HC-VC-27-S2 | Chrysene | 4200 | 1400 | 3.00 | | |
| HC-VC-42-S1 | Chrysene | 8900 | 1400 | 6.36 | | |
| HC-VC-42-S2 | Chrysene | 19000 | 1400 | 13.57 | | |
| HC-VC-7-S1 | Chrysene | 20000 | 1400 | 14.29 | | |
| HC-VC-7-S2 | Chrysene | 9800 | 1400 | 7.00 | | |
| HC-VC-11-S1 | Fluoranthene | 10000 | 1700 | 5.88 | | |
| HC-VC-11-S2 | Fluoranthene | 21000 | 1700 | 12.35 | | |
| HC-VC-18-S1 | Fluoranthene | 5700 | 1700 | 3.35 | | |
| HC-VC-18-S2 | Fluoranthene | 2300 | 1700 | 1.35 | | |
| HC-VC-27-S1 | Fluoranthene | 5500 | 1700 | 3.24 | | |
| HC-VC-27-S2 | Fluoranthene | 6200 | 1700 | 3.65 | | |
| HC-VC-42-S1 | Fluoranthene | 11000 | 1700 | 6.47 | | |
| HC-VC-42-S2 | Fluoranthene | 27000 | 1700 | 15.88 | | |
| HC-VC-7-S1 | Fluoranthene | 28000 | 1700 | 16.47 | | |
| HC-VC-7-S2 | Fluoranthene | 14000 | 1700 | 8.24 | | |
| HC-VC-11-S1 | Indeno(1,2,3-cd)pyrene | 9200 | 600 | 15.33 | 4400 | 2.09 |
| HC-VC-11-S2 | Indeno(1,2,3-cd)pyrene | 18000 | 600 | 30.00 | 4400 | 4.09 |
| HC-VC-18-S1 | Indeno(1,2,3-cd)pyrene | 4400 | 600 | 7.33 | | |
| HC-VC-18-S2 | Indeno(1,2,3-cd)pyrene | 2200 | 600 | 3.67 | | |
| HC-VC-27-S1 | Indeno(1,2,3-cd)pyrene | 5500 | 600 | 9.17 | 4400 | 1.25 |
| HC-VC-27-S2 | Indeno(1,2,3-cd)pyrene | 6000 | 600 | 10.00 | 4400 | 1.36 |
| HC-VC-32-S1 | Indeno(1,2,3-cd)pyrene | 690 | 600 | 1.15 | | |
| HC-VC-39-S1 | Indeno(1,2,3-cd)pyrene | 1100 | 600 | 1.83 | | |
| HC-VC-39-S2 | Indeno(1,2,3-cd)pyrene | 730 | 600 | 1.22 | | |
| HC-VC-42-S1 | Indeno(1,2,3-cd)pyrene | 15000 | 600 | 25.00 | 4400 | 3.41 |
| HC-VC-42-S2 | Indeno(1,2,3-cd)pyrene | 32000 | 600 | 53.33 | 4400 | 7.27 |
| HC-VC-7-S1 | Indeno(1,2,3-cd)pyrene | 25000 | 600 | 41.67 | 4400 | 5.68 |
| HC-VC-7-S2 | Indeno(1,2,3-cd)pyrene | 12000 | 600 | 20.00 | 4400 | 2.73 |
| HC-VC-11-S1 | Pyrene | 9100 | 2600 | 3.50 | | |
| HC-VC-11-S2 | Pyrene | 18000 | 2600 | 6.92 | 16000 | 1.13 |
| HC-VC-18-S1 | Pyrene | 5000 | 2600 | 1.92 | | |
| HC-VC-27-S1 | Pyrene | 5000 | 2600 | 1.92 | | |
| HC-VC-27-S2 | Pyrene | 5600 | 2600 | 2.15 | | |
| HC-VC-42-S1 | Pyrene | 10000 | 2600 | 3.85 | | |
| HC-VC-42-S2 | Pyrene | 24000 | 2600 | 9.23 | 16000 | 1.50 |
| HC-VC-7-S1 | Pyrene | 24000 | 2600 | 9.23 | 16000 | 1.50 |
| HC-VC-7-S2 | Pyrene | 12000 | 2600 | 4.62 | | |

**Refer to notes at the end of this table.**

## Table 10 - Subsurface Locations that Exceeded LCRMA SLs or MLs
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon

Hart Crowser
J-5624-10

| Sample ID | Chemical Constituent | Concentration (mg/kg) | SL | SL Enrichment Ratio | ML | ML Enrichment Ratio |
|---|---|---|---|---|---|---|
| HC-VC-11-S1 | Total Benzofluoranthenes | 13100 | 3200 | 4.09 | 9900 | 1.32 |
| HC-VC-11-S2 | Total Benzofluoranthenes | 25000 | 3200 | 7.81 | | |
| HC-VC-18-S1 | Total Benzofluoranthenes | 7500 | 3200 | 2.34 | | |
| HC-VC-18-S2 | Total Benzofluoranthenes | 3400 | 3200 | 1.06 | | |
| HC-VC-27-S1 | Total Benzofluoranthenes | 7100 | 3200 | 2.22 | | |
| HC-VC-27-S2 | Total Benzofluoranthenes | 7300 | 3200 | 2.28 | | |
| HC-VC-42-S1 | Total Benzofluoranthenes | 17100 | 3200 | 5.34 | 9900 | 1.73 |
| HC-VC-42-S2 | Total Benzofluoranthenes | 36000 | 3200 | 11.25 | 9900 | 3.64 |
| HC-VC-7-S1 | Total Benzofluoranthenes | 36000 | 3200 | 11.25 | 9900 | 3.64 |
| HC-VC-7-S2 | Total Benzofluoranthenes | 18000 | 3200 | 5.63 | 9900 | 1.82 |
| HC-VC-11-S1 | Total HPAHs | 70100 | 12000 | 5.84 | 69000 | 1.02 |
| HC-VC-11-S2 | Total HPAHs | 140600 | 12000 | 11.72 | 69000 | 2.04 |
| HC-VC-18-S1 | Total HPAHs | 38300 | 12000 | 3.19 | | |
| HC-VC-18-S2 | Total HPAHs | 16500 | 12000 | 1.38 | | |
| HC-VC-27-S1 | Total HPAHs | 38600 | 12000 | 3.22 | | |
| HC-VC-27-S2 | Total HPAHs | 42300 | 12000 | 3.53 | | |
| HC-VC-42-S1 | Total HPAHs | 91700 | 12000 | 7.64 | 69000 | 1.33 |
| HC-VC-42-S2 | Total HPAHs | 200000 | 12000 | 16.67 | 69000 | 2.90 |
| HC-VC-7-S1 | Total HPAHs | 192000 | 12000 | 16.00 | 69000 | 2.78 |
| HC-VC-7-S2 | Total HPAHs | 94900 | 12000 | 7.91 | 69000 | 1.38 |

**Notes:**

J = Estimated concentration. Value is less than Method Reporting Limit, but greater than Method Detection Limit.

SL = Screening Level from LCRMA.

ML = Maximum Level from LCRMA.

E-Ratio = The enrichment ratio of a sample concentration to the SL and ML value.

**Table 11 - Vertical Distribution of Chemical Constituents above the LCRMA**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | HC-S-07 | HC-VC-7-S1 | HC-VC-7-S2 | HC-S-11 | HC-VC-11-S1 | HC-VC-11-S2 | HC-S-13 | HC-VC-13-S1 | HC-VC-13-S2 | HC-S-18 | HC-VC-18-S1 | HC-VC-18-S2 | HC-S-22 | HC-VC-22-S1 | HC-VC-22-S2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth in Feet | 0 to 0.3 | 0 to 2.0 | 2.0 to 4.2 | 0 to 0.3 | 0 to 2.1 | 2.1 to 4.0 | 0 to 0.3 | 0 to 2.0 | 2.0 to 4.0 | 0 to 0.3 | 0 to 2.2 | 2.2 to 4.0 | 0 to 0.3 | 0 to 2.0 | 2.0 to 4.0 |
| **Metals in mg/kg** | | | | | | | | | | | | | | | |
| Antimony | 0.3 | 0.6 | 1.4 | 0.6 | 0.3 | 1.1 | 0.2 | 0.1 | 0.1 | NR | NR | NR | 0.2 | 0.1 | 0.1 |
| Arsenic | 7 | 8 | 15 | 9 | 7 | 12 | 5 | 2 | 2 | NR | NR | NR | 5 | 2 | 2 |
| Cadmium | 2 | 2.4 | 3.3 | 1.9 | 1.2 | 3.2 | 2 | 0.2 | 0.2 | NR | NR | NR | 1 | 0.1 | 0.1 |
| Chromium | 31.9 | 27.3 | 23.2 | 31.2 | 25.3 | 22.6 | 24.6 | 9 | 10.7 | NR | NR | NR | 23.1 | 11.8 | 9.6 |
| Copper | 64 | 62.8 | 83.2 | 70.4 | 52.1 | 78.3 | 45.3 | 13.3 | 15.2 | NR | NR | NR | 44.1 | 17.6 | 13.4 |
| Lead | 322 | 361 | 576 | 357 | 169 | 527 | 289 | 25.8 | 23.9 | NR | NR | NR | 125 | 12.1 | 3 |
| Mercury | 0.16 | 0.15 | 0.18 | 0.13 | 0.09 | 0.12 | 0.06 | 0.03 | 0.02 | NR | NR | NR | 0.09 | 0.02 | 0.02 |
| Nickel | 27 | 26 | 25 | 27 | 24 | 24 | 21 | 15 | 17 | NR | NR | NR | 23 | 17 | 16 |
| Silver | 0.8 | 0.9 | 1.4 | 0.7 | 0.6 | 1.2 | 0.4 | 0.1 | 0.1 | NR | NR | NR | 0.3 | 0.1 | 0.1 |
| Zinc | 399 | 469 | 650 | 397 | 273 | 656 | 798 | 61 | 65 | NR | NR | NR | 225 | 55 | 37 |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | | |
| Total LPAHs | 9,920 | 12,000 | 16,100 | 9,380 | 7,300 | 18,400 | 3,500 | 182 | 148 | NR | 3,830 | 1,320 | 3,120 | 237 | 60 |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | | |
| Total HPAHs | 122,700 | 192,000 | 94,900 | 121,500 | 70,100 | 140,600 | 54,570 | 2,256 | 2,073 | NR | 38,300 | 16,500 | 44,500 | 2,563 | 100 |
| **TPH in mg/kg** | | | | | | | | | | | | | | | |
| Pencil Pitch | 1,240 | 1,920 | 938 | 1,230 | 703 | 1,400 | 551 | 23 | 21 | 2,600 | 385 | 166 | 449 | 26 | ND |
| Diesel | 106 | NR | NR | <100 | <100 | <100 | <100 | <25 | NR | <100 | NR | NR | <100 | NR | NR |

**Notes:**
exceeds LCRMA Screening Level
exceeds LCRMA Maximum Level
NR Not Reported
ND Not Detected

**Table 11 - Vertical Distribution of Chemical Constituents above the LCRMA**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID | HC-S-27 | HC-VC-27-S1 | HC-VC-27-S2 | HC-S-32 | HC-VC-32-S1 | HC-VC-32-S2 | HC-S-39 | HC-VC-39-S1 | HC-VC-39-S2 | HC-S-42 | HC-VC-42-S1 | HC-VC-42-S2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth in Feet | 0 to 0.3 | 0 to 1.9 | 1.9 to 3.5 | 0 to 0.3 | 0 to 1.8 | 1.8 to 4.0 | 0 to 0.3 | 0 to 2.0 | 2.0 to 4.0 | 0 to 0.3 | 0 to 2.0 | 2.0 to 4.0 |
| **Metals in mg/kg** | | | | | | | | | | | | |
| Antimony | NR | 0.3 | 0.2 | 0.1 | NR | NR | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 |
| Arsenic | NR | 5 | 5 | 4 | NR | NR | 4 | 3 | 4 | 4 | 4 | 5 |
| Cadmium | NR | 0.8 | 1.1 | 0.5 | NR | NR | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.7 |
| Chromium | NR | 22.1 | 18.5 | 21.8 | NR | NR | 26.4 | 23.8 | 27.4 | 27.3 | 25.5 | 29.4 |
| Copper | NR | 47.8 | 43 | 34.6 | NR | NR | 38 | 38.4 | 44.4 | 40.7 | 40.4 | 54.6 |
| Lead | NR | 116 | 144 | 51.6 | NR | NR | 30.1 | 19.3 | 27.6 | 36 | 23.9 | 79.1 |
| Mercury | NR | 0.08 | 0.08 | 0.07 | NR | NR | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.13 |
| Nickel | NR | 22 | 22 | 22 | NR | NR | 22 | 22 | 24 | 22 | 23 | 23 |
| Silver | NR | 0.4 | 0.4 | 0.2 | NR | NR | 0.2 | 0.4 | 0.4 | 0.2 | 0.2 | 0.4 |
| Zinc | NR | 193 | 245 | 146 | NR | NR | 104 | 89 | 109 | 124 | 100 | 207 |
| **LPAHs in µg/kg** | | | | | | | | | | | | |
| Total LPAHs | NR | 4,700 | 4,900 | 1,383 | 530 | 60 | 6,269 | 870 | 60 | 8,255 | 14,500 | 20,000 |
| **HPAHs in µg/kg** | | | | | | | | | | | | |
| Total HPAHs | NR | 38,600 | 42,300 | 12,890 | 4,770 | 100 | 7,200 | 8,010 | 5,380 | 120,500 | 91,700 | 200,000 |
| **TPH in mg/kg** | | | | | | | | | | | | |
| Pencil Pitch | 1,400 | 385 | 422 | 130 | 48 | ND | 727 | 80 | 54 | 1,220 | 906 | 2,000 |
| Diesel | <100 | NR | NR | <100 | NR | NR | <50 | NR | NR | <100 | NR | NR |

**Notes:**
exceeds LCRMA Screening Level
exceeds LCRMA Maximum Level
NR Not Reported
ND Not Detected

## Table 12 - Summary of Pencil Pitch and Diesel Results
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon

| Sample Name | Lab Code | Pencil Pitch[1] | Pencil Pitch[2] | Pencil Pitch[3] | Diesel[4] | Diesel[5] |
|---|---|---|---|---|---|---|
| HC-S-01 | K9807097-031 | - | 7730 | - | - | 779 |
| HC-S-02 | K9807097-032 | - | 7620 | - | - | 87 |
| HC-S-03 | K9807097-033 | - | 2940 | - | - | <50 |
| HC-S-04 | K9807097-034 | - | 1350 | - | - | 183 |
| HC-S-05 | K9807097-035 | - | 963 | - | - | 115 |
| HC-S-06 | K9807097-036 | - | 763 | - | - | 135 |
| HC-S-07 | K9807097-037 | - | 1240 | - | - | 106 |
| HC-S-08 | K9807097-038 | - | 894 | - | <100 | - |
| HC-S-09 | K9807097-039 | - | 1080 | - | <100 | - |
| HC-S-101 | K9807097-040 | - | 1260 | - | <100 | - |
| HC-S-10 | K9807115-001 | 960 | - | - | <100 | - |
| HC-S-11 | K9807115-002 | - | 1230 | - | <100 | - |
| HC-S-12 | K9807115-003 | - | | 647 | - | 77 |
| HC-S-13 | K9807115-004 | - | 551 | | <100 | - |
| HC-S-14 | K9807115-005 | - | 630 | - | <100 | - |
| HC-S-15 | K9807115-006 | 350 | - | - | <100 | - |
| HC-S-16 | K9807115-007 | - | 1130 | - | - | 115 |
| HC-S-17 | K9807115-008 | 1100 | - | - | <100 | - |
| HC-S-18 | K9807169-012 | 2600 | - | - | <100 | - |
| HC-S-19 | K9807169-013 | - | - | 8430 | - | <50 |
| HC-S-20 | K9807169-014 | - | 1600 | - | <100 | - |
| HC-S-21 | K9807169-015 | 1800 | - | - | <100 | - |
| HC-S-22 | K9807115-009 | - | 449 | - | <100 | - |
| HC-S-23 | K9807115-010 | - | - | 573 | - | 58 |
| HC-S-24 | K9807115-011 | - | 4320 | - | - | 77 |
| HC-S-102 | K9807115-012 | - | 1930 | - | <25 | - |
| HC-S-25 | K9807115-013 | - | 157 | - | - | 962 |
| HC-S-26 | K9807115-014 | - | 289 | - | <100 | - |
| HC-S-27 | K9807115-015 | 1400 | - | - | <100 | - |
| HC-S-28 | K9807115-016 | - | 384 | - | <100 | - |
| HC-S-29 | K9807115-017 | 910 | - | - | <100 | - |
| HC-S-30 | K9807169-017 | - | 319 | - | - | <50 |
| HC-S-31 | K9807169-016 | - | - | 57.6 | - | <50 |
| HC-S-32 | K9807115-020 | - | 130 | - | <100 | - |
| HC-S-33 | K9807115-021 | - | - | 131 | - | 212 |
| HC-S-34 | K9807169-002 | - | 100 | - | - | 375 |
| HC-S-35 | K9807115-018 | - | 170 | - | <100 | - |
| HC-S-36 | K9807169-001 | - | 20.9 | - | - | 96 |
| HC-S-37 | K9807115-019 | - | 88.7 | - | <100 | - |
| HC-S-38 | K9807169-005 | - | 3360 | - | - | <50 |
| HC-S-39 | K9807169-004 | - | 727 | - | - | <50 |
| HC-S-40 | K9807169-003 | - | - | 195 | - | <50 |
| HC-S-41 | K9807169-009 | - | 1710 | - | <100 | - |
| HC-S-42 | K9807169-008 | - | 1220 | - | <100 | - |
| HC-S-43 | K9807169-007 | - | 101 | - | <100 | - |
| HC-S-44 | K9807169-006 | - | 84.1 | - | <100 | - |

**Refer to notes at the end of this table.**

## Table 12 - Summary of Pencil Pitch and Diesel Results
## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation
## Portland, Oregon

| Sample Name | Lab Code | Pencil Pitch[1] | Pencil Pitch[2] | Pencil Pitch[3] | Diesel[4] | Diesel[5] |
|---|---|---|---|---|---|---|
| HC-VC-7-S1 | K9807097-004 | - | 1920 | - | NR | NR |
| HC-VC-7-S2 | K9807097-005 | - | 938 | - | NR | NR |
| HC-VC-11-S1 | K9807097-013 | - | 703 | - | <100 | - |
| HC-VC-11-S2 | K9807097-014 | - | 1400 | - | <100 | - |
| HC-VC-13-S1 | K9807097-007 | - | 23 | - | <25 | - |
| HC-VC-13-S2 | K9807097-008 | - | 21 | - | NR | NR |
| HC-VC-18-S1 | K9807097-001 | - | 385 | - | NR | NR |
| HC-VC-18-S2 | K9807097-002 | - | 166 | - | NR | NR |
| HC-VC-22-S1 | K9807097-016 | - | 26 | - | NR | NR |
| HC-VC-22-S2 | K9807097-017 | - | ND | - | NR | NR |
| HC-VC-27-S1 | K9807097-019 | - | 385 | - | NR | NR |
| HC-VC-27-S2 | K9807097-020 | - | 422 | - | NR | NR |
| HC-VC-32-S1 | K9807097-022 | - | 48 | - | NR | NR |
| HC-VC-32-S2 | K9807097-023 | - | ND | - | NR | NR |
| HC-VC-39-S1 | K9807097-025 | - | 80 | - | NR | NR |
| HC-VC-39-S2 | K9807097-026 | - | 54 | - | NR | NR |
| HC-VC-42-S1 | K9807097-028 | - | 906 | - | NR | NR |
| HC-VC-42-S2 | K9807097-029 | - | 2000 | - | NR | NR |

**Notes:**

[1] Pencil Pitch measured by NWTPH-Dx.

[2] Pencil Pitch calculated as a function of LCRMA HPAHs using the BNA extract for analysis.

[3] Pencil Pitch calculated as a function of LCRMA HPAHs + alkylated homologs of fluoranthene, pyrene and chrysene. The aromatic fraction of the NWTPH-Dx extract was used for the analysis.

[4] Diesel measured by NWTPH-Dx.

[5] Diesel calculated as a function of Pristane and Phytane. The aliphatic fraction of the NWTPH-Dx extract was used for the analysis.

NR = Not Reported

**Table 13 - Presentation of Sediment Grain Size for Bioassay Samples and Selection of Appropriate Reference Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample # | % Fines [1] | Reference Sediment for Statistical Analyses |
|---|---|---|
| **Phase 1** | | |
| HC-S-26 | 23.1 | REF-C |
| HC-S-28 | 84.0 | REF-B |
| HC-S-35 | 64.5 | REF-B |
| HC-S-36 | 23.4 | REF-C |
| HC-S-39 | 85.1 | REF-B |
| HC-S-42 | 92.9 | REF-B |
| **Phase 2** | | |
| HC-S-01 | 80.8 | REF-B |
| HC-S-04 | 81.6 | REF-B |
| HC-S-05 | 60.4 | REF-B |
| HC-S-07 | 87.1 | REF-B |
| HC-S-11 | 86.6 | REF-B |
| HC-S-16 | 70.4 | REF-B |
| HC-S-19 | 31.9 | REF-C |
| HC-S-22 | 61.0 | REF-B |
| HC-S-24 | 40.8 | REF-C |
| HC-S-30 | 40.8 | REF-C |
| REF-B | 99.1 | -- |
| REF-C | 19.8 | -- |

**Notes:**
[1] Percent Fines is the sum of % Silt and % Clay.

**Table 14 - Summary of Sediment Bioassay Results - Amphipod Bioassay *(Hyallela azteca)***
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample Identification | Test Mean Mortality ($M_T$) in percent | Reference Mean Mortality ($M_R$) in percent | $M_T$ - $M_R$ | P-Value | Single-Hit Criteria [1] ($M_T$ - $M_R$ > 15%) | Two-Hit Criteria [2] (significant diff. btwn $M_T$ and $M_R$) | Overall Result[3] |
|---|---|---|---|---|---|---|---|
| **PHASE 1** | | | | | | | |
| HC-S-26 | 7.5 | 1.3 | 6.2 | 0.04 | Pass | yes | **Pass** |
| HC-S-28 | 16.3 | 3.8 | 12.5 | 0.01 | Pass | yes | **Pass** |
| HC-S-35 | 5.0 | 3.8 | 1.2 | – | Pass | no | **Pass** |
| HC-S-36 | 3.8 | 1.3 | 2.5 | – | Pass | no | **Pass** |
| HC-S-39 | 6.3 | 3.8 | 2.5 | – | Pass | no | **Pass** |
| HC-S-42 | 7.5 | 3.8 | 3.7 | – | Pass | no | **Pass** |
| Ref B | 3.8 | – | – | – | – | – | – |
| Ref C | 1.3 | – | – | – | – | – | – |
| Neg. Control | 1.3 | – | – | – | – | – | – |
| **PHASE 2** | | | | | | | |
| HC-S-01 | 35.0 | 13.8 | 21.2 | 0.003 | Fail | yes | **Fail** |
| HC-S-04 | 37.5 | 13.8 | 23.7 | 0.002 | Fail | yes | **Fail** |
| HC-S-05 | 28.8 | 13.8 | 15 | 0.04 | Pass | yes | **Fail** |
| HC-S-07 | 20.0 | 13.8 | 6.2 | – | Pass | no | **Fail** |
| HC-S-11 | 18.8 | 13.8 | 5 | – | Pass | no | **Pass** |
| HC-S-16 | 27.5 | 13.8 | 13.7 | 0.04 | Pass | yes | **Fail** |
| HC-S-19 | 16.3 | 26.3 | -10 | – | Pass | no | **Pass** |
| HC-S-22 | 30.0 | 13.8 | 16.2 | 0.01 | Fail | yes | **Fail** |
| HC-S-24 | 33.8 | 26.3 | 7.5 | – | Pass | no | **Pass** |
| HC-S-30 | 12.5 | 26.3 | -13.8 | – | Pass | no | **Pass** |
| Ref B | 13.8 | – | – | – | – | – | – |
| Ref C | 26.3 | – | – | – | – | – | – |
| Neg. Control | 15.0 | – | – | – | – | – | – |

**Notes:**

[1] One Hit Required to Fail Bioassay

[2] Two Hits Required to Fail Bioassay

[3] A test fails if either of the following is true:

"Fail" of the single-hit criteria for the corresponding sample from any of Tables 10, 11, or 12.

"Yes" for any two-hit criteria for the corresponding sample from any two of Tables 10, 11, or 12.

**Table 15 - Summary of Sediment Bioassay Results - Midge Acute Bioassay *(Chironomus tentans)***
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample Identification | Test Mean Mortality ($M_T$) in percent | Reference Mean Mortality ($M_R$) in percent | $M_T$ - $M_R$ | P-Value | Single-Hit Criteria [1] ($M_T$ - $M_R$ > 20%) | Two-Hit Criteria [2] (significant diff. btwn $M_T$ and $M_R$) | Overall Result[3] |
|---|---|---|---|---|---|---|---|
| **PHASE 1** | | | | | | | |
| HC-S-26 | 27.5 | 20.0 | 7.5 | – | Pass | no | **Pass** |
| HC-S-28 | 40.0 | 28.8 | 11.2 | – | Pass | no | **Pass** |
| HC-S-35 | 35.0 | 28.8 | 6.2 | – | Pass | no | **Pass** |
| HC-S-36 | 26.3 | 20.0 | 6.3 | – | Pass | no | **Pass** |
| HC-S-39 | 41.3 | 28.8 | 12.5 | 0.03 | Pass | yes | **Pass** |
| HC-S-42 | 28.8 | 28.8 | 0 | – | Pass | no | **Pass** |
| Ref B | 28.8 | – | – | – | – | – | – |
| Ref C | 20.0 | – | – | – | – | – | – |
| Neg. Control | 15.0 | – | – | – | – | – | – |
| **PHASE 2** | | | | | | | |
| HC-S-01 | 47.5 | 12.5 | 35 | 0.00001 | Fail | yes | **Fail** |
| HC-S-04 | 30.0 | 12.5 | 17.5 | 0.03 | Pass | yes | **Fail** |
| HC-S-05 | 31.3 | 12.5 | 18.8 | 0.04 | Pass | yes | **Fail** |
| HC-S-07 | 25.0 | 12.5 | 12.5 | – | Pass | no | **Fail** |
| HC-S-11 | 26.3 | 12.5 | 13.8 | – | Pass | no | **Pass** |
| HC-S-16 | 17.5 | 12.5 | 5 | – | Pass | no | **Fail** |
| HC-S-19 | 12.5 | 21.3 | -8.8 | – | Pass | no | **Pass** |
| HC-S-22 | 33.8 | 12.5 | 21.3 | 0.007 | Fail | yes | **Fail** |
| HC-S-24 | 30.0 | 21.3 | 8.7 | – | Pass | no | **Pass** |
| HC-S-30 | 8.6 | 21.3 | -12.7 | – | Pass | no | **Pass** |
| Ref B | 12.5 | – | – | – | – | – | – |
| Ref C | 21.3 | – | – | – | – | – | – |
| Neg. Control | 3.8 | – | – | – | – | – | – |

**Notes:**

[1] One Hit Required to Fail Bioassay

[2] Two Hits Required to Fail Bioassay

[3] A test fails if either of the following is true:

"Fail" of the single-hit criteria for the corresponding sample from any of Tables 10, 11, or 12.

"Yes" for any two-hit criteria for the corresponding sample from any two of Tables 10, 11, or 12.

**Table 16 - Summary of Sediment Bioassay Results - Midge Chronic Bioassay *(Chironomus tentans)***
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample Identification | Test Mean Individual Biomass ($B_T$) in mg | Reference Mean Individual Biomass ($B_R$) in mg | $B_T/B_R$*100 | P-Value | Single-Hit Criteria [1] ($B_T/B_R$ < 60%) | Two-Hit Criteria [2] (significant diff. btwn $M_T$ and $M_R$) | Overall Result[3] |
|---|---|---|---|---|---|---|---|
| **PHASE 1** | | | | | | | |
| HC-S-26 | 2.01 | 1.73 | 116.2 | – | Pass | no | **Pass** |
| HC-S-28 | 1.32 | 1.60 | 82.5 | – | Pass | no | **Pass** |
| HC-S-35 | 1.71 | 1.60 | 106.9 | – | Pass | no | **Pass** |
| HC-S-36 | 1.50 | 1.73 | 86.7 | – | Pass | no | **Pass** |
| HC-S-39 | 1.64 | 1.60 | 102.5 | – | Pass | no | **Pass** |
| HC-S-42 | 1.46 | 1.60 | 91.3 | – | Pass | no | **Pass** |
| Ref B | 1.60 | – | – | – | – | – | – |
| Ref C | 1.73 | – | – | – | – | – | – |
| Neg. Control | 1.69 | – | – | – | – | – | – |
| **PHASE 2** | | | | | | | |
| HC-S-01 | 0.19 | 1.15 | 16.5 | 0.00002 | Fail | yes | **Fail** |
| HC-S-04 | 0.37 | 1.15 | 32.2 | 0.00001 | Fail | yes | **Fail** |
| HC-S-05 | 0.51 | 1.15 | 44.3 | 0.00002 | Fail | yes | **Fail** |
| HC-S-07 | 0.59 | 1.15 | 51.3 | 0.0003 | Fail | yes | **Fail** |
| HC-S-11 | 0.81 | 1.15 | 70.4 | 0.009 | Pass | yes | **Pass** |
| HC-S-16 | 0.74 | 1.15 | 64.3 | 0.002 | Pass | yes | **Fail** |
| HC-S-19 | 1.09 | 1.37 | 79.6 | – | Pass | no | **Pass** |
| HC-S-22 | 1.02 | 1.15 | 88.7 | – | Pass | no | **Fail** |
| HC-S-24 | 0.96 | 1.37 | 70.1 | 0.08 | Pass | yes | **Pass** |
| HC-S-30 | 0.95 | 1.37 | 69.3 | 0.01 | Pass | yes | **Pass** |
| Ref B | 1.15 | – | – | – | – | – | – |
| Ref C | 1.37 | – | – | – | – | – | – |
| Neg. Control | 1.46 | – | – | – | – | – | – |

**Notes:**

[1] One Hit Required to Fail Bioassay

[2] Two Hits Required to Fail Bioassay

[3] A test fails if either of the following is true:
"Fail" of the single-hit criteria for the corresponding sample from any of Tables 10, 11, or 12.
"Yes" for any two-hit criteria for the corresponding sample from any two of Tables 10, 11, or 12.

**Table 17 - Analytical Results for Bioassay Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Sample ID<br>Depth in Feet | HC-S-01<br>0 to 0.3 | HC-S-04<br>0 to 0.3 | HC-S-05<br>0 to 0.3 | HC-S-07<br>0 to 0.3 | HC-S-11<br>0 to 0.3 | HC-S-16<br>0 to 0.3 | HC-S-19<br>0 to 0.3 | HC-S-22<br>0 to 0.3 | HC-S-24<br>0 to 0.3 | HC-S-26<br>0 to 0.3 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Metals in mg/kg** | | | | | | | | | | |
| Antimony, Total | | 0.4 J | 0.8 J | 0.3 J | 0.6 J | 0.4 J | 4.4 J | 0.2 J | 0.3 J | 0.2 J |
| Arsenic, Total | | 6 | 6 | 7 | 9 | 6 | 11 | 5 | 5 | 4 |
| Cadmium, Total | | 2.6 | 2.2 | 2 | 1.9 J | 1.3 J | 5.6 | 1 J | 1.5 J | 2.5 J |
| Chromium, Total | | 29.2 | 23.6 | 31.9 | 31.2 | 29.4 | 18.3 | 23.1 | 23 | 14.3 |
| Copper, Total | | 57.3 | 44.6 | 64 | 70.4 | 52.2 | 62.9 | 44.1 | 41.4 | 26 |
| Lead, Total | | 294 | 272 | 322 | 357 J | 210 J | 1160 | 125 J | 118 J | 68.4 J |
| Mercury, Total | | 0.13 | 0.08 | 0.16 | 0.13 | 0.25 | 0.07 | 0.09 | 0.08 | 0.04 |
| Nickel, Total | | 25 | 21 | 27 | 27 | 27 | 16 | 23 | 36 | 22 |
| Silver, Total | | 0.8 | 0.8 | 0.8 | 0.7 | 0.1 | 1.9 | 0.3 | 0.3 | 0.1 |
| Zinc, Total | | 450 | 385 | 399 | 397 J | 306 J | 1020 J | 225 J | 279 J | 435 J |
| **Volatiles in µg/kg** | | | | | | | | | | |
| 1,2-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| 1,3-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| 1,4-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Benzene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Ethylbenzene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Tetrachloroethene (PCE) | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Toluene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Total Xylenes | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| Trichloroethene (TCE) | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| m- & p-Xylenes | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| o-Xylene | 10 U | 10 U | 10 U | 10 U | 25 U | 5 U | 5 U | 10 U | 10 U | 5 U |
| **TPH in mg/kg** | | | | | | | | | | |
| Diesel | 779 | 183 | 115 | 106 | 100 U | 115 | 50 U | 100 U | 77 | 100 U |
| Pencil Pitch | 7730 | 1350 | 963 | 1240 | 1230 | 1130 | 8430 | 449 | 4320 | 289 |
| **LPAHs in µg/kg** | | | | | | | | | | |
| Acenaphthene | *20000 U* | 1100 | 560 | 990 | 940 | 630 | 6100 | 310 | 410 | 73 |
| Acenaphthylene | *20000 U* | 400 U | 460 | 400 U | 200 | 480 | 71 | 110 | 3600 | 140 |
| Anthracene | *20000 U* | 1700 | 1400 | 1700 | 1700 | 1900 | 5900 | 560 | 6600 | 350 |
| Fluorene | *20000 U* | 670 | 570 | 730 | 590 | 620 | 2500 | 230 | 1200 | 100 |
| Naphthalene | *20000 U* | 400 | 440 | 400 U | 250 | 450 | 1400 | 20 U | 2200 | 100 |
| Phenanthrene | 49000 | 6400 | 4700 | 6100 | 5700 | 4900 | 26000 | 1900 | 15000 | 1000 |
| Total LPAHs | 99000 | 10470 | 8130 | 9920 | 9380 | 8980 | 41971 | 3120 | 29010 | 1763 |
| **HPAHs in µg/kg** | | | | | | | | | | |
| Benz(a)anthracene | 77000 | 13000 | 8600 | 12000 | 11000 | 9000 | 44000 | 4000 | 37000 | 2300 |
| Benzo(a)pyrene | 86000 | 15000 | 9600 | 13000 | 13000 | 11000 | 55000 | 4900 | 39000 | 2700 |

**Table 17 - Analytical Results for Bioassay Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

Hart Crowser
J-5624-10

| Sample ID<br>Depth in Feet | HC-S-01<br>0 to 0.3 | HC-S-04<br>0 to 0.3 | HC-S-05<br>0 to 0.3 | HC-S-07<br>0 to 0.3 | HC-S-11<br>0 to 0.3 | HC-S-16<br>0 to 0.3 | HC-S-19<br>0 to 0.3 | HC-S-22<br>0 to 0.3 | HC-S-24<br>0 to 0.3 | HC-S-26<br>0 to 0.3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzo(b)fluoranthene | 83000 | 13000 | 7700 | 12000 | 10000 | 7600 | 44000 | 3700 | 23000 | 1600 |
| Benzo(g,h,i)perylene | 55000 | 11000 | 7100 | 9400 | 8900 | 7600 | 38000 | 3300 | 27000 | 1900 |
| Benzo(k)fluoranthene | 61000 | 9100 | 5800 | 8100 | 8400 | 7000 | 35000 | 3300 | 24000 | 1800 |
| Chrysene | 75000 | 11000 | 7800 | 10000 | 11000 | 8900 | 46000 | 3800 | 38000 | 2200 |
| Dibenz(a,h)anthracene | *20000* U | 1200 | 730 | 1200 | 2200 | 1700 | 11000 | 800 | 4700 | 350 |
| Fluoranthene | 120000 | 21000 | 18000 | 19000 | 21000 | 21000 | 70000 J | 7200 | 84000 | 5500 |
| Indeno(1,2,3-cd)pyrene | 110000 | 19000 | 10000 | 17000 | 14000 | 13000 | 60000 | 6000 | 41000 | 3400 |
| Pyrene | 98000 | 21000 | 20000 | 21000 | 22000 | 25000 | 68000 | 7500 | 110000 | 6800 |
| Total HPAHs | 775000 | 134300 | 95330 | 122700 | 121500 | 111800 | 471000 | 44500 | 427700 | 28550 |
| Total Benzofluoranthenes | 144000 | 22100 | 13500 | 20100 | 18400 | 14600 | 79000 | 7000 | 47000 | 3400 |
| **Phenols in µg/kg** | | | | | | | | | | |
| 2,4-Dimethylphenol | *6000* U | *120* U | *120* U | *120* U | 6 U | 6 U | 31 | 6 U | 6 U | 6 U |
| 2-Methylphenol | *6000* U | *120* U | *120* U | *120* U | 6 U | 6 U | 51 | 6 U | 6 U | 6 U |
| 4-Methylphenol | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 130 | 20 U | 20 U | 20 U |
| Pentachlorophenol (PCP) | *60000* U | *1200* U | *1200* U | *1200* U | 60 U | 60 U | 60 U | 60 U | 60 U | 60 U |
| Phenol | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 110 | 20 U | 20 U | 20 U |
| **Phthalates in µg/kg** | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | *20000* U | 460 | 400 U | 540 | 450 | 420 | 360 | 310 | 2000 U | 110 |
| Butyl Benzyl Phthalate | *20000* U | 400 U | 400 U | 400 U | 36 | 47 | 20 U | 24 | *2000* U | 20 U |
| Di-n-butyl Phthalate | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Di-n-octyl Phthalate | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 20 U | 20 U | 2000 U | 20 U |
| Diethyl Phthalate | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Dimethyl Phthalate | *20000* U | 400 U | 400 U | 400 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| **Semivolatiles in µg/kg** | | | | | | | | | | |
| Benzoic Acid | *100000* U | *2000* U | *2000* U | *2000* U | 100 U | 100 U | 110 | 100 U | 100 U | 100 U |
| Benzyl Alcohol | *6000* U | *120* U | *120* U | *120* U | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U |
| Dibenzofuran | *20000* U | 400 U | 400 U | 400 U | 200 | 160 | 660 | 75 | 170 | 30 |
| Hexachlorobenzene | *20000* U | *400* U | *400* U | *400* U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Hexachlorobutadiene | *20000* U | *400* U | *400* U | *400* U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| N-Nitrosodiphenylamine | *12000* U | *240* U | *240* U | *240* U | 12 U | 12 U | 12 U | 12 U | 12 U | 12 U |

**Table 17 - Analytical Results for Bioassay Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

| Sample ID<br>Depth in Feet | HC-S-28<br>0 to 0.3 | | HC-S-30<br>0 to 0.3 | | HC-S-35<br>0 to 0.3 | | HC-S-36<br>0 to 0.3 | | HC-S-39<br>0 to 0.3 | | HC-S-42<br>0 to 0.3 | | HC-REF-B<br>0 to 0.3 | | HC-REF-C<br>0 to 0.3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals in mg/kg** | | | | | | | | | | | | | | | | |
| Antimony, Total | 0.2 | J | 0.2 | UJ | 0.1 | J | 0.2 | UJ | 0.2 | UJ | 0.2 | UJ | 0.2 | UJ | 0.2 | UJ |
| Arsenic, Total | 5 | | 4 | | 4 | | 3 | | 4 | | 4 | | 9 | | 3 | |
| Cadmium, Total | 0.9 | J | 0.6 | | 0.4 | J | 0.2 | | 0.2 | | 0.3 | | 0.9 | | 0.3 | |
| Chromium, Total | 28.4 | | 21.1 | | 23.3 | | 15.2 | | 26.4 | | 27.3 | | 25.4 | | 10.1 | |
| Copper, Total | 50.4 | | 62 | | 35.5 | | 20.9 | | 38 | | 40.7 | | 36.8 | | 10.7 | |
| Lead, Total | 87.6 | J | 80.7 | | 39 | J | 15.2 | | 30.1 | | 36 | | 23.5 | | 7.3 | |
| Mercury, Total | 0.1 | | 0.06 | | 0.08 | | 0.05 | | 0.08 | | 0.07 | | 0.12 | | 0.06 | |
| Nickel, Total | 25 | | 22 | | 21 | | 17 | | 22 | | 22 | | 21 | | 10 | |
| Silver, Total | 0.3 | | 0.3 | | 0.2 | | 0.1 | | 0.2 | | 0.2 | | 0.2 | | 0.1 | U |
| Zinc, Total | 220 | J | 167 | J | 122 | J | 82 | J | 104 | J | 124 | J | 142 | J | 84 | J |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| 1,3-Dichlorobenzene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| 1,4-Dichlorobenzene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Benzene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Ethylbenzene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Tetrachloroethene (PCE) | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Toluene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Total Xylenes | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| Trichloroethene (TCE) | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| m- & p-Xylenes | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| o-Xylene | 10 | U | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U | 25 | U | 5 | U |
| **TPH in mg/kg** | | | | | | | | | | | | | | | | |
| Diesel | 100 | U | 50 | U | 100 | U | 96 | | 50 | U | 100 | U | | | | |
| Pencil Pitch | 384 | | 319 | | 170 | | 20.9 | | 727 | | 1220 | | | | | |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | | | |
| Acenaphthene | 260 | | 260 | | 120 | | 23 | | 520 | | 920 | | 20 | U | 20 | U |
| Acenaphthylene | 120 | | 44 | | 30 | | 20 | U | 20 | U | 23 | | 20 | U | 20 | U |
| Anthracene | 510 | | 370 | | 220 | | 27 | | 600 | | 1500 | | 20 | U | 20 | U |
| Fluorene | 200 | | 160 | | 85 | | 20 | U | 390 | | 420 | | 20 | U | 20 | U |
| Naphthalene | 100 | | 64 | | 40 | | 33 | | 49 | | 92 | | 20 | U | 20 | U |
| Phenanthrene | 1700 | | 1600 | | 730 | | 150 | | 4700 | | 5300 | | 20 | U | 20 | U |
| Total LPAHs | 2890 | | 2498 | | 1225 | | 253 | | 6269 | | 8255 | | | | | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | | | |
| Benz(a)anthracene | 3200 | | 2700 | | 1500 | | 170 | | 6200 | | 11000 | | 35 | | 20 | U |
| Benzo(a)pyrene | 4000 | | 3300 | | 1800 | | 180 | | 6700 | | 14000 | | 43 | | 20 | U |

**Table 17 - Analytical Results for Bioassay Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Remedial Investigation**
**Portland, Oregon**

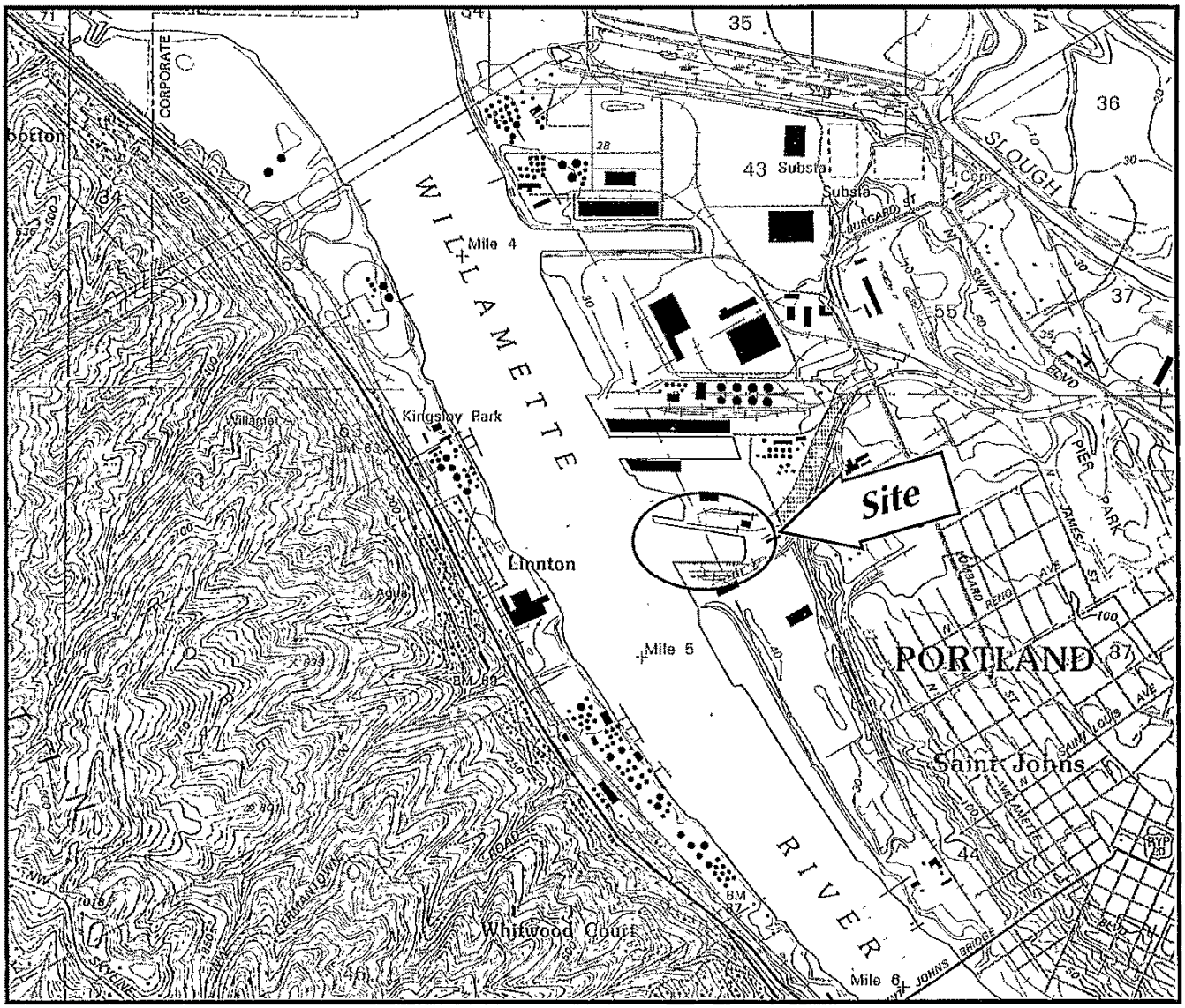
| Sample ID<br>Depth in Feet | HC-S-28<br>0 to 0.3 | | HC-S-30<br>0 to 0.3 | | HC-S-35<br>0 to 0.3 | | HC-S-36<br>0 to 0.3 | | HC-S-39<br>0 to 0.3 | | HC-S-42<br>0 to 0.3 | | HC-REF-B<br>0 to 0.3 | | HC-REF-C<br>0 to 0.3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzo(b)fluoranthene | 2900 | | 2400 | | 1500 | | 150 | | 6500 | | 11000 | | 37 | | 20 | U |
| Benzo(g,h,i)perylene | 2800 | | 2500 | | 1200 | | 220 | | 5400 | | 11000 | | 57 | | 23 | |
| Benzo(k)fluoranthene | 2700 | | 2400 | | 1300 | | 98 | | 5500 | | 8900 | | 22 | | 20 | U |
| Chrysene | 3200 | | 3000 | | 1500 | | 170 | | 7000 | | 11000 | | 35 | | 20 | U |
| Dibenz(a,h)anthracene | 630 | | 540 | | 280 | | 50 | | 1700 | | 2600 | | 20 | U | 20 | U |
| Fluoranthene | 6500 | | 5200 | | 2700 | | 310 | | 13000 | | 17000 | | 63 | | 23 | |
| Indeno(1,2,3-cd)pyrene | 5100 | | 4600 | | 2300 | | 340 | | 10000 | | 18000 | | 110 | | 43 | |
| Pyrene | 7000 | | 5000 | | 2700 | | 380 | | 10000 | | 16000 | | 68 | | 27 | |
| Total HPAHs | 38030 | | 31640 | | 16780 | | 2068 | | 72000 | | 120500 | | | | | |
| Total Benzofluoranthenes | 5600 | | 4800 | | 2800 | | 248 | | 12000 | | 19900 | | | | | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| 2-Methylphenol | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| 4-Methylphenol | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Pentachlorophenol (PCP) | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U |
| Phenol | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 370 | | 300 | | 260 | | 50 | | 290 | | 500 | | 62 | | 20 | U |
| Butyl Benzyl Phthalate | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 37 | | 20 | U | 20 | U |
| Di-n-butyl Phthalate | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Di-n-octyl Phthalate | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 100 | | 20 | U | 20 | U |
| Diethyl Phthalate | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Dimethyl Phthalate | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | | | |
| Benzoic Acid | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U |
| Benzyl Alcohol | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| Dibenzofuran | 62 | | 52 | | 31 | | 20 | U | 160 | | 170 | | 20 | U | 20 | U |
| Hexachlorobenzene | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Hexachlorobutadiene | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| N-Nitrosodiphenylamine | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U |

**Notes:**
Indicates Exceedence of SL
Indicates Exceedence of ML
DUP = Duplicate
U = Undetected
J = Estimated concentration
*Italics* = Detection limit exceeds SL or ML.

Figures

# Site Location Map

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




**Note:** Base map prepared from the USGS 7.5-minute quadrangle of Linnton, Oregon, dated 1990.

SCALE 1 : 24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

N

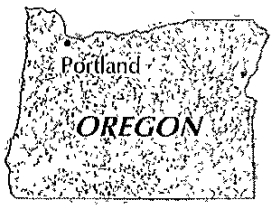



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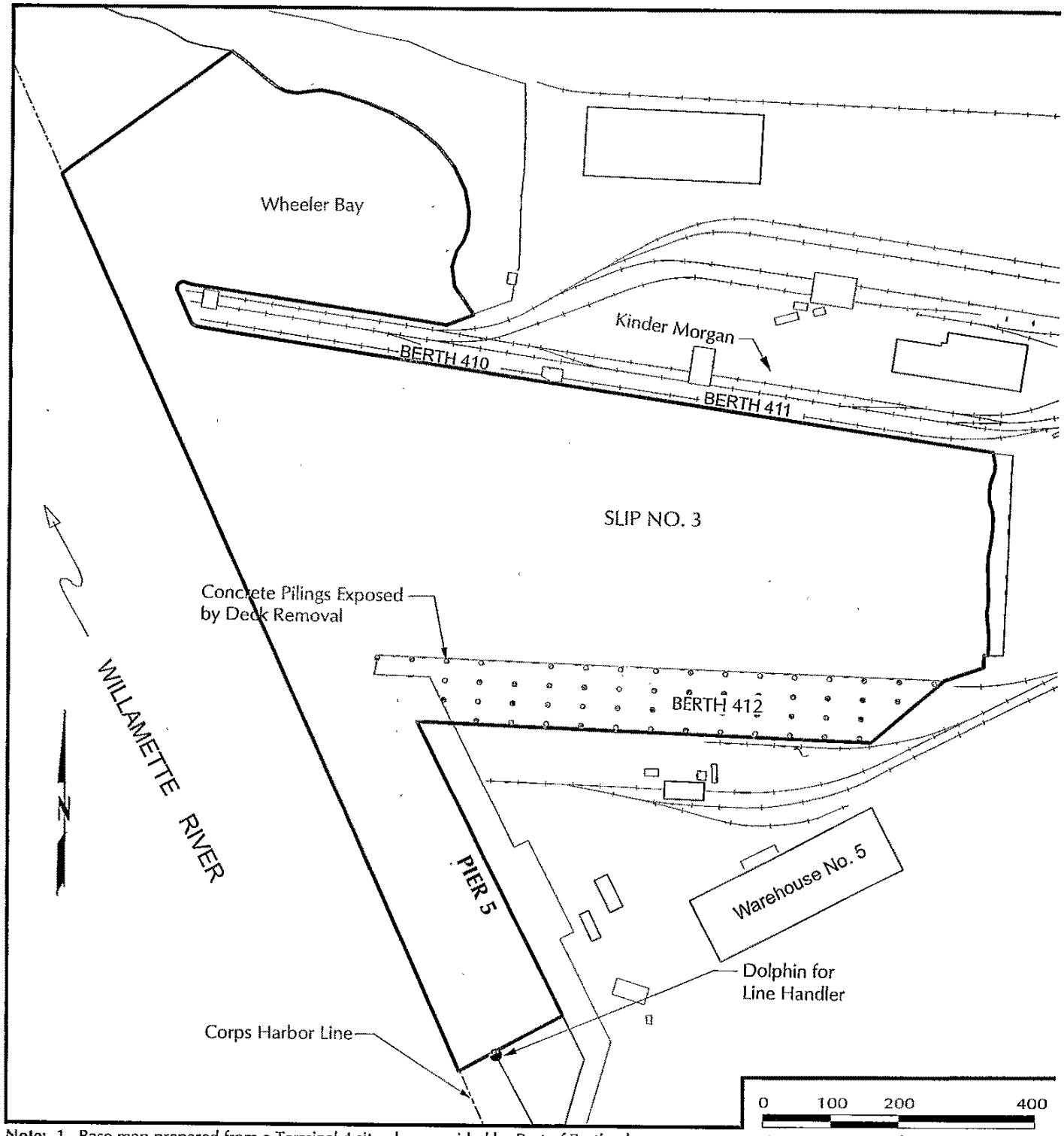
Figure 1

# Study Area Map - Slip 3, Pier 5, and Wheeler Bay

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




**Note:** 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

Study Area

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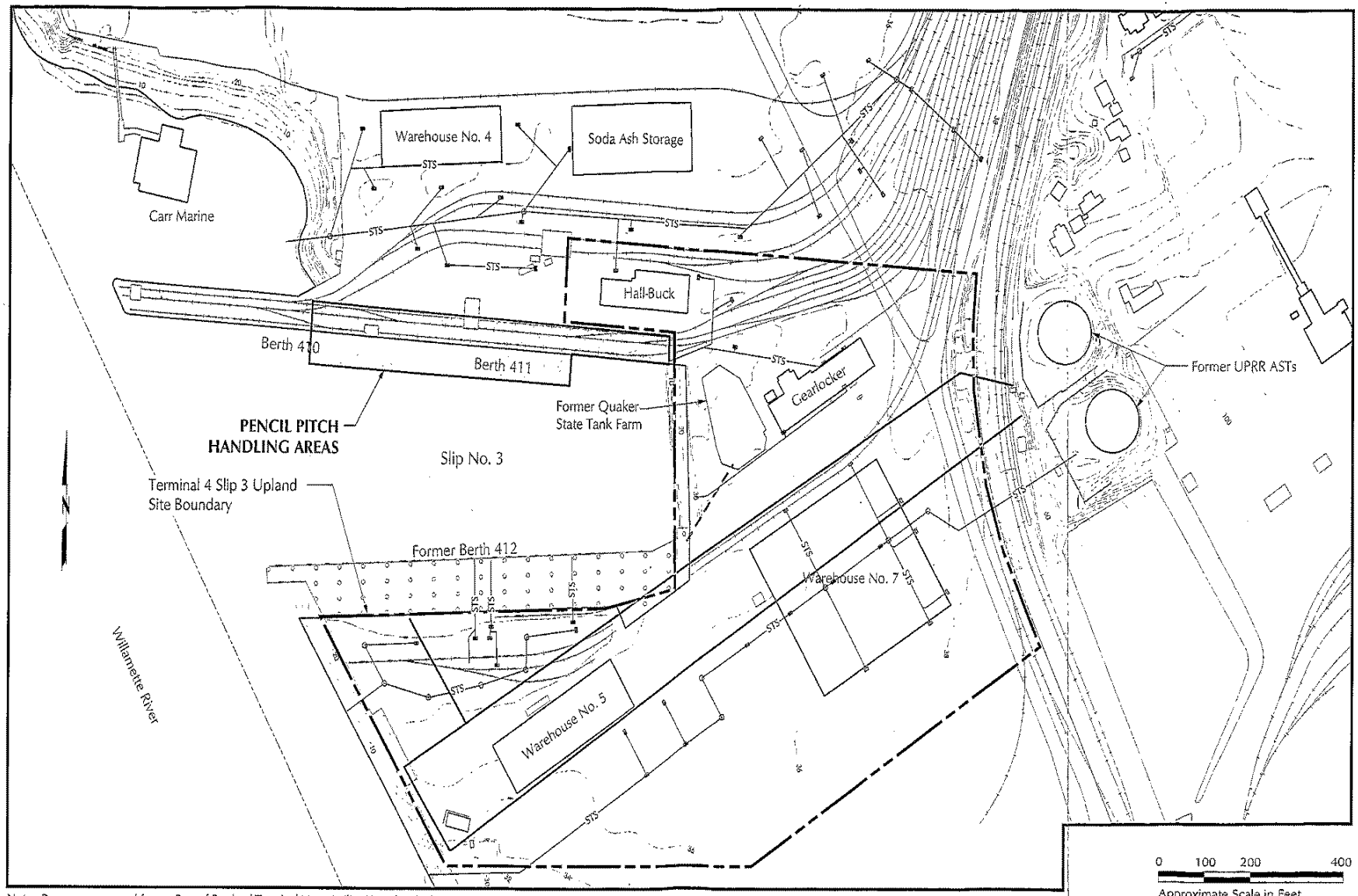
Figure 2

# Location of Pipelines and Storm Drains

## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization




0 100 200 400

Approximate Scale in Feet

Note: Base map prepared from a Port of Portland Terminal No. 4 Utility Plan, dated 4/98.

**Legend:**

—STS— Underground Storm Sewer Line

——— Decommissioned Abandoned UPRR Fuel Line

– – – Former Quaker State Oil Line

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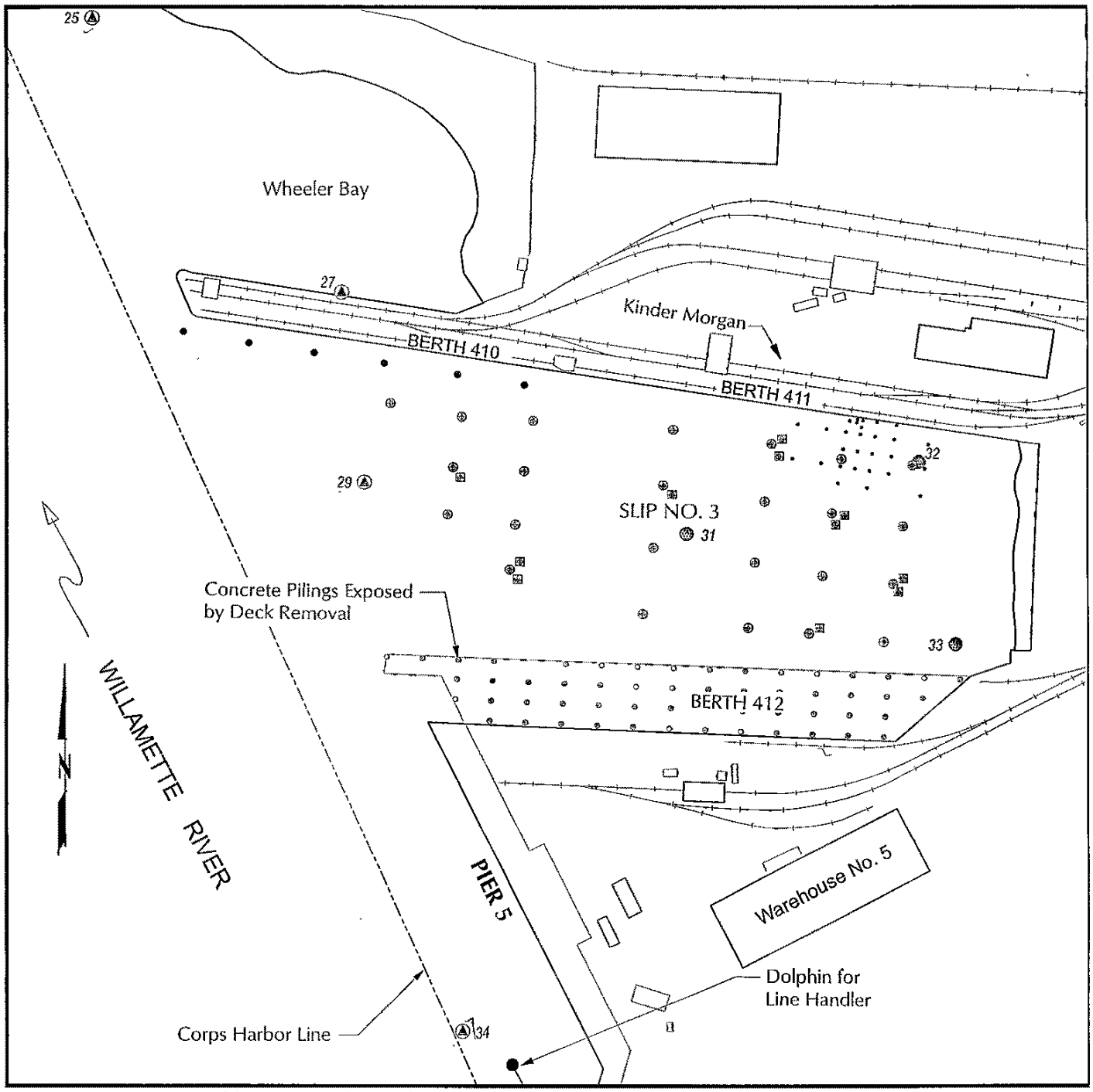
Figure 3

# Historical Sediment Sample Location Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

- Grab Sample Location (1994)
- Core Sample Location (1994) (Dredged 1995)
- 31 Portland Harbor Study Split Sediment Sample Location and Number (9/97)
- 34 Portland Harbor Study Sediment Sample Location and Number (9/97)
- Pencil Pitch Sediment Sample Location (7/97)
- Maintenance Dredging Sediment Sample Location (5/97)

0 100 200 400

Approximate Scale in Feet

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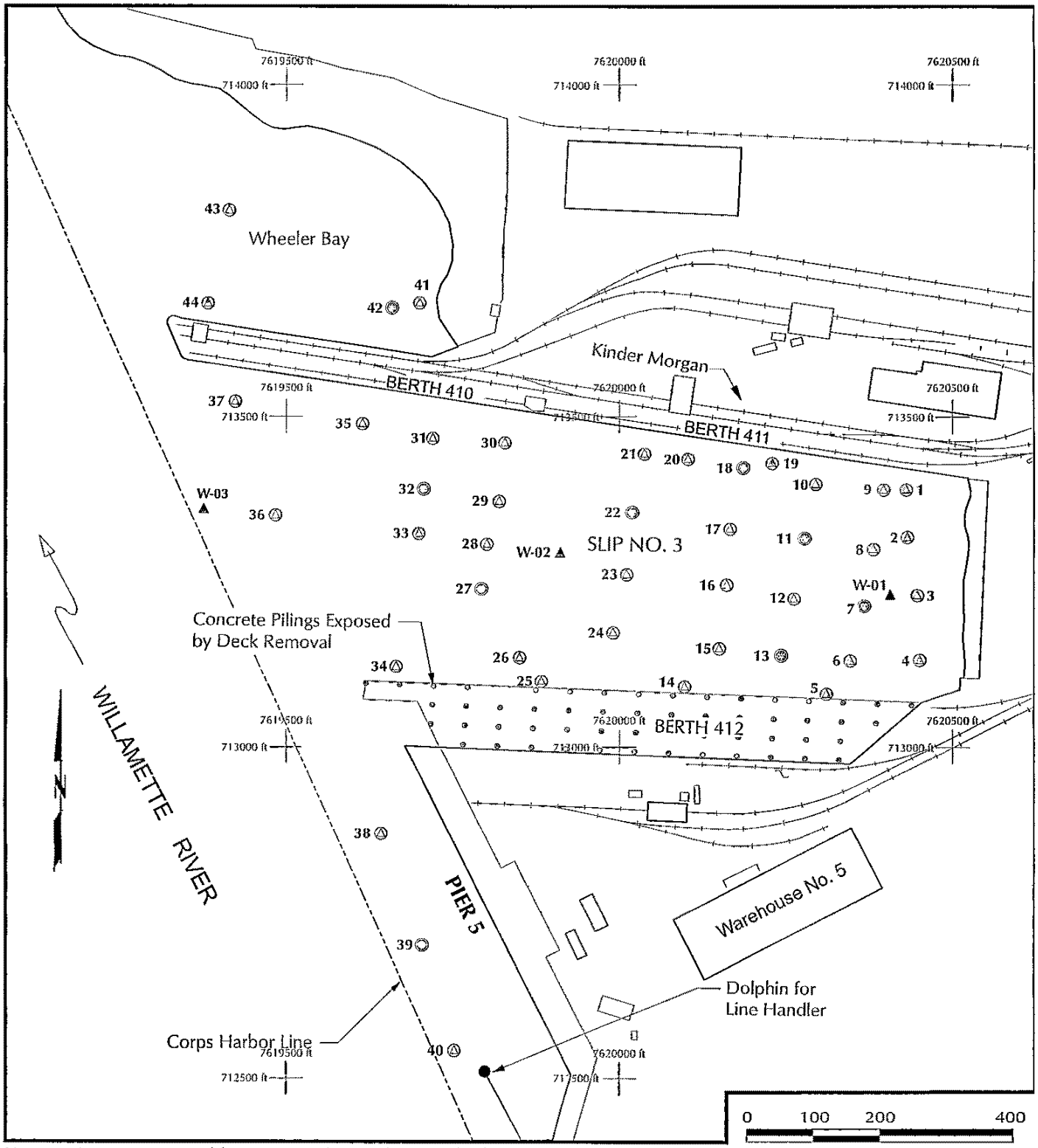
Figure 4

# RI Sample Location Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

- 40 ⊗ Surface Sediment Sample Location and Number (Referred in Text and Tables as HC-S-#)
- 39 ◎ Collocated Surface and Subsurface Sediment Sample Location and Number (Referred in Text and Tables as HC-S-#/HC-VC-#)
- W-03 ▲ Water Sample Location and Number (Referred in Text and Tables as HC-W-#)

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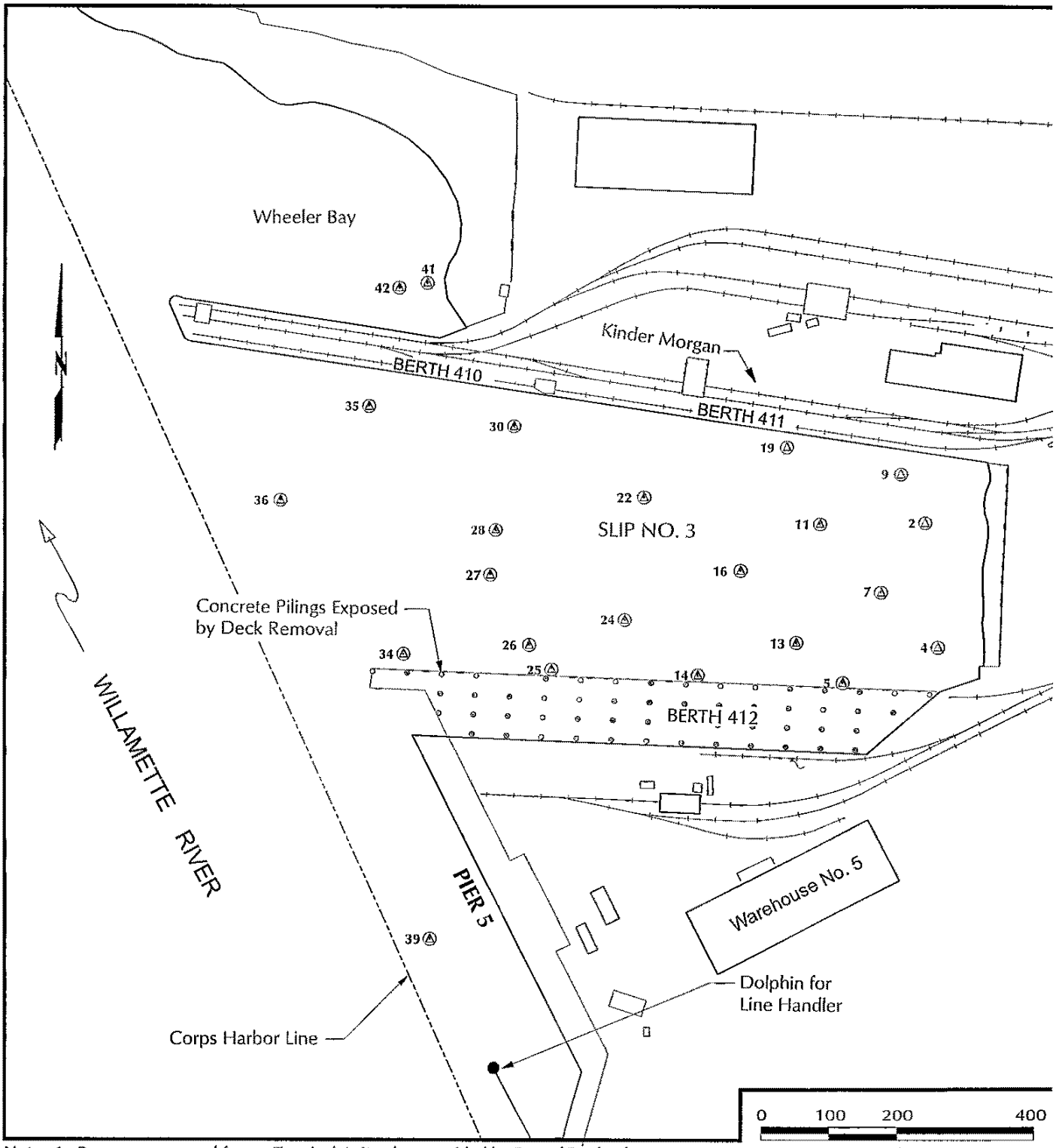
Figure 5

# Sediment Sampling Location Plan for Metals Analysis

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

39 Sediment Sampling Location and Number

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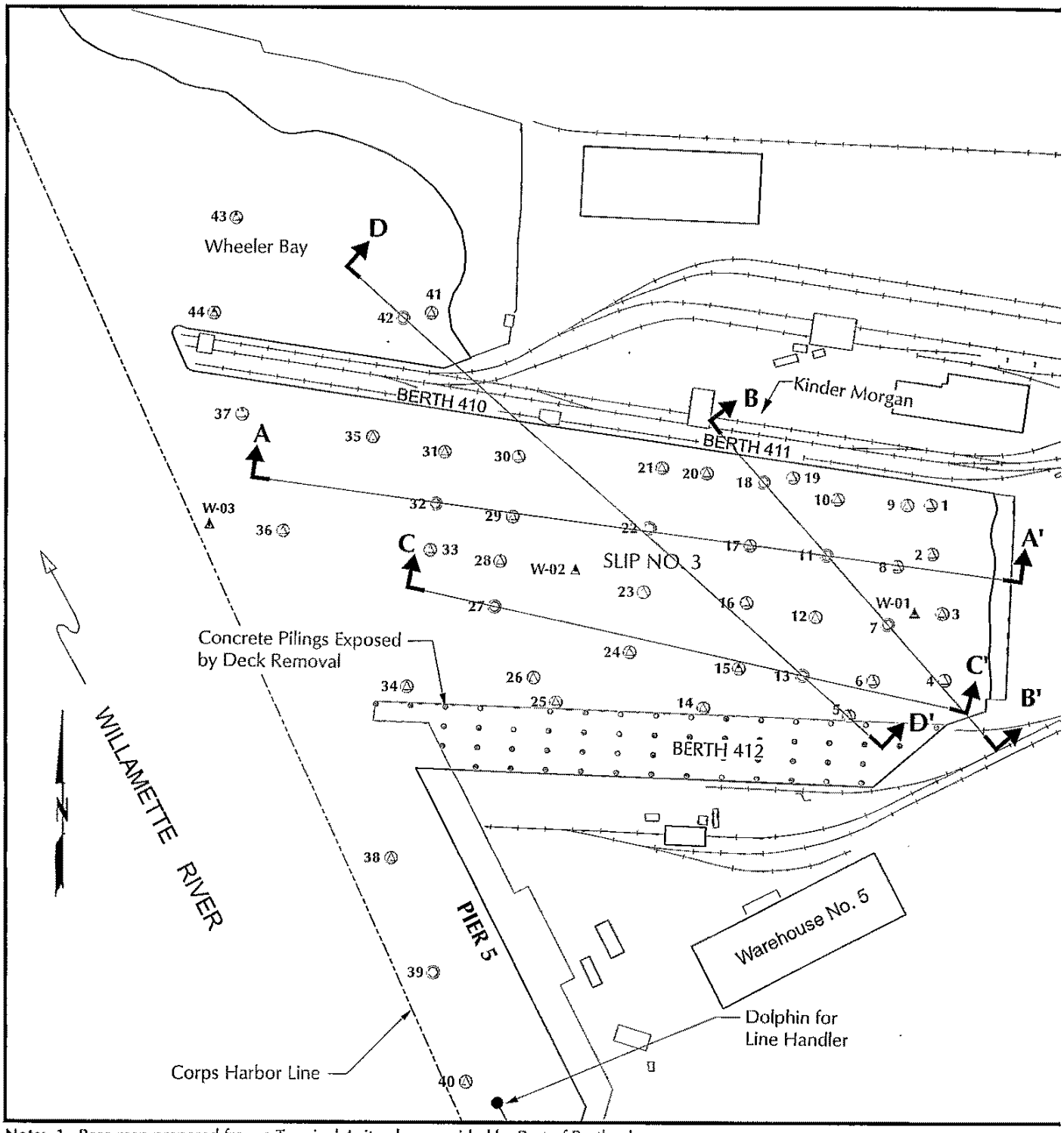
Figure 6

# Cross Section Location Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

40 Surface Sediment Sample Location and Number (Referred in Text and Tables as HC-S-#)

39 Collocated Surface and Subsurface Sediment Sample Location and Number (Referred in Text and Tables as HC-S-#/HC-VC-#)

W-03 Water Sample Location and Number (Referred in Text and Tables as HC-W-#)

C C' Cross Section Location and Designation

0 100 200 400

Approximate Scale in Feet

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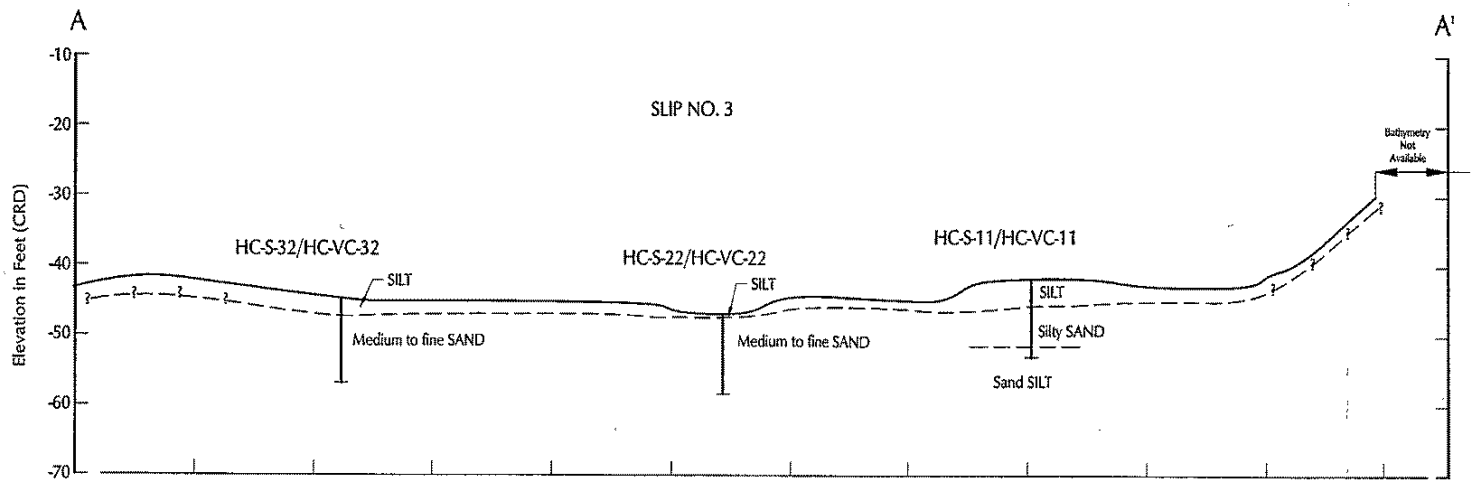
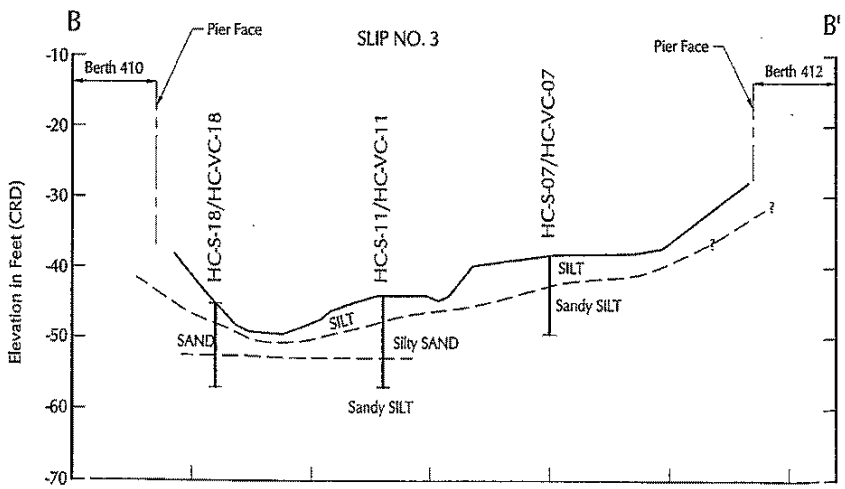
Figure 7

# Generalized Subsurface Cross Sections A-A' and B-B'

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




HC-S-11 Sediment Boring Number

Sediment Boring Location

Berth 412 Location of Pier Structures

Horizontal Scale in Feet
0 100 200
0 20 40
Vertical Scale in Feet
Vertical Exaggeration x 5

Notes: 1. Contacts between sediment units are based upon interpretation between explorations and represent our interpretation of subsurface conditions based on currently available data.
2. Cross section locations shown on Figure 7.
3. Elevations are referenced to Columbia River datum (CRD).

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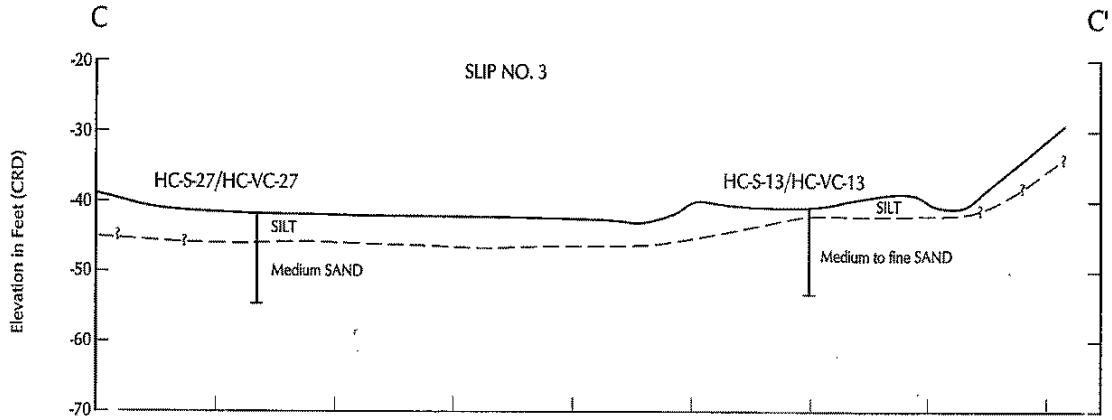
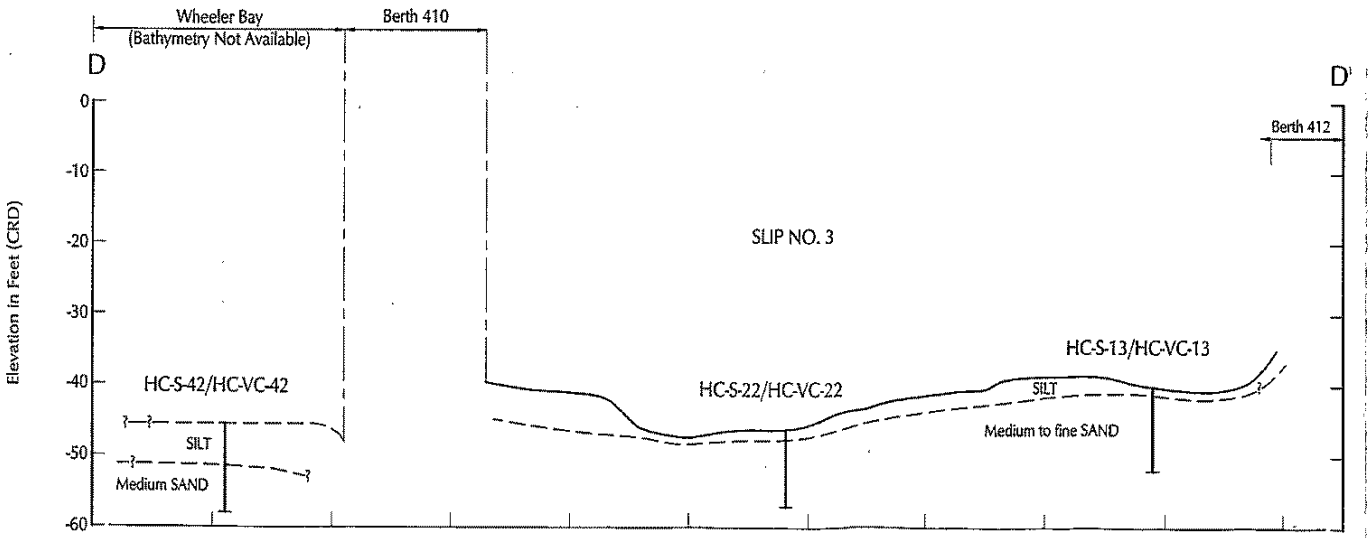
Figure 8

# Generalized Subsurface Cross Sections C-C' and D-D'

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




HC-S-11 Sediment Boring Number

Sediment Boring Location

Berth 412 Location of Pier Structures

Horizontal Scale in Feet
0 100 200

0 20 40
Vertical Scale in Feet
Vertical Exaggeration x 5

Notes:
1. Contacts between sediment units are based upon interpretation between explorations and represent our interpretation of subsurface conditions based on currently available data.
2. Cross section locations shown on Figure 7.
3. Elevations are referenced to Columbia River datum (CRD).

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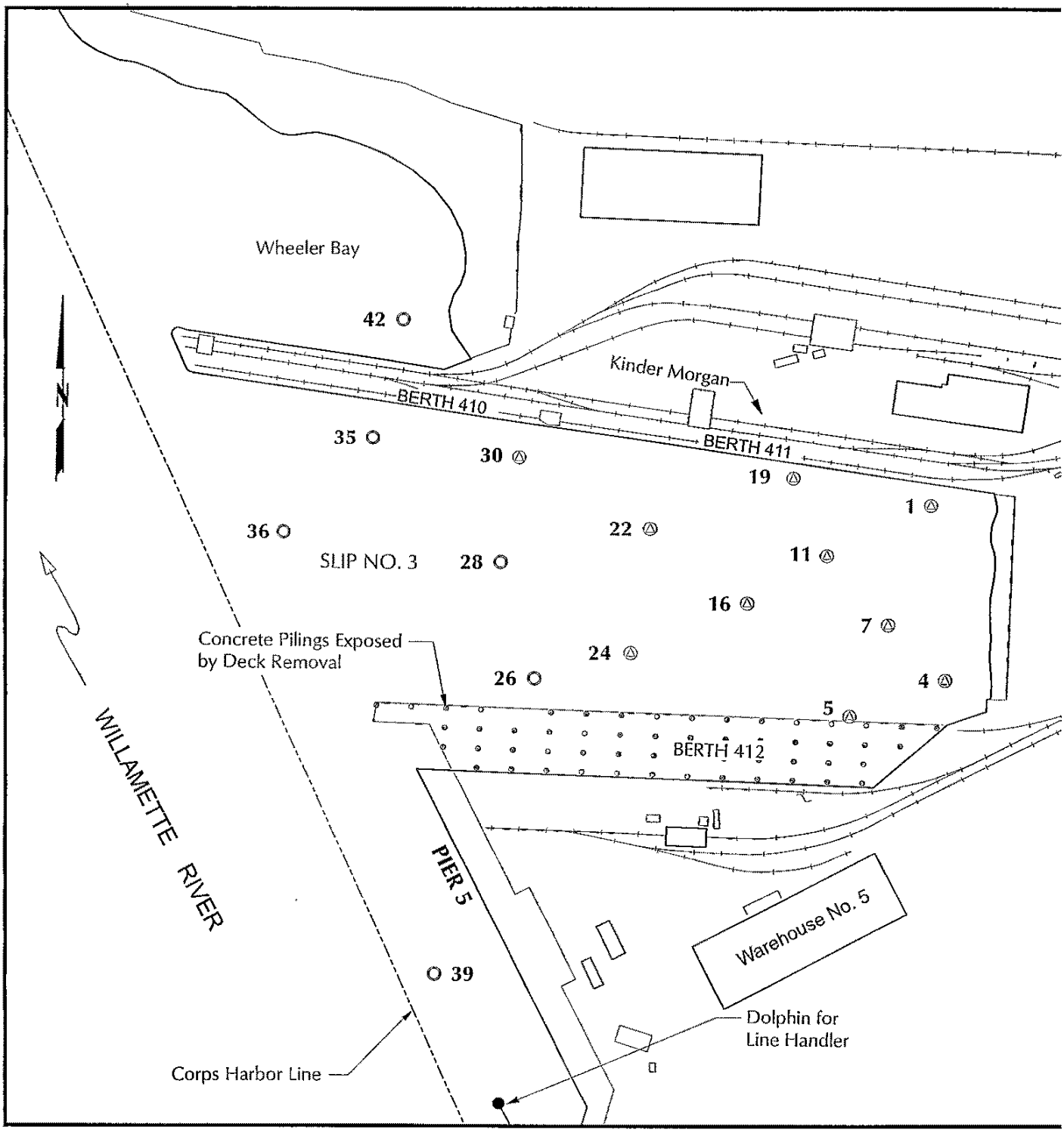
Figure 9

# Bioassay Sampling Location Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400

Approximate Scale in Feet

**Legend:**

39 ○ Phase I Bioassay Sediment Sampling Location and Number

16 ◬ Phase II Bioassay Sediment Sampling Location and Number

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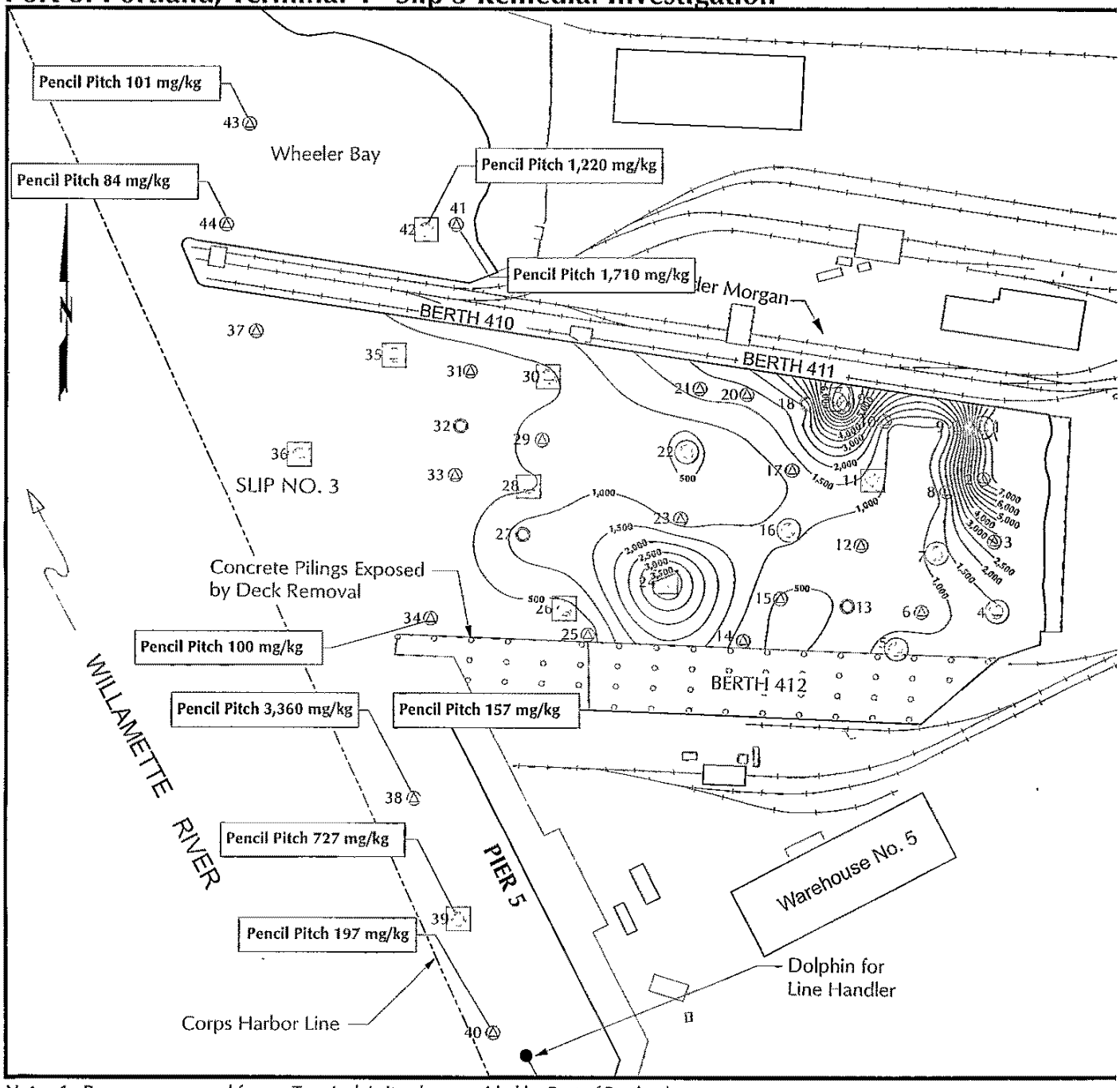
Figure 10

# Pencil Pitch Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400

Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- Pencil Pitch Concentration Contour in mg/kg
- Bioassay Failure
- Bioassay Pass

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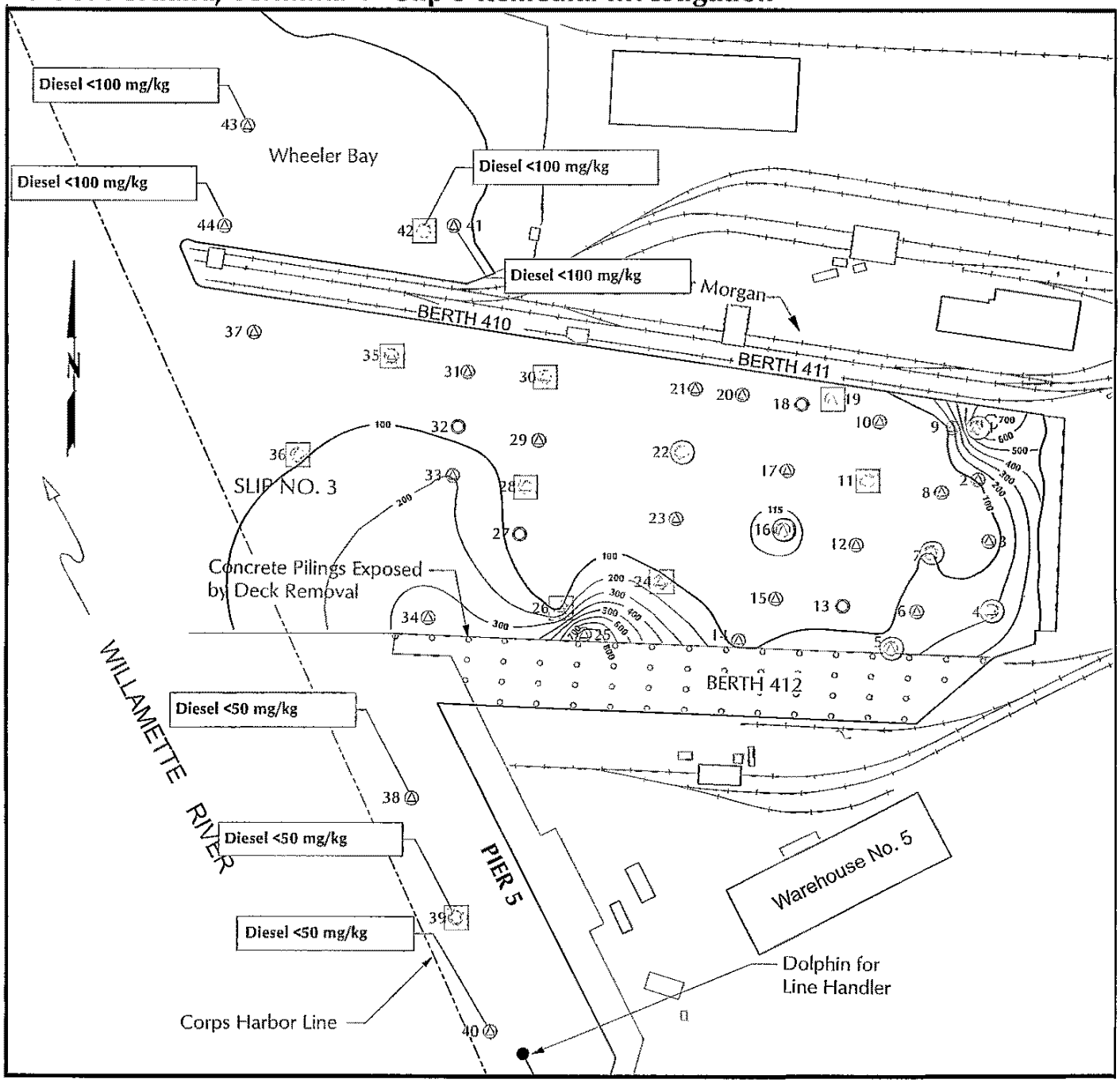
Figure 11

# Diesel Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400

Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- Diesel Concentration Contour in mg/kg
- Bioassay Failure
- Bioassay Pass

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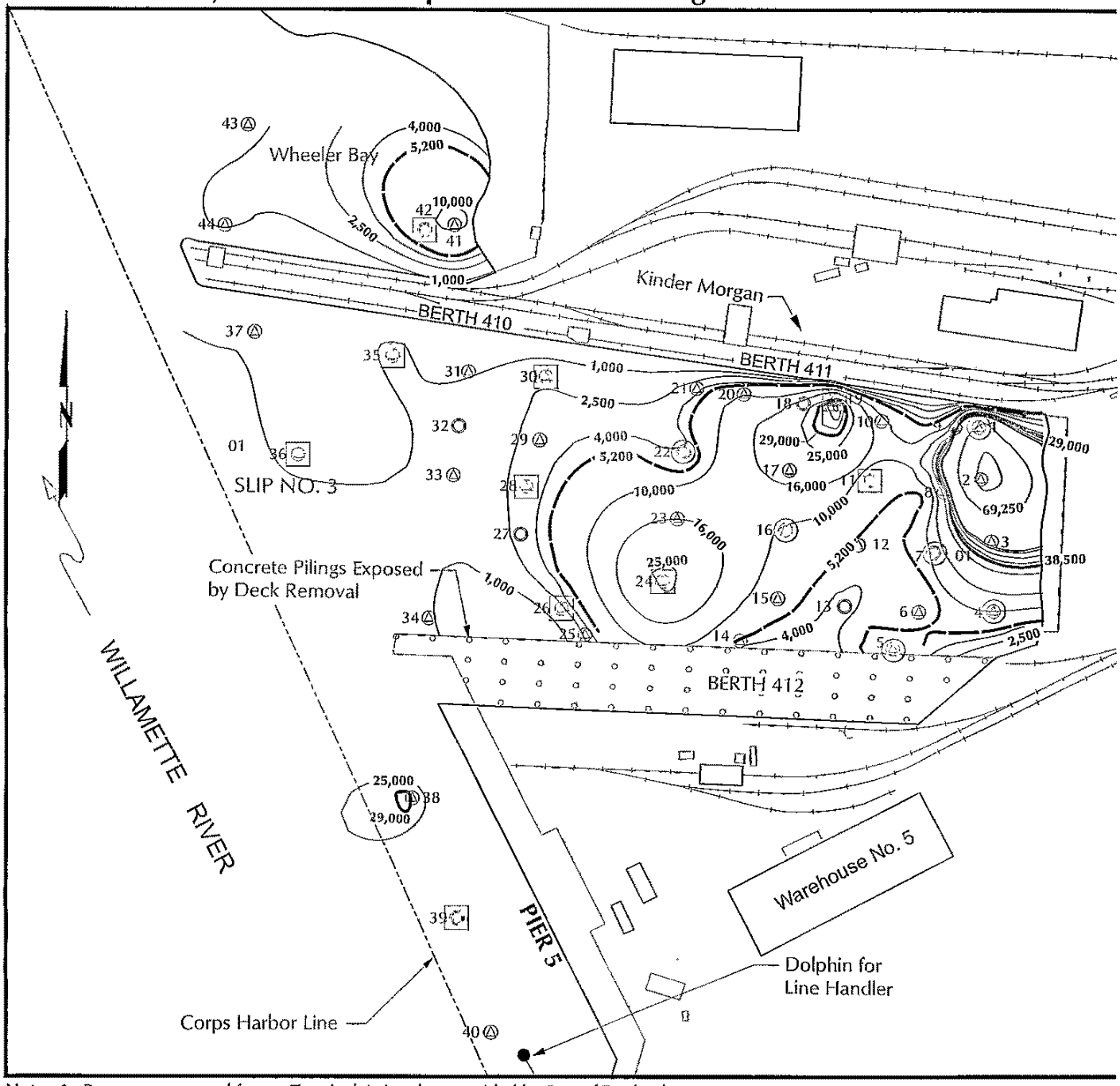
Figure 12

# LPAH Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400

Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- LPAH Concentration Contour in µg/kg
- LPAH LCRMA Maximum Level (ML) Contour in µg/kg
- LPAH LCRMA Screening Level (SL) Contour in µg/kg
- Bioassay Failure
- Bioassay Pass

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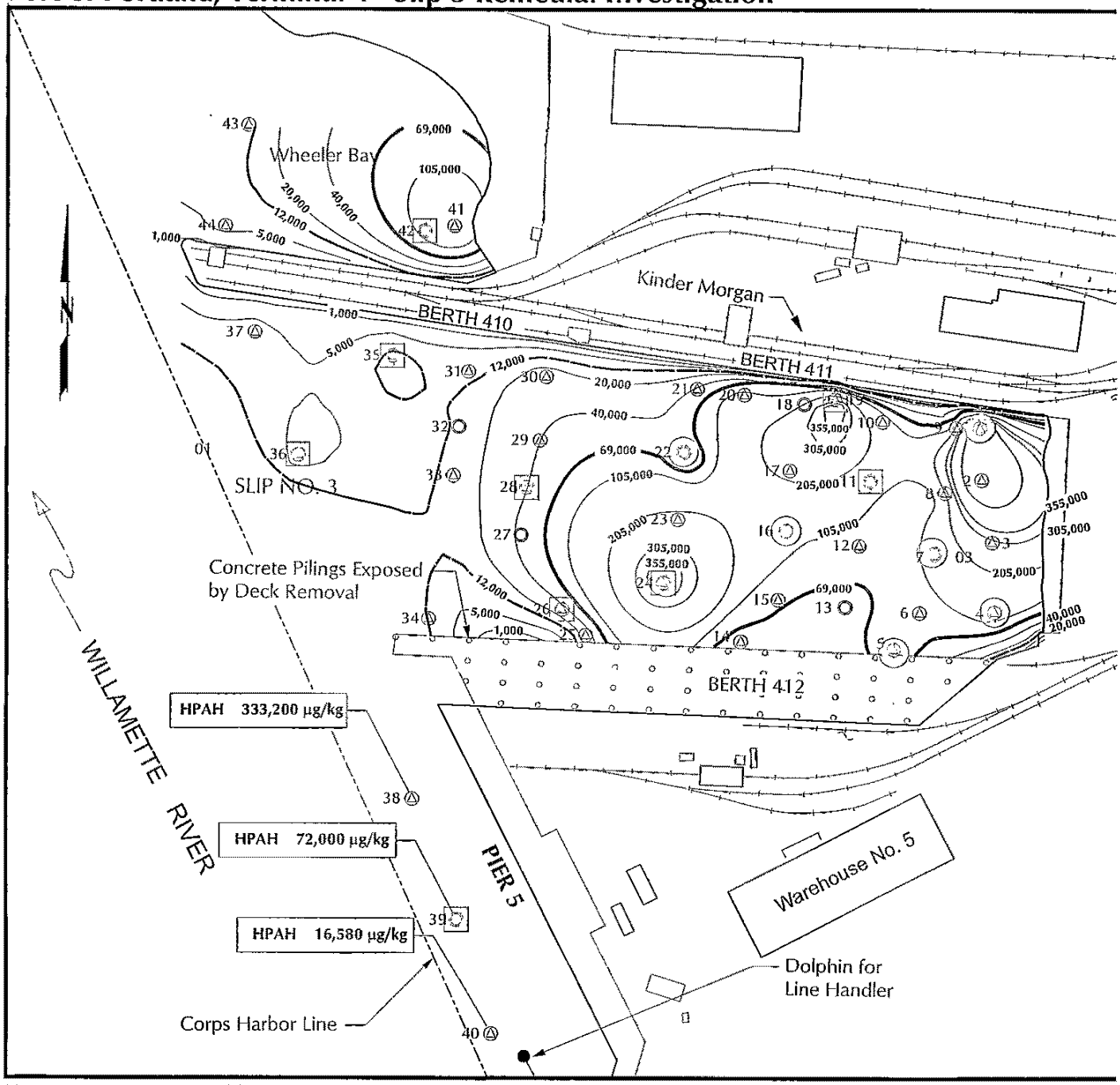
Figure 13

# HPAH Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400
Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- HPAH Concentration Contour in µg/kg
- HPAH LCRMA Maximum Level (ML) Contour in µg/kg
- HPAH LCRMA Screening Level (SL) Contour in µg/kg
- Bioassay Failure
- Bioassay Pass

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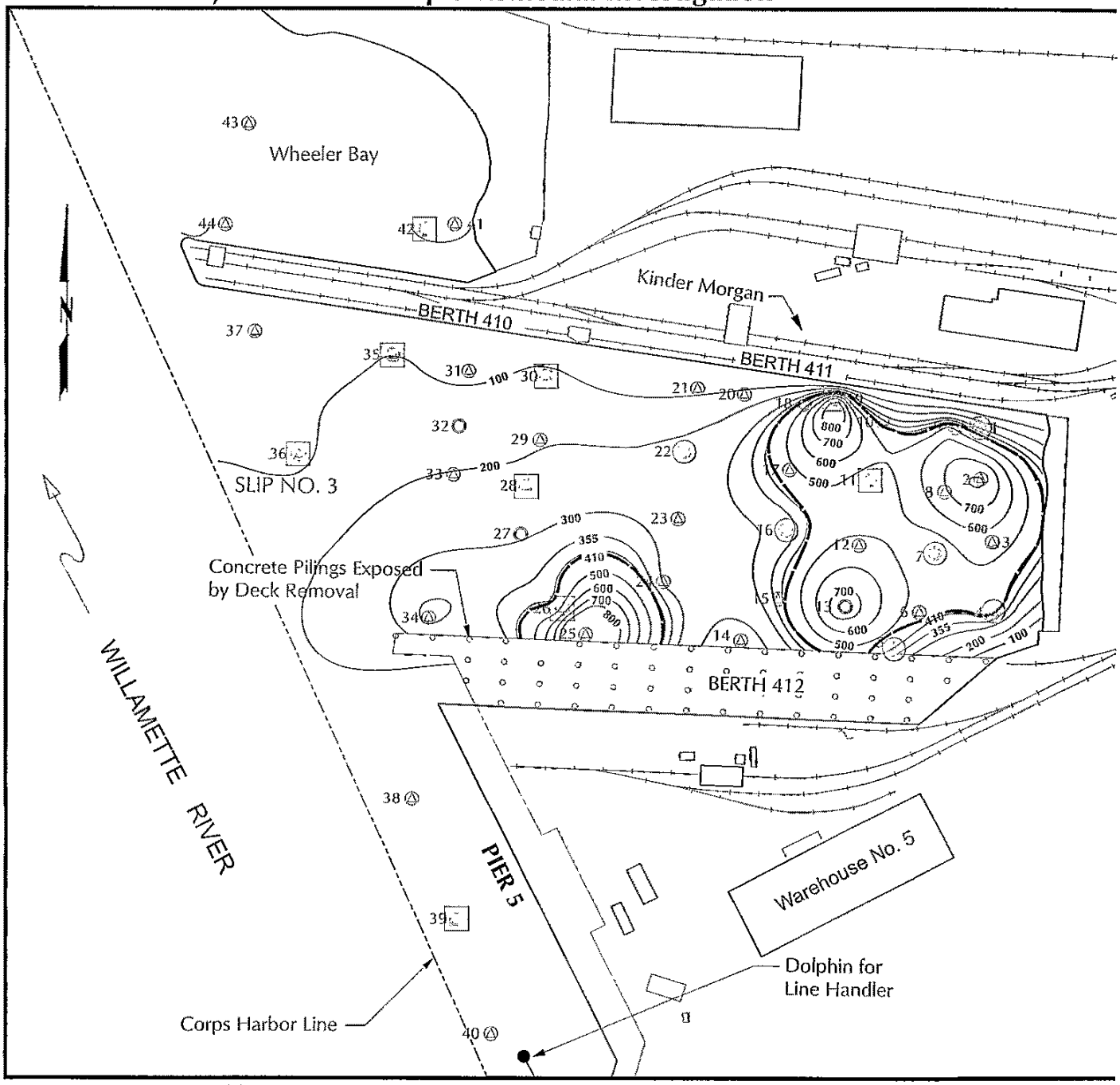
Figure 14

# Zinc Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400
Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- Zinc Concentration Contour in mg/kg
- Zinc LCRMA Screening Level (SL) Contour in mg/kg
- Bioassay Failure
- Bioassay Pass

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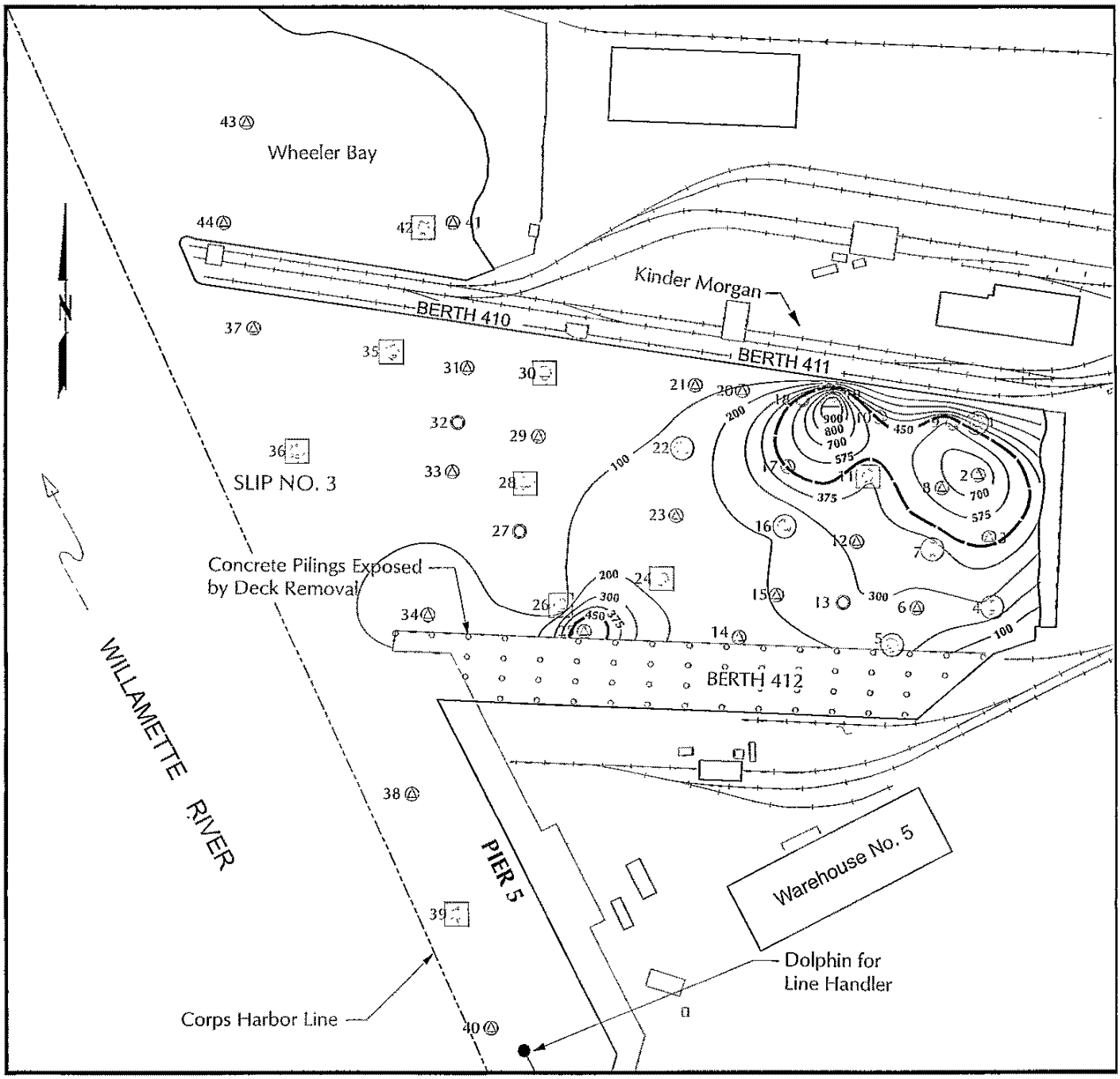
Figure 15

# Lead Concentration Contour Plan

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400
Approximate Scale in Feet

**Legend:**

- 40 Surface Sediment Sample Location and Number
- 39 Collocated Surface and Subsurface Sediment Sample Location and Number
- Lead Concentration Contour in mg/kg
- Lead LCRMA Screening Level (SL) Contour in mg/kg
- Bioassay Failure
- Bioassay Pass

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Figure 16

# Vertical Distribution of Chemical Constituents: HC-7

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-07 | 0 - 0.3 | 9,920 (>SL) | 122,700 (>SL/ML) | 322 Pb (<SL)<br>399 Zn (<SL)<br>2 Cd (<SL) | 1,240 | 106 |
| HC-VC-7-S1 | 0 - 2.0 | 12,000 (>SL) | 192,000 (>SL/ML) | 361 Pb (<SL)<br>469 Zn (>SL)<br>2.4 Cd (<SL) | 1,920 | NR |
| HC-VC-7-S2 | 2.0 - 4.2 | 16,100 (>SL) | 94,900 (>SL/ML) | 576 Pb (>SL)<br>650 Zn (>SL)<br>3.3 Cd (<SL) | 938 | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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Figure 17

# Vertical Distribution of Chemical Constituents: HC-11

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-11 | 0 - 0.3 | 9,380 (>SL) | 121,500 (>SL/ML) | 357 Pb (<SL)<br>397 Zn (<SL)<br>1.9 Cd (<SL) | 1,230 | <100 |
| HC-VC-11-S1 | 0 - 2.1 | 7,300 (>SL) | 70,100 (>SL/ML) | 169 Pb (<SL)<br>273 Zn (>SL)<br>1.2 Cd (<SL) | 703 | <100 |
| HC-VC-11-S2 | 2.1 - 4.0 | 18,400 (>SL) | 140,600 (>SL/ML) | 527 Pb (>SL)<br>656 Zn (>SL)<br>3.2 Cd (<SL) | 1,400 | <100 |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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Figure 18

# Vertical Distribution of Chemical Constituents: HC-13

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-13 | 0 - 0.3 | 54,570 (>SL) | 3,500 (<SL/ML) | 798 Pb (>SL)<br>798 Zn (>SL) | 551 | <100 |
| HC-VC-13-S1 | 0 - 2.0 | 2,256 (<SL) | 182 (<SL/ML) | 61 Pb (<SL)<br>61 Zn (>SL) | 23 | <25 |
| HC-VC-13-S2 | 2.0 - 4.0 | 2,073 (<SL) | 148 (<SL/ML) | 65 Pb (<SL)<br>65 Zn (<SL) | 21 | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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Figure 19

# Vertical Distribution of Chemical Constituents: HC-18

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-18 | 0 - 0.3 | NR | NR | | 2,600 | <100 |
| HC-VC-18-S1 | 0 - 2.2 | 3,830 (<SL) | 38,300 (>SL/ML) | | 385 | NR |
| HC-VC-18-S2 | 2.2 - 4.0 | 1,320 (<SL) | 16,500 (>SL/ML) | | 166 | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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Figure 20

# Vertical Distribution of Chemical Constituents: HC-22

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-22 | 0 - 0.3 | 3,120 (<SL) | 44,500 (>SL/ML) | 125 Pb (<SL)<br>225 Zn (<SL) | 449 | <100 |
| HC-VC-22-S1 | 0 - 2.0 | 237 (<SL) | 2,563 (<SL/ML) | 12.1 Pb (<SL)<br>55 Zn (<SL) | 26 | NR |
| HC-VC-22-S2 | 2.0 - 4.0 | 60 (<SL) | 100 (<SL/ML) | 3 Pb (<SL)<br>37 Zn (<SL) | ND | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

ND Not Detected

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Figure 21

# Vertical Distribution of Chemical Constituents: HC-27

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-27 | 0 - 0.3 | NR | NR | | 449 | <100 |
| HC-VC-27-S1 | 0 - 1.9 | 4,700 (<SL) | 38,600 (>SL/ML) | | 26 | NR |
| HC-VC-27-S2 | 1.9 - 3.5 | 4,900 (<SL) | 42,300 (<SL/ML) | | ND | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

ND Not Detected

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Figure 22

# Vertical Distribution of Chemical Constituents: HC-32

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-32 | 0 - 0.3 | 1,383 (<SL) | 12,890 (<SL/ML) | | 130 | <100 |
| HC-VC-32-S1 | 0 - 1.8 | 530 (<SL) | 4,770 (<SL/ML) | | 48 | NR |
| HC-VC-32-S2 | 1.8 - 4.0 | 60 (<SL) | 100 (<SL/ML) | | ND | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

ND Not Detected

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Figure 23

# Vertical Distribution of Chemical Constituents: HC-39

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-39 | 0 - 0.3 | 6,269 (<SL) | 7,200 (<SL/ML) | 30.1 Pb (<SL)<br>104 Zn (<SL) | 727 | <50 |
| HC-VC-39-S1 | 0 - 2.0 | 870 (<SL) | 8,010 (<SL/ML) | 19.3 Pb (<SL)<br>89Zn (<SL) | 80 | NR |
| HC-VC-39-S2 | 2.0 - 4.0 | 60 (<SL) | 5,380 (<SL/ML) | 27.6 Pb (<SL)<br>109 Zn (<SL) | 54 | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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Figure 24

# Vertical Distribution of Chemical Constituents: HC-42

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation

| Sample ID | Depth in Feet | LPAH (µg/kg) | HPAH (µg/kg) | Metals (mg/kg) | Pencil Pitch (mg/kg) | Diesel (mg/kg) |
|---|---|---|---|---|---|---|
| HC-S-42 | 0 - 0.3 | 8,255 (>SL) | 120,500 (>SL/ML) | 36 Pb (<SL)<br>124 Zn (<SL)<br>0.3 Cd (<SL) | 1,220 | <100 |
| HC-VC-42-S1 | 0 - 2.0 | 14,500 (>SL) | 91,700 (>SL/ML) | 23.9 Pb (<SL)<br>100 Zn (<SL)<br>0.2 Cd (<SL) | 906 | NR |
| HC-VC-42-S2 | 2.0 - 4.2 | 20,000 (>SL) | 200,000 (>SL/ML) | 79.1 Pb (<SL)<br>207 Zn (<SL)<br>0.7Cd (<SL) | 2,000 | NR |

**Legend:**

SL Screening Level

ML Maximum Level

NR Not Reported

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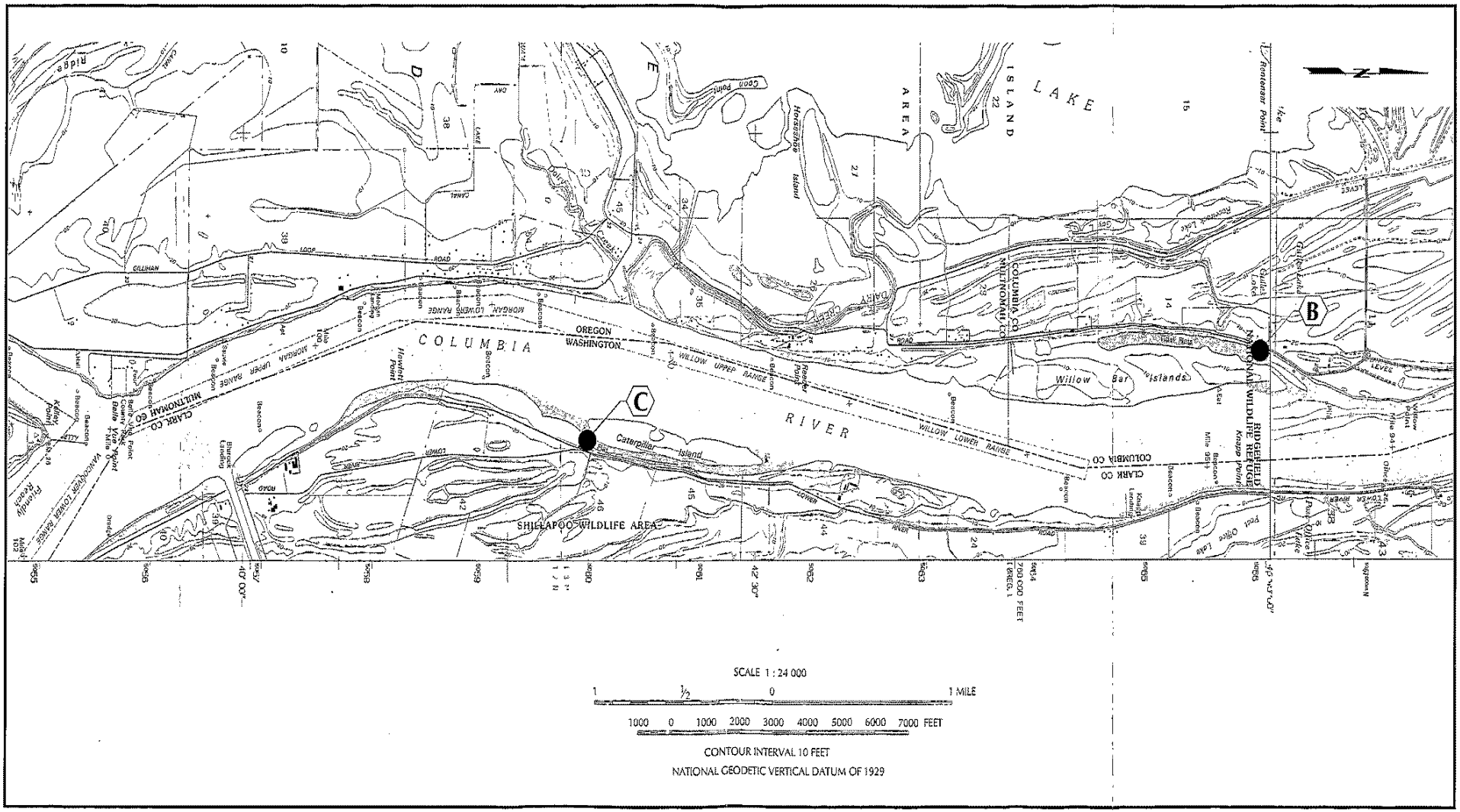
Figure 25

# Bioassay Reference Sediment Sample Locations

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




**Note:** Base map prepared from the USGS 7.5-minute quadrangle of Sauvie Island, Oregon, dated 1990.

**Legend:**

(C) ● Reference Sediment Sample Location and Site Designation

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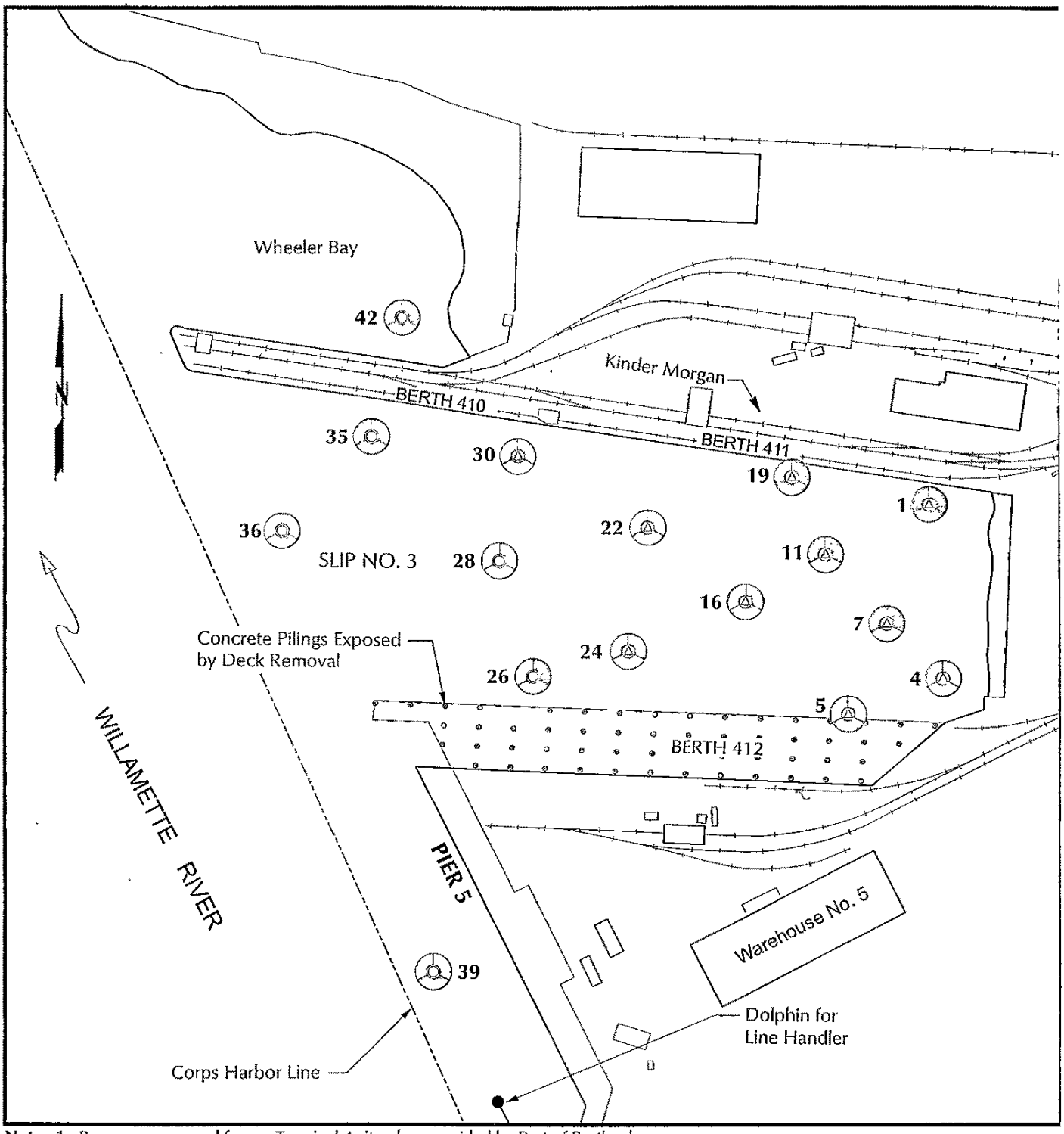
Figure 26

# Bioassay Testing Results

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




**Note:** 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

0 100 200 400

Approximate Scale in Feet

**Legend:**

39 ○ Phase I Bioassay Sediment Sampling Location and Number

16 △ Phase II Bioassay Sediment Sampling Location and Number

AS = Amphipod Survival
MS = Midge Survival
MG = Midge Growth

**Color Code:**

| |
|---|
| Green = Pass |
| Yellow = 2-Hit Criteria |
| Red = 1-Hit Criteria |

One failure of 1-hit criteria required for overall bioassay failure.

Two failures of 2-hit criteria required for overall bioassay failure.

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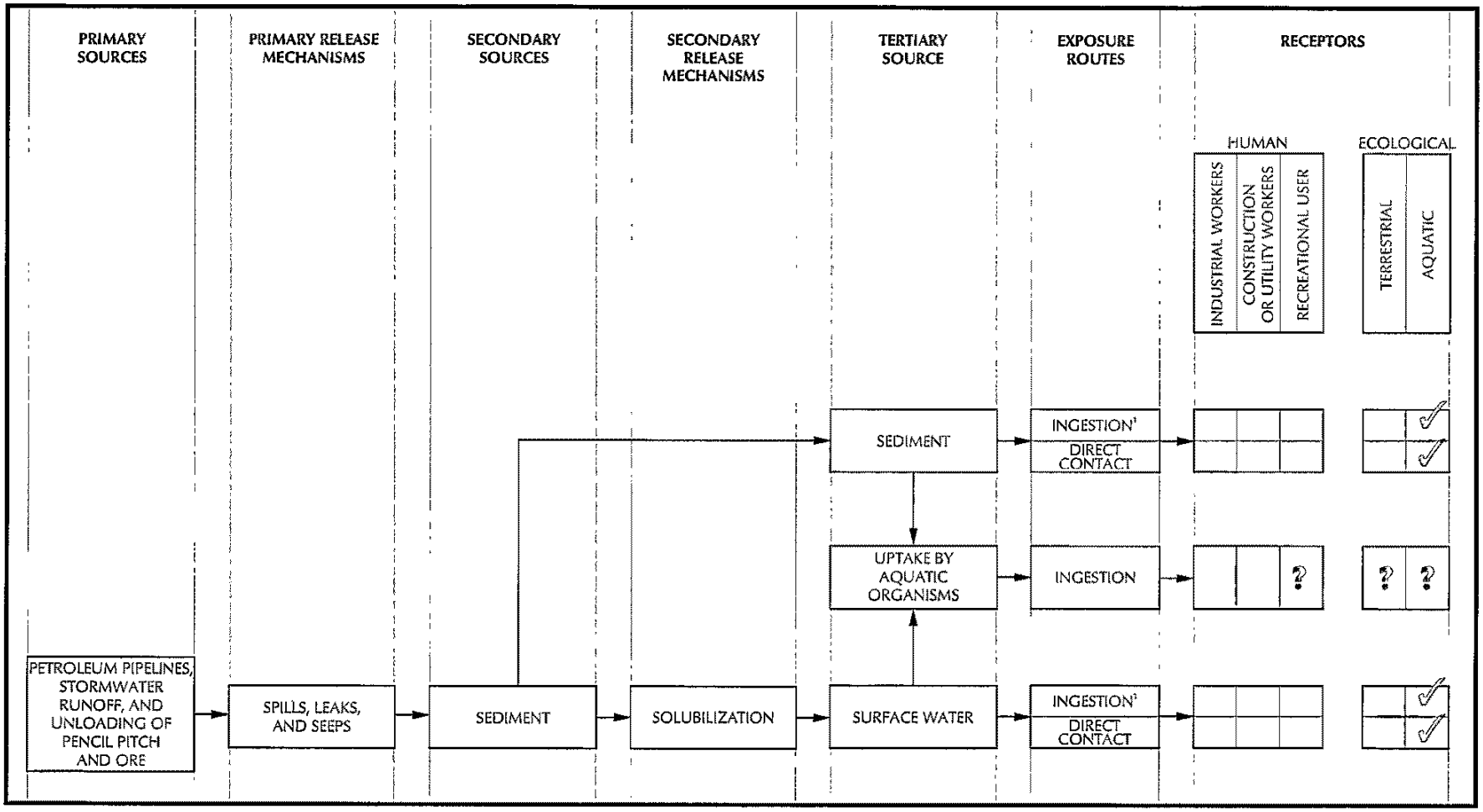
Figure 27

# Exposure Pathway Evaluation

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




**Legend:**

✓ Complete Exposure Pathway

? Uncertain Exposure Pathway Pending Future Analysis

**Notes:**

[1]Ingestion also includes incidental ingestion.

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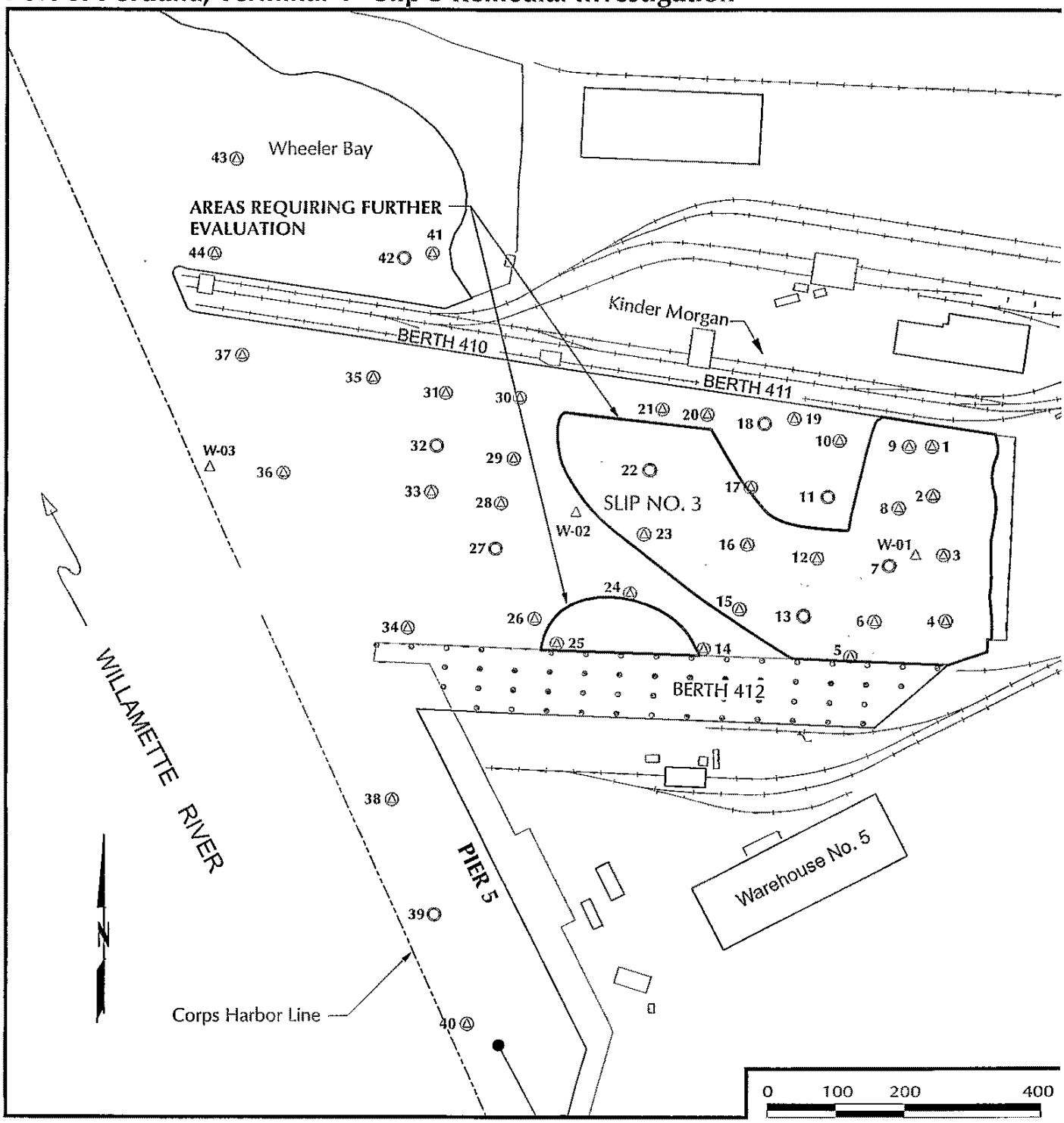
# Delineation of Areas Requiring Further Evaluation Based on Confirmatory Bioassay Tests

## Port of Portland, Terminal 4 - Slip 3 Remedial Investigation




Note: 1. Base map prepared from a Terminal 4 site plan, provided by Port of Portland.

**Legend:**

40 Surface Sediment Sample Location and Number

39 Collocated Surface and Subsurface Sediment Sample Location and Number

W-03 Water Sample Location and Number

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Figure 29

## Appendix A

# APPENDIX A
# FIELD ACTIVITIES SUMMARY

# APPENDIX A
# FIELD ACTIVITIES SUMMARY
# TERMINAL 4, SLIP 3 REMEDIAL INVESTIGATION

This appendix summarizes the field activities conducted October 12 through 15, 1998, as part of the Terminal 4, Slip 3 (Slip 3) Remedial Investigation (RI). All sediment sampling and handling activities were performed in accordance with the Oregon Department of Environmental Quality (DEQ)-approved Sampling and Analysis Plan (SAP) developed for this project (Hart Crowser, 1998a). A brief summary of the specific field activities and sample collection methods is presented below along with a discussion of modifications to the approved plan.

## *Summary of Field Activities*

Surface sediment, subsurface sediment, and water quality sampling was performed in the Marine Terminal 4 Area (T-4). The T-4 study area consisted of the sediments located upriver at Pier 5 Willamette River Dock (Pier 5), Slip 3, and in Wheeler Bay, which is immediately down river and adjacent to Slip 3. This sampling was performed by Hart Crowser and subcontractor personnel. Field activities included the following:

- Hydraulic grab sampling of surface sediments;
- Subsurface sediment core sampling; and
- Water column sampling.

## *Surface Sediment Sampling Methods*

Surface sediment samples (0 to 10 centimeters) were collected at forty-four locations, including nine surface samples collocated with core locations using hydraulic grab methods briefly described below. All samples were submitted for chemical and physical testing and fifteen of these samples plus two reference site samples were also submitted for sediment bioassay analyses. Surface sediment sampling was conducted in general accordance with the approved project plan; modifications are described at the end of each section.

Surface sediment locations are presented on Figure 5. A summary of surface sediment sample locations, dates, coordinates, and mudline elevations are presented in Table 2.

### *Hydraulic Surface Grab Sampling*

Sediment samples were collected from 0 to 10 centimeters, in depth, using a hydraulic grab sampler. The sampler deployed from the vessel *R/V Nancy Anne* was used to collect surficial sediment samples for chemical, biological, and physical testing. This sampler was designed by Marine Sampling Systems (MSS) to collect large volumes of sediment from difficult matrices and bottom conditions. Other instruments used to collect surficial samples included a siphon hose to remove standing water, and stainless steel trowels, spoons, and bowls to sample and mix the sediments as described in Section 4.4.3 of the SAP. A qualified geologist logged each sample after hydraulic grab retrieval and acceptance. Sample information recorded at each location included coordinates, mudline elevation, date, time, visual description of sediment, estimations of percent wood by volume, number of deployments, recovery depth, sample I.D., and types of analysis to be performed.

Sampling equipment was decontaminated prior to and between sampling activities as outlined in Section 4.4.3 of the SAP. Sample containers were placed in cooled ice chests until transfer to the specified laboratory as described in Section 6.4 of the Quality Assurance Project Plan (QAPP).

**Field QA/QC.** Two homogenized field duplicates were collected from surface sample locations HC-S-09 and HC-S-24 and labeled HC-S-101 and HC-S-102, respectively. Homogenized duplicates were collected as separate jars filled from the same mixing bowl to assess laboratory variability. Duplicates were analyzed for the chemicals of potential concern (COPCs) identified by the Port of Portland (Port) and DEQ as well as total ammonia, total volatile solids, total sulfides, total organic carbon (TOC), and grain size.

### *Modifications to the Surface Sediment Sampling Plan*

All proposed sampling locations along the shoreline of Slip 3 were slightly modified to avoid riprap and debris, which was abundant in the failed attempts. The proposed sampling location HC-S-41, in Wheeler Bay, was modified as it was located on the riprapped bank.

## *Subsurface Sediment Core Sampling and Processing*

Subsurface sediment sampling was completed with the collection of nine cores on October 12, 1998. Sediment cores were collected using a vibracore with a

4-inch-diameter aluminum core tube deployed from the research vessel *R/V Nancy Anne*. Sediment core sampling, decontamination, and processing were conducted in general accordance with the approved project plan. Core locations are presented on Figure 5. Subsurface locations, dates sampled, positioning coordinates, and sediment elevations are presented in Table 2. Core logs and geologic descriptions are compiled on Figures B-2 through B-10. A key to sediment log descriptions is presented on Figure B-1 (Appendix B).

## ***Subsurface Sediment Core Sampling***

After the cores were retrieved and accepted, cores were capped, labeled, and sealed tightly enough to prevent leakage or disturbance and stored upright in an insulated core box filled with Blue-Ice until transport to the on-site location (Warehouse 7) where processing was performed. Cores were handled in general accordance with Sections 4.4 through 4.8 of the SAP.

Core samples were divided into three separate sections: top and bottom. Top samples consisted of sediments 0 to -2 feet (consistent with the grab samples); bottom samples consisted of sediments from -2 to -4 feet in the sediment column. A deeper layer representing the -4 to -6 feet sediment column was also sampled. These deeper sediment sections were archived for potential future chemical analyses.

Sediment sections were placed in separate stainless steel bowls for mixing. The samples were thoroughly homogenized using stainless steel spoons until uniform in texture and color. Homogenized sediments were placed into a pre-cleaned sample container, labeled, and transferred immediately to cooled ice chests until transport to the laboratory. Each sample container was clearly labeled with the project name, sample identification number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book. Samples were stored at approximately 4°C until withdrawn for analysis.

**Field QA/QC.** Three homogenized field duplicates were collected from subsurface sample locations HC-VC-13-S1, HC-VC-13-S2, and HC-VC-11-S1, and were labeled HC-VC-103, HC-VC-104, and HC-VC-105, respectively. Homogenized duplicates were collected as separate jars filled from the same mixing bowl to assess laboratory variability. Duplicate HC-VC-103 was analyzed for total sulfide, total volatile solids, and volatile organics. Duplicate HC-VC-104 was analyzed for total volatile solids and semivolatile organics. Duplicate HC-VC-105 was analyzed for total and dissolved priority pollutant metals, total volatile solids, total ammonia, and total organic carbon (TOC).

### *Modifications to the Subsurface Sediment Core Sampling Plans*

The core samples were collected at the proposed location except for HC-VC-22, which was moved approximately 38 feet toward the Hall Buck pier face after three low-recovery attempts. It appeared that the proposed location was positioned in the propeller scour zone for the berth. This condition was evidenced by the lack of soft, recently deposited material overlying medium to fine sand.

## *Water Sampling*

### *Water Column Sampling*

Water samples were collected from three locations to assess the contributions of various sources (both aquatic and upland) to the water quality in the slip (Figure 5). Water samples were collected using a 2-liter Van Dorn Bottle deployed from the research vessel *R/V Nancy Anne* on October 15, 1998. Samples were collected in general accordance with Response to DEQ's Comments on the Remedial Investigation Work Plan (Hart Crowser, 1998b).

Water samples were collected at the mid-point between the water surface and mudline and 1 meter above the sediment surface. Three water sampling locations; HC-WS-01, HC-WS-02, and HC-WS-03 represented two depths: middle water column (M) and bottom water column (B). Water samples were preserved with Hydrogen Chloride (HCL) and analyzed for total suspended solids (TSS); benzene, toluene, ethylbenzene, and total xylenes (BTEX); polycyclic aromatic hydrocarbons (PAHs); and total and dissolved priority pollutant metals (Table 6). A summary of analytical surface water results are presented in Table 7.

**QA/QC Samples.** Two rinseate blanks were collected during water column sampling activities to assess the effectiveness of decontamination procedures. The rinseate blanks were labeled HC-RB-100 and HC-RB-101. Rinseate blanks were analyzed for TSS; BTEX; PAHs; and total and dissolved priority metals.

### *Modifications to the Water Sampling Plans*

The number of water column samples proposed in the initial work plan was reduced from 12 to 6. Samples were collected in general accordance with Response to DEQ's Comments on the Remedial Investigation Work Plan (Hart Crowser, 1998b).

## *Location Control and Documentation*

Sampling location control was performed in accordance with the SAP. The objective of the positioning procedure was to accurately determine and record the positions (±3 m) of sampling locations. This determination was achieved by referencing each sampling location to state plane coordinates with the use of known survey control points and differential global positioning system (DGPS).

The following parameters were documented at each sampling location:

- Horizontal location in state plane coordinates, as appropriate;
- Vertical elevation in feet (including mudline and river elevation above the mudline);
- Time and date; and
- River elevation referenced to Columbia River Datum (CRD).

These parameters were measured using combinations of DGPS, river elevation gages, and back-up methods (i.e., triangulation or taping to survey control points and/or terminal landmarks or structures).

Positioning while sampling was performed using a DGPS, which provided positions every second with submeter accuracy for precise positioning of sample locations. The navigation system onboard the vessel provided the vessel pilot with a navigation display to enable piloting to sample locations and recording of the exact location of the sediment core.

### ***Modifications to the Location Control Plans***

Modifications to the RI/FS Project Plans and significant comments for location control methods include the following:

- The proposed sampling locations along the shoreline of Slip 3 were slightly modified to avoid riprap and debris which was abundant in the failed attempts.
- The proposed sampling location HC-S-41, in Wheeler Bay, was modified as it was located on the riprapped bank.
- The proposed sampling location HC-VC-22 was moved approximately 38 feet toward the Hall Buck pier face after three low-recovery attempts. It appeared that the proposed location was positioned in the propeller

scour zone for the berth. This condition was evidenced by the lack of soft, recently deposited material overlying medium to fine sand.

### *Sediment Quality Sample Handling*

Sediment quality sample handling (collecting, packaging, transporting, and documenting) was performed in general accordance with the SAP. On the sampling vessel, the field representative in the "support zone" labeled each jar with the sample identification information, filled out and signed the custody forms, and checked each sample set before transport to the laboratory. The person working in the "hot zone" composited and mixed the sediment surface grab samples, filled the sample jars with sediment, and placed the jars into cooled ice chests until transport to the specific laboratory.

Subsurface core samples were processed in Warehouse 7 located at the site. Cores were extruded (pushed or cut with a circular saw), logged, composited, and processed in this designated area. Samples were transported to Columbia Analytical Services and Northwestern Aquatic Sciences, every one or two days following proper chain of custody procedures outlined in the QAPP. The sediment samples were submitted to the laboratories for selected chemical, physical, and biological analyses in accordance with the project plans. The results of the laboratory analysis and bioassays are presented in Appendices G and H (presented in Volume II) of this document.

# Appendix B

# APPENDIX B
# SEDIMENT CORE LOGS

# Key for Soil/Sediment Logs

## Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

## Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance.
Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

| SAND or GRAVEL Density | Standard Penetration Resistance (N) in Blows/Foot | SILT or CLAY Consistency | Standard Penetration Resistance (N) in Blows/Foot | Approximate Shear Strength in TSF |
|---|---|---|---|---|
| Very loose | 0 – 4 | Very soft | 0 – 2 | <0.125 |
| Loose | 4 – 10 | Soft | 2 – 4 | 0.125 – 0.25 |
| Medium dense | 10 – 30 | Medium stiff | 4 – 8 | 0.25 – 0.5 |
| Dense | 30 – 50 | Stiff | 8 – 15 | 0.5 – 1.0 |
| Very dense | >50 | Very stiff | 15 – 30 | 1.0 – 2.0 |
| | | Hard | >30 | >2.0 |

## Moisture

| | |
|---|---|
| Dry | Little perceptible moisture |
| Damp | Some perceptible moisture, probably below optimum |
| Moist | Probably near optimum moisture content |
| Wet | Much perceptible moisture, probably above optimum |

## Minor Constituents

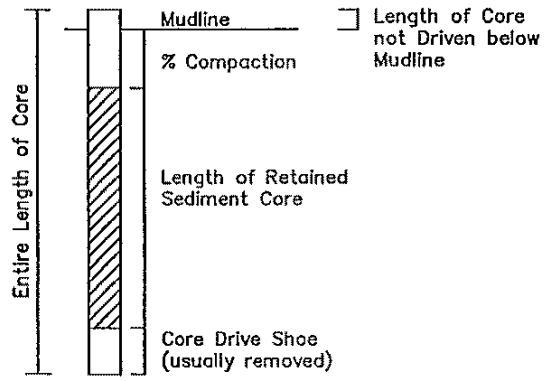
| | Estimated Percentage |
|---|---|
| Not identified in description | 0 – 5 |
| Slightly (clayey, silty, etc.) | 5 – 12 |
| Clayey, silty, sandy, gravelly | 12 – 30 |
| Very (clayey, silty, etc.) | 30 – 50 |

## Legends

### Sample Acceptability Criteria:

1. Overlying water is present
2. Water has low turbidity
3. Sampler is not overfilled
4. Surface is flat
5. Penetration depth is acceptable
6. Compaction is less than 25 percent
7. Core tube is intact

### Core Observations




### Estimated Percentage of Other Minor Constituents

(i.e.. shells, wood, organics, plastic, metal brick, refuse)

| Description | Estimated Percentage |
|---|---|
| Dusting | Trace on Surface |
| Trace | Discernible |
| Scattered | 0–5 |
| Moderate | 5–20 |
| Substantial | 20–50 |
| Major Constituent | >50 |

### Test Symbols

| | |
|---|---|
| CHEM | Chemical Testing |
| GS | Grain Size |
| ARCH | Archive |
| ▨ | Continuous Vibracore |
| AL | Atterberg Limits |
| SP GR | Specfic Gravity |
| Rad | Radio Isotopes Pb–210 and Cs–137 |

A-1\sed_key 1=1

——————— Major Sediment Unit Contacts
— — — — Minor Sediment Unit Contacts

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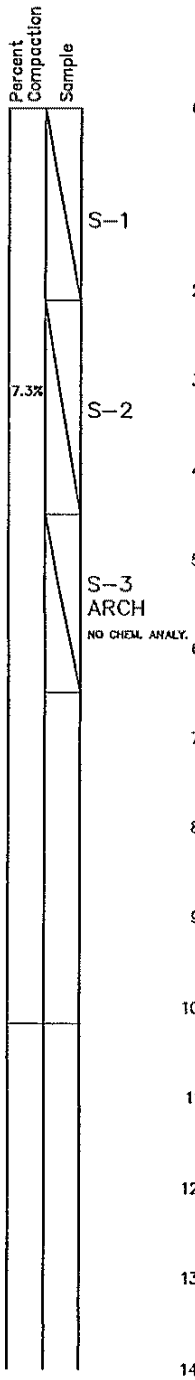
Figure B-1

# Sediment Core Log HC-VC-7

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1615
Recovery Length in Feet: 10.2
Total Drive Depth below Mudline in Feet: 11.0

Northing: 713,216
Easting: 7,620,366
Mudline Elevation in Feet: –40.2 CRD
Core Tube Length in Feet: 14

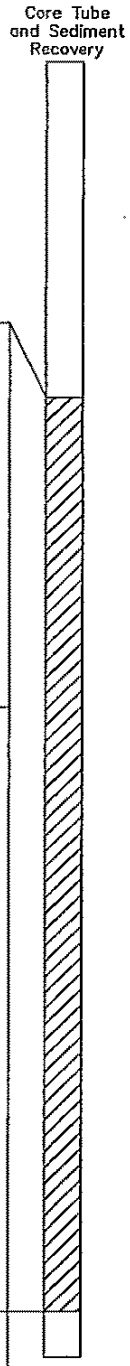



Length in Feet

SEDIMENT DESCRIPTIONS

(Very soft to soft), wet, brown SILT with trace wood over (medium stiff), wet, brown organic SILT with occasional Sand lenses to 2 inches thick.

(Medium stiff), wet, brown, slightly sandy SILT with wood and grass.




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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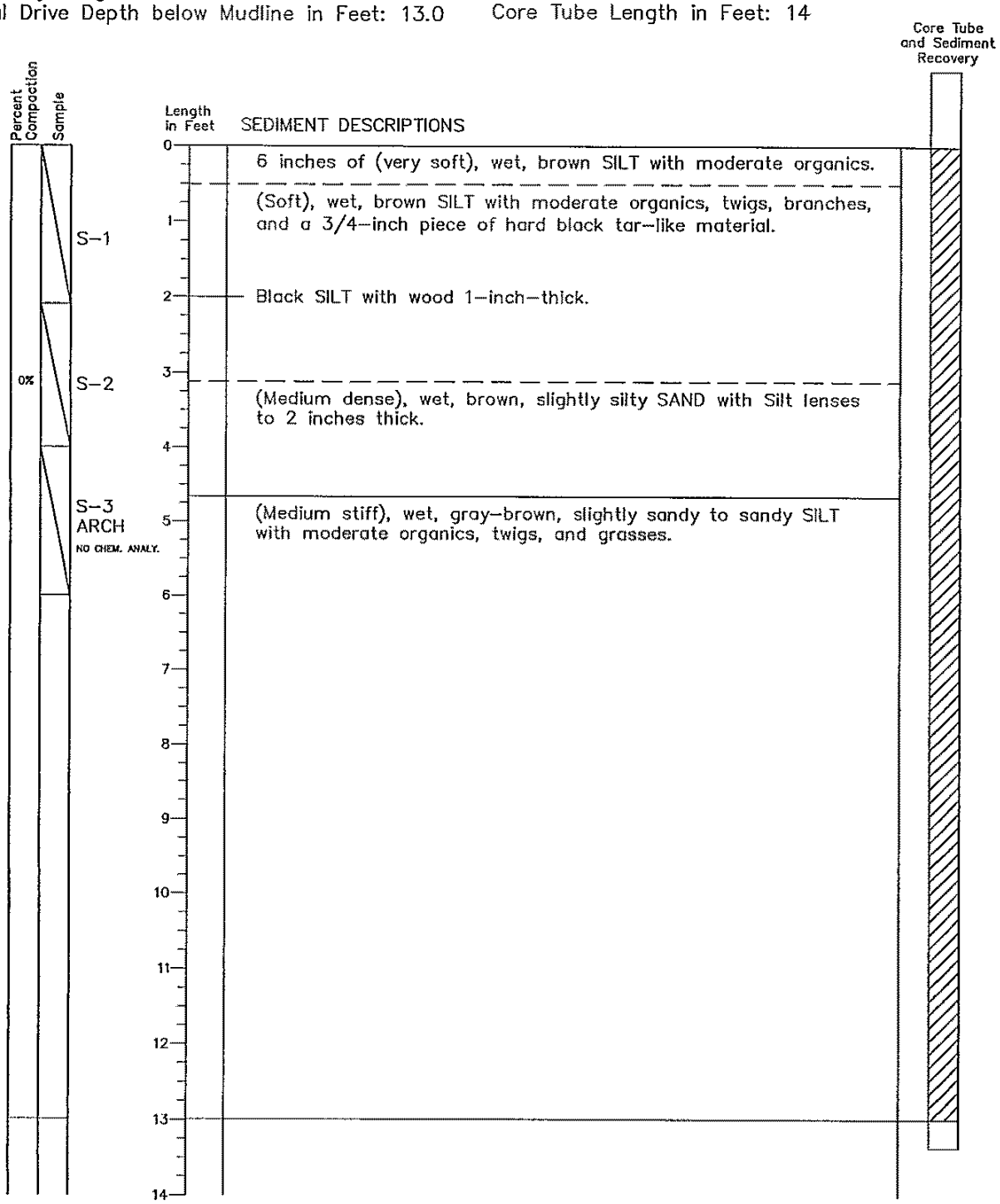
Figure B-2

1=1 ACAD LOG

# Sediment Core Log HC-VC-11

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1030
Recovery Length in Feet: 13.0
Total Drive Depth below Mudline in Feet: 13.0

Northing: 713,314
Easting: 7,620,275
Mudline Elevation in Feet: –44 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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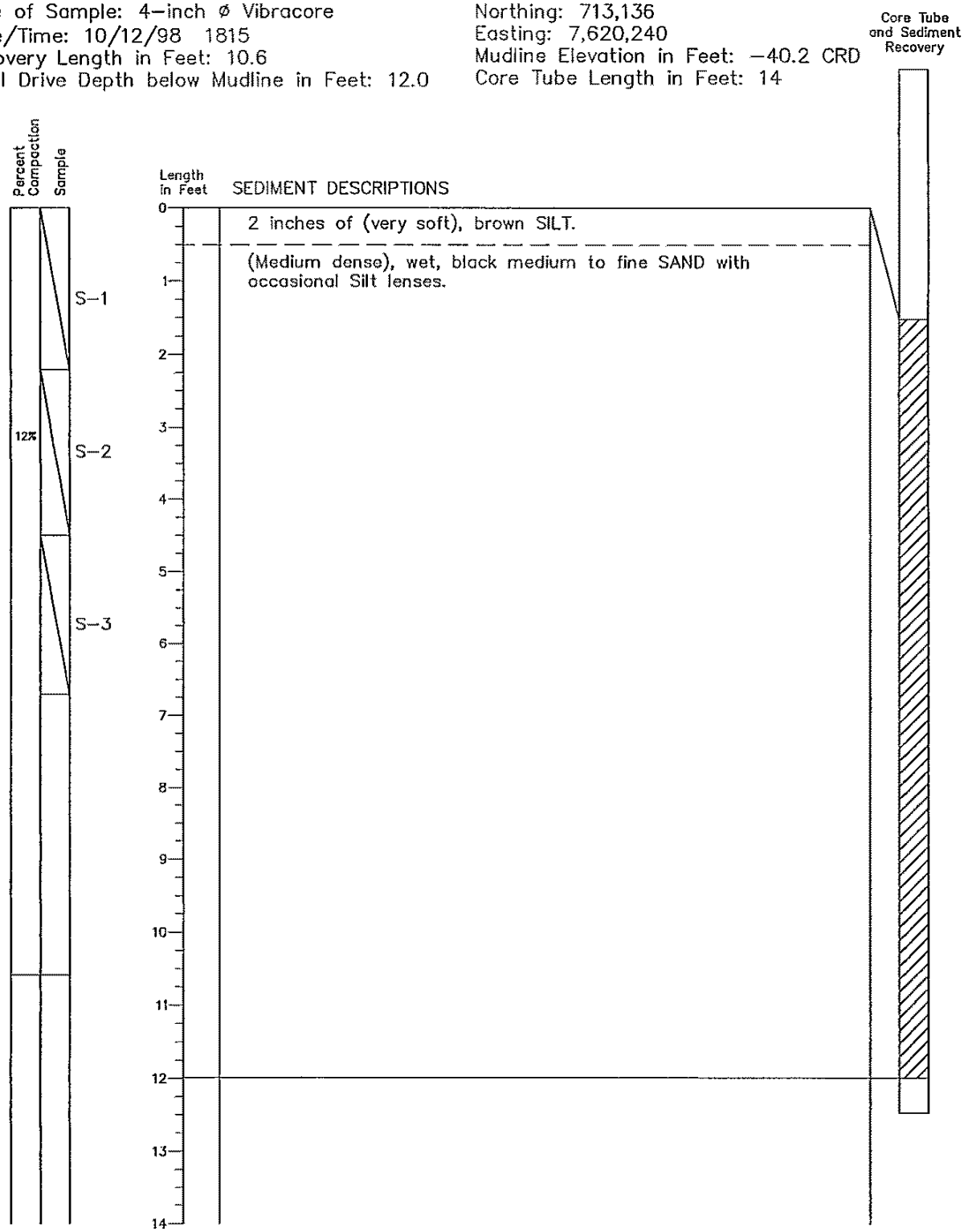
Figure B-3

1=1 ACAD LOG

# Sediment Core Log HC-VC-13

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1815
Recovery Length in Feet: 10.6
Total Drive Depth below Mudline in Feet: 12.0

Northing: 713,136
Easting: 7,620,240
Mudline Elevation in Feet: –40.2 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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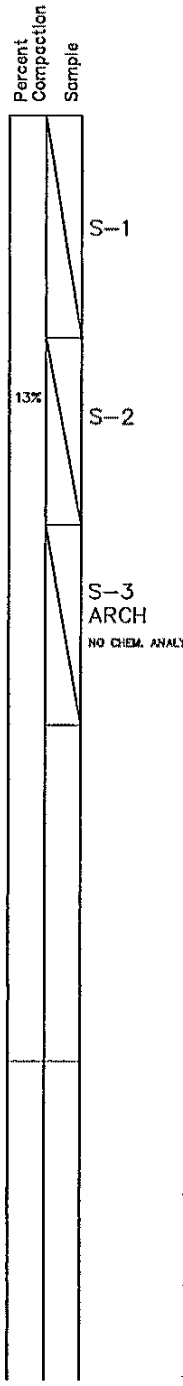
Figure B-4

1=1 ACAD LOG

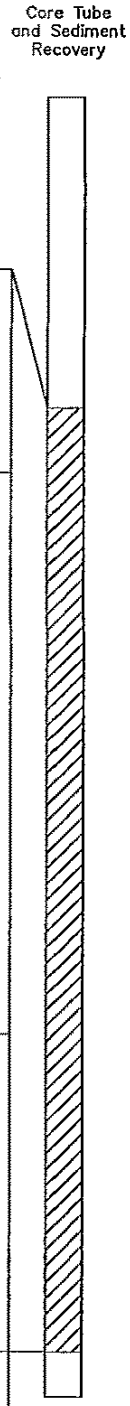
# Sediment Core Log HC-VC-18

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1515
Recovery Length in Feet: 10.5
Total Drive Depth below Mudline in Feet: 12.0

Northing: 713,420
Easting: 7,620,183
Mudline Elevation in Feet: –48.0 CRD
Core Tube Length in Feet: 14




| Length in Feet | SEDIMENT DESCRIPTIONS |
|---|---|
| 0–2 | 4 inches of (very soft), wet, brown SILT over alternating black, medium to fine SAND and (medium stiff), brown SILT. Hard tar–like fragments to 1–inch (<1%) and trace concrete–like gravels to 2–1/2 inches. Sand and Silt layer 4 to 6 inches thick. |
| 2–8 | (Medium dense), wet, black, medium to fine SAND. |
| 8–12 | (Medium stiff to stiff), wet, brown, organic SILT with wood (twigs and branches). |




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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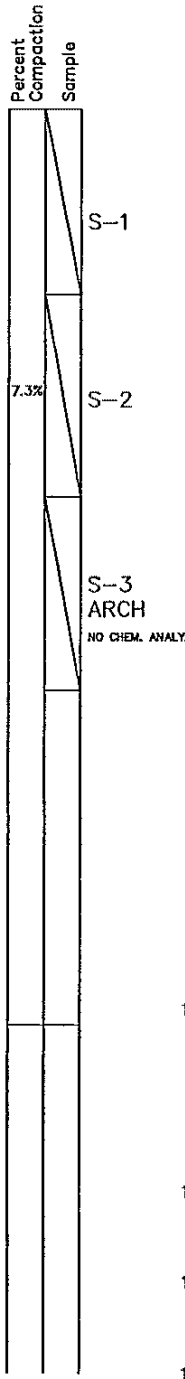
Figure B-5

1=1 ACAD LOG

# Sediment Core Log HC-VC-22

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1130
Recovery Length in Feet: 10.2
Total Drive Depth below Mudline in Feet: 11.0

Northing: 713,390
Easting: 7,760,016
Mudline Elevation in Feet: –46.7 CRD
Core Tube Length in Feet: 14

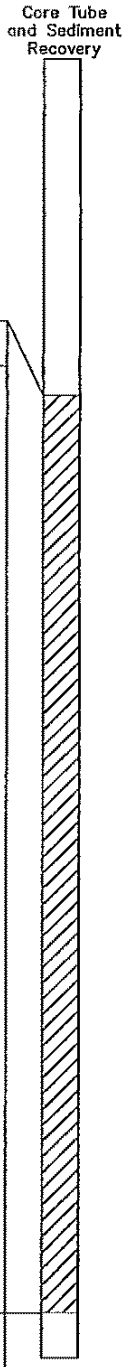



Length in Feet

SEDIMENT DESCRIPTIONS

(Medium stiff), wet, brown SILT.

(Medium dense), wet, black, medium to fine SAND with occasional gravel.




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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J-5624-10 7/99

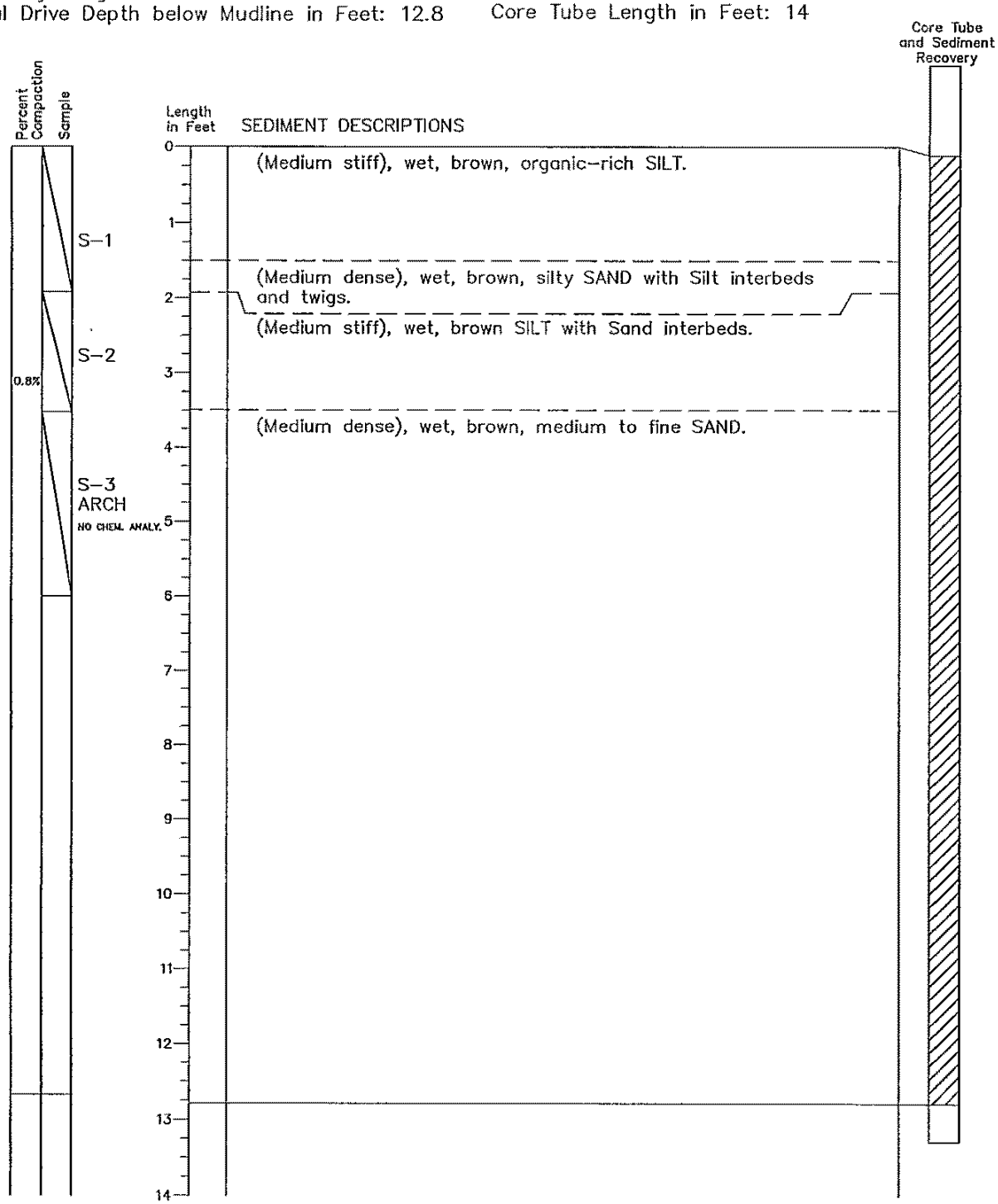
Figure B-6

1=1 ACAD LOG

# Sediment Core Log HC-VC-27

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1215
Recovery Length in Feet: 12.7
Total Drive Depth below Mudline in Feet: 12.8

Northing: 713,243
Easting: 7,619,799
Mudline Elevation in Feet: –43.0 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

HARTCROWSER

J-5624-10 7/99

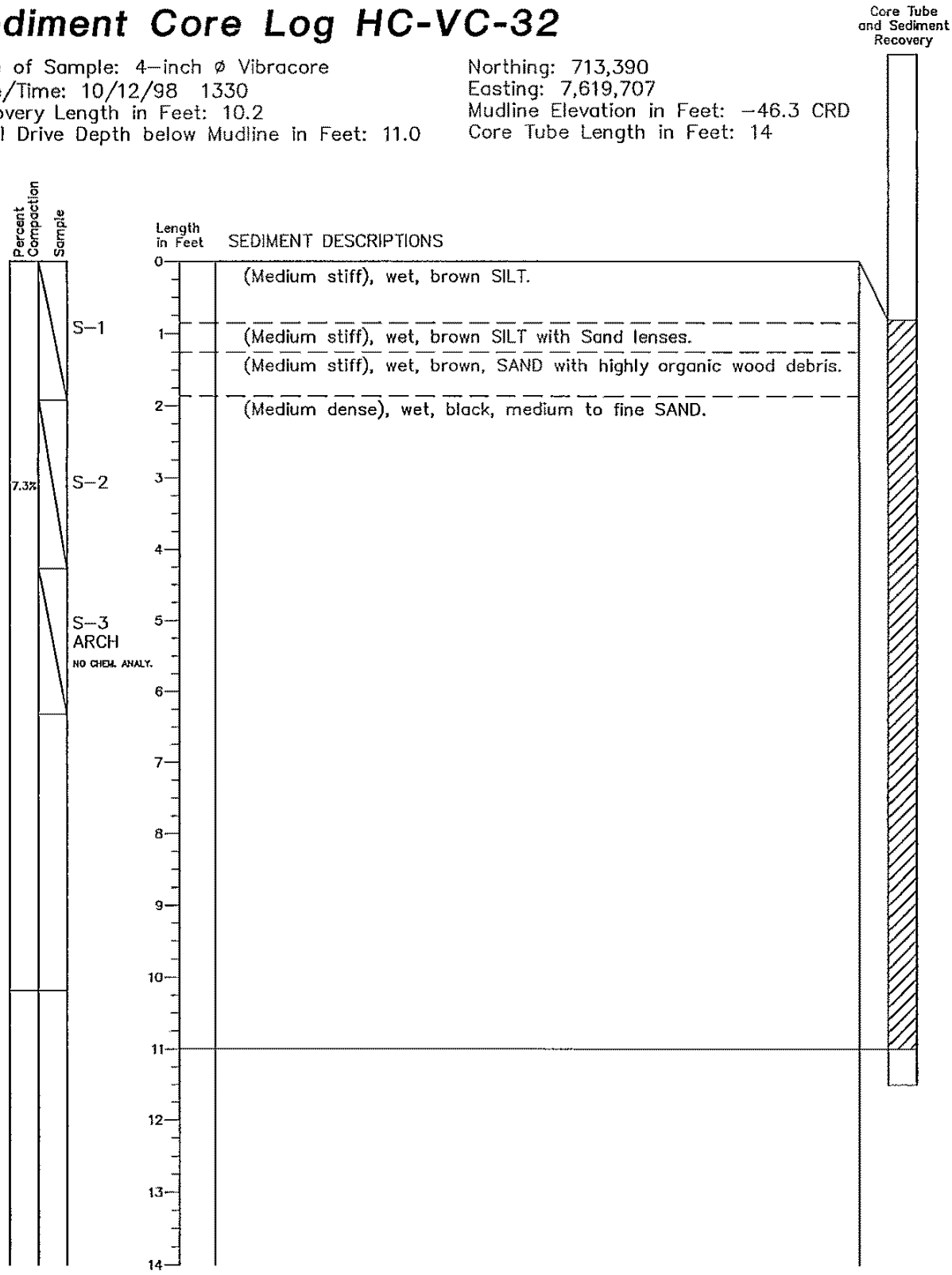
Figure B-7

1=1 ACAD LOG

# Sediment Core Log HC-VC-32

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1330
Recovery Length in Feet: 10.2
Total Drive Depth below Mudline in Feet: 11.0

Northing: 713,390
Easting: 7,619,707
Mudline Elevation in Feet: –46.3 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

HARTCROWSER

J-5624-10 7/99

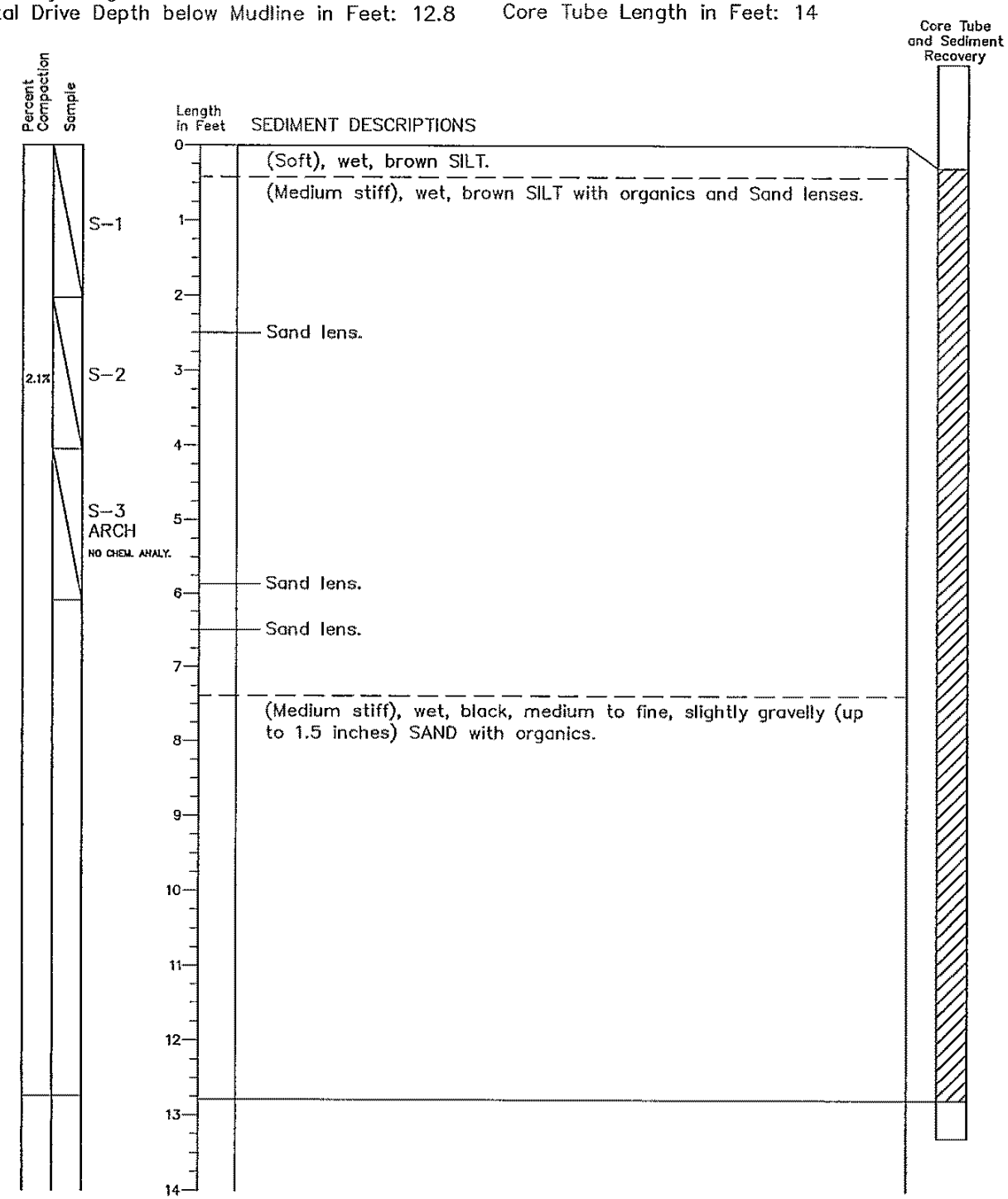
Figure B-8

1=1 ACAD LOG

# Sediment Core Log HC-VC-39

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1430
Recovery Length in Feet: 12.5
Total Drive Depth below Mudline in Feet: 12.8

Northing: 712,699
Easting: 7,619,693
Mudline Elevation in Feet: –27.1 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

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J-5624-10 7/99

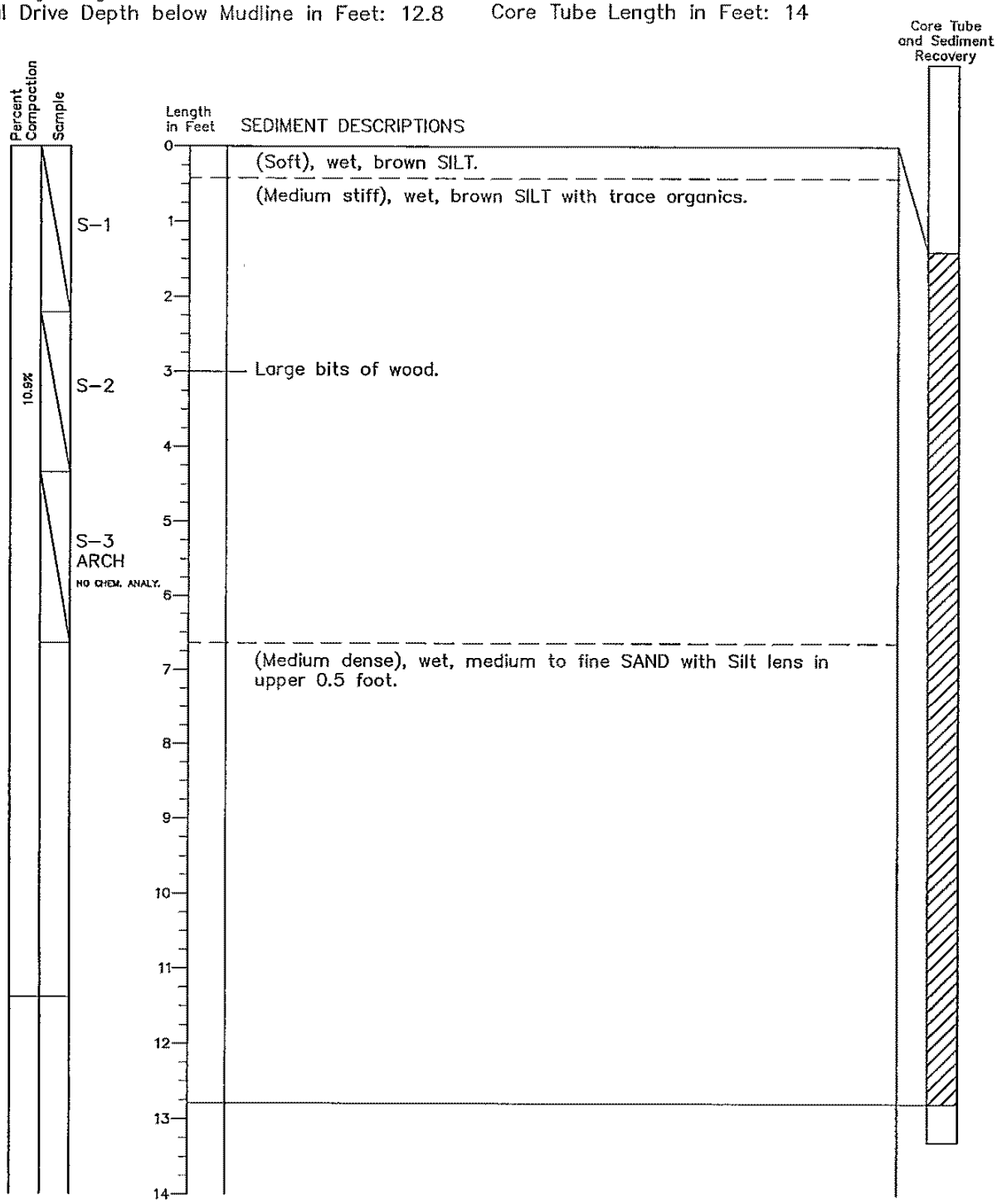
Figure B-9

1=1 ACAD LOG

# Sediment Core Log HC-VC-42

Type of Sample: 4–inch ø Vibracore
Date/Time: 10/12/98 1515
Recovery Length in Feet: 11.4
Total Drive Depth below Mudline in Feet: 12.8

Northing: 713,669
Easting: 7,619,653
Mudline Elevation in Feet: –46.3 CRD
Core Tube Length in Feet: 14




Notes: 1. Sediment contacts are inferred and actual contacts may vary.
2. Horizontal datum – (DGPS) – Oregon State Plane North and vertical control is based on MLLW datum.

HARTCROWSER

J-5624-10 7/99

Figure B-10

1=1 ACAD LOG

Appendix C

# APPENDIX C
# ANALYTICAL RESULTS FOR SURFACE AND SUBSURFACE SEDIMENT SAMPLES

# SURFACE SEDIMENT

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807169-010 | | K9807169-011 | | K9807097-031 | | K9807097-032 | | K9807097-033 | | K9807097-034 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-REF-B | | HC-REF-C | | HC-S-01 | | HC-S-02 | | HC-S-03 | | HC-S-04 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 82.9 | | 6 | | 224 | | 107 | | 70.1 | | 112 | |
| Sulfide, Total | | | 3.8 | | 0.7 | U | 249 | J | 127 | J | 90.3 | J | 6.6 | J |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 2.3 | | 0.38 | | 3.69 | | 2.42 | | 2.38 | J | 2.74 | J |
| Solids, Total | | | 34.8 | | 72 | | 38.9 | | 54.1 | | 55 | | 40.7 | |
| Solids, Total Volatile | | | 6.37 | | 1.38 | | 9.28 | | 12.9 | | 5.65 | | 7.97 | |
| Gravel | | | 0 | | 1.1 | | | | 0.3 | | | | 0.7 | |
| Sand | | | 0.9 | | 79.1 | | | | 54.5 | | | | 17.7 | |
| Silt | | | 73.6 | | 16.6 | | | | 33.1 | | | | 66.6 | |
| Clay | | | 25.5 | | 3.2 | | | | 12.1 | | | | 15 | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.2 | UJ | 0.2 | UJ | | | 2 | J | | | 0.4 | J |
| Arsenic, Total | 57 | 700 | 9 | | 3 | | | | 14 | | | | 6 | |
| Cadmium, Total | 5.1 | 14 | 0.9 | | 0.3 | | | | 4.2 | | | | 2.6 | |
| Chromium, Total | | | 25.4 | | 10.1 | | | | 23.7 | | | | 29.2 | |
| Copper, Total | 390 | 1300 | 36.8 | | 10.7 | | | | 90.1 | | | | 57.3 | |
| Lead, Total | 450 | 1200 | 23.5 | | 7.3 | | | | 837 | | | | 294 | |
| Mercury, Total | 0.41 | 2.3 | 0.12 | | 0.06 | | | | 0.14 | | | | 0.13 | |
| Nickel, Total | 140 | 370 | 21 | | 10 | | | | 22 | | | | 25 | |
| Silver, Total | 6.1 | 8.4 | 0.2 | | 0.1 | U | | | 2 | | | | 0.8 | |
| Zinc, Total | 410 | 3800 | 142 | J | 84 | J | | | 855 | | | | 450 | |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| 1,3-Dichlorobenzene | 170 | | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Benzene | | | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Ethylbenzene | 10 | 50 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Toluene | | | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Total Xylenes | 40 | 160 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| m- & p-Xylenes | | | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |
| o-Xylene | | | 25 | U | 5 | U | 10 | U | 5 | U | 5 | U | 10 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807169-010 | | K9807169-011 | | K9807097-031 | | K9807097-032 | | K9807097-033 | | K9807097-034 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-REF-B | | HC-REF-C | | HC-S-01 | | HC-S-02 | | HC-S-03 | | HC-S-04 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | | | | | 779 | | 87 | | 50 | U | 183 | |
| Fluoranthene | 1700 | 30000 | | | | | 120 | | 58 | | 37 | | 18 | |
| Lube Oil | | | | | | | 100 | U | 100 | U | 100 | U | 100 | U |
| Pencil Pitch | | | | | | | 7730 | | 7620 | | 2940 | | 1350 | |
| Phytane | | | | | | | 5.5 | | 0.8 | | 0.5 | U | 0.9 | |
| Pristane | | | | | | | 5.3 | | 0.6 | | 0.5 | U | 1.3 | |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 20 | U | 20 | U | 20000 | U | 14000 | | 10000 | U | 1100 | |
| Acenaphthylene | 560 | 1300 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Anthracene | 960 | 13000 | 20 | U | 20 | U | 20000 | U | 12000 | | 10000 | U | 1700 | |
| Fluorene | 540 | 3600 | 20 | U | 20 | U | 20000 | U | 14000 | | 10000 | U | 670 | |
| Naphthalene | 2100 | 2400 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | |
| Phenanthrene | 1500 | 21000 | 20 | U | 20 | U | 49000 | | 74000 | | 16000 | | 6400 | |
| Total LPAHs | 5200 | 29000 | | | | | 99000 | | 124000 | | 41000 | | 10470 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 35 | | 20 | U | 77000 | | 81000 | | 28000 | | 13000 | |
| Benzo(a)pyrene | 1600 | 3600 | 43 | | 20 | U | 86000 | | 82000 | | 33000 | | 15000 | |
| Benzo(b)fluoranthene | | | 37 | | 20 | U | 83000 | | 78000 | | 30000 | | 13000 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 57 | | 23 | | 55000 | | 50000 | | 22000 | | 11000 | |
| Benzo(k)fluoranthene | | | 22 | | 20 | U | 61000 | | 63000 | | 26000 | | 9100 | |
| Chrysene | 1400 | 21000 | 35 | | 20 | U | 75000 | | 78000 | | 30000 | | 11000 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 1200 | |
| Fluoranthene | 1700 | 30000 | 63 | | 23 | | 120000 | | 130000 | | 42000 | | 21000 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 110 | | 43 | | 110000 | | 92000 | | 40000 | | 19000 | |
| Pyrene | 2600 | 16000 | 68 | | 27 | | 98000 | | 100000 | | 40000 | | 21000 | |
| Total HPAHs | 12000 | 69000 | | | | | 775000 | | 759000 | | 296000 | | 134300 | |
| Total Benzofluoranthenes | 3200 | 9900 | | | | | 144000 | | 141000 | | 56000 | | 22100 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 6 | U | 6 | U | 6000 | U | 3000 | U | 3000 | U | 120 | U |
| 2-Methylphenol | 63 | 77 | 6 | U | 6 | U | 6000 | U | 3000 | U | 3000 | U | 120 | U |
| 4-Methylphenol | 670 | 3600 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 60 | U | 60 | U | 60000 | U | 30000 | U | 30000 | U | 1200 | U |
| Phenol | 420 | 1200 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807169-010 | | K9807169-011 | | K9807097-031 | | K9807097-032 | | K9807097-033 | | K9807097-034 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-REF-B | | HC-REF-C | | HC-S-01 | | HC-S-02 | | HC-S-03 | | HC-S-04 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | 62 | | 20 | U | 20000 | U | 10000 | U | 10000 | U | 460 | |
| Butyl Benzyl Phthalate | 970 | | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Di-n-butyl Phthalate | 5100 | | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Di-n-octyl Phthalate | 6200 | | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Diethyl Phthalate | 1200 | | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Dimethyl Phthalate | 1400 | | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 100 | U | 100 | U | 100000 | U | 50000 | U | 50000 | U | 2000 | U |
| Benzyl Alcohol | 57 | 870 | 6 | U | 6 | U | 6000 | U | 3000 | U | 3000 | U | 120 | U |
| Dibenzofuran | 540 | 1700 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Hexachlorobenzene | 22 | 230 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| Hexachlorobutadiene | 29 | 290 | 20 | U | 20 | U | 20000 | U | 10000 | U | 10000 | U | 400 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 12 | U | 12 | U | 12000 | U | 6000 | U | 6000 | U | 240 | U |

Notes:
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-035 | | K9807097-036 | K9807097-037 | | K9807097-038 | | K9807097-039 | | K9807097-040 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-05 | | HC-S-06 | HC-S-07 | | HC-S-08 | | HC-S-09 | | HC-S-101 (DUP) | |
| Sampling Date | | | Oct 13,1998 | | Oct 13,1998 | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 114 | | | 121 | | 118 | | 114 | | 116 | |
| Sulfide, Total | | | 590 | J | | 92.4 | J | 49.7 | J | 44.9 | J | 40.6 | J |
| **Conventionals in %** | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 3 | J | | 2.61 | J | 2.38 | J | 2.41 | J | 2.35 | J |
| Solids, Total | | | 47.3 | | 35.1 | 36.3 | | 35 | | 35.1 | | 34.2 | |
| Solids, Total Volatile | | | 7.15 | | 8.89 | 8.81 | | 9 | | 8.91 | | 8.96 | |
| Gravel | | | 0 | | | 0 | | 0 | | | | | |
| Sand | | | 39.6 | | | 12.9 | | 5.6 | | | | | |
| Silt | | | 45.8 | | | 68.3 | | 73.7 | | | | | |
| Clay | | | 14.6 | | | 18.8 | | 20.7 | | | | | |
| **Metals in mg/kg** | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.8 | J | | 0.3 | J | | | 0.7 | J | 1.4 | J |
| Arsenic, Total | 57 | 700 | 6 | | | 7 | | | | 9 | | 9 | |
| Cadmium, Total | 5.1 | 14 | 2.2 | | | 2 | | | | 3.2 | | 3.1 | J |
| Chromium, Total | | | 23.6 | | | 31.9 | | | | 30 | | 29.2 | |
| Copper, Total | 390 | 1300 | 44.6 | | | 64 | | | | 68.1 | | 68.8 | |
| Lead, Total | 450 | 1200 | 272 | | | 322 | | | | 626 | | 640 | J |
| Mercury, Total | 0.41 | 2.3 | 0.08 | | | 0.16 | | | | 0.13 | | 0.17 | |
| Nickel, Total | 140 | 370 | 21 | | | 27 | | | | 25 | | 23 | |
| Silver, Total | 6.1 | 8.4 | 0.8 | | | 0.8 | | | | 1.3 | | 1.5 | |
| Zinc, Total | 410 | 3800 | 385 | | | 399 | | | | 563 | | 584 | J |
| **Volatiles in µg/kg** | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| 1,3-Dichlorobenzene | 170 | | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Benzene | | | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Ethylbenzene | 10 | 50 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Toluene | | | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Total Xylenes | 40 | 160 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| m- & p-Xylenes | | | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |
| o-Xylene | | | 10 | U | | 10 | U | 10 | U | 10 | U | 10 | U |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-035 | | K9807097-036 | | K9807097-037 | | K9807097-038 | | K9807097-039 | | K9807097-040 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-05 | | HC-S-06 | | HC-S-07 | | HC-S-08 | | HC-S-09 | | HC-S-101 (DUP) | |
| Sampling Date | | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 115 | | 135 | | 106 | | 100 | U | 100 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 15 | | 12 | | 15 | | 16 | J | 36 | | 16 | |
| Lube Oil | | | 100 | U | 100 | U | 100 | U | 100 | UJ | 100 | U | 100 | U |
| Pencil Pitch | | | 963 | | 763 | | 1240 | | 894 | | 1080 | | 1260 | |
| Phytane | | | 0.9 | | 1 | | 0.6 | | 1 | UJ | 1 | U | 1 | U |
| Pristane | | | 1.5 | | 1 | | 0.8 | | 0.6 | J | 0.6 | | 1 | U |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 560 | | 500 | | 990 | | 810 | | 960 | | 1300 | |
| Acenaphthylene | 560 | 1300 | 460 | | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Anthracene | 960 | 13000 | 1400 | | 870 | | 1700 | | 1200 | | 1300 | | 1700 | |
| Fluorene | 540 | 3600 | 570 | | 340 | | 730 | | 490 | | 540 | | 710 | |
| Naphthalene | 2100 | 2400 | 440 | | 200 | U | 400 | U | 220 | | 210 | | 400 | U |
| Phenanthrene | 1500 | 21000 | 4700 | | 3100 | | 6100 | | 4300 | | 5000 | | 6300 | |
| Total LPAHs | 5200 | 29000 | 8130 | | 5010 | | 9920 | | 7120 | | 8110 | | 10410 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 8600 | | 7000 | | 12000 | | 8200 | | 11000 | | 13000 | |
| Benzo(a)pyrene | 1600 | 3600 | 9600 | | 9100 | | 13000 | | 11000 | | 12000 | | 14000 | |
| Benzo(b)fluoranthene | | | 7700 | | 6800 | | 12000 | | 8100 | | 10000 | | 13000 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 7100 | | 5100 | | 9400 | | 6800 | | 8600 | | 9800 | |
| Benzo(k)fluoranthene | | | 5800 | | 4500 | | 8100 | | 5700 | | 6000 | | 8400 | |
| Chrysene | 1400 | 21000 | 7800 | | 6300 | | 10000 | | 8600 | | 11000 | | 11000 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 730 | | 670 | | 1200 | | 1100 | | 1300 | | 1600 | |
| Fluoranthene | 1700 | 30000 | 18000 | | 13000 | | 19000 | | 13000 | | 16000 | | 18000 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 10000 | | 10000 | | 17000 | | 12000 | | 15000 | | 18000 | |
| Pyrene | 2600 | 16000 | 20000 | | 13000 | | 21000 | | 14000 | | 16000 | | 18000 | |
| Total HPAHs | 12000 | 69000 | 95330 | | 75470 | | 122700 | | 88500 | | 106900 | | 124800 | |
| Total Benzofluoranthenes | 3200 | 9900 | 13500 | | 11300 | | 20100 | | 13800 | | 16000 | | 21400 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 120 | U | 60 | U | 120 | U | 60 | U | 60 | U | 120 | U |
| 2-Methylphenol | 63 | 77 | 120 | U | 60 | U | 120 | U | 60 | U | 60 | U | 120 | U |
| 4-Methylphenol | 670 | 3600 | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 1200 | U | 600 | U | 1200 | U | 600 | U | 600 | U | 1200 | U |
| Phenol | 420 | 1200 | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-035 | | K9807097-036 | | K9807097-037 | | K9807097-038 | | K9807097-039 | | K9807097-040 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-05 | | HC-S-06 | | HC-S-07 | | HC-S-08 | | HC-S-09 | | HC-S-101 (DUP) | |
| Sampling Date | | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | | Oct 13,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | 400 | U | 420 | | 540 | | 480 | | 370 | | 560 | |
| Butyl Benzyl Phthalate | 970 | | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Di-n-butyl Phthalate | 5100 | | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Di-n-octyl Phthalate | 6200 | | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Diethyl Phthalate | 1200 | | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Dimethyl Phthalate | 1400 | | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 2000 | U | 1000 | U | 2000 | U | 1000 | U | 1000 | U | 2000 | U |
| Benzyl Alcohol | 57 | 870 | 120 | U | 60 | U | 120 | U | 60 | U | 60 | U | 120 | U |
| Dibenzofuran | 540 | 1700 | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Hexachlorobenzene | 22 | 230 | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| Hexachlorobutadiene | 29 | 290 | 400 | U | 200 | U | 400 | U | 200 | U | 200 | U | 400 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 240 | U | 120 | U | 240 | U | 120 | U | 120 | U | 240 | U |

Notes:
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-001 | K9807115-002 | K9807115-003 | K9807115-004 | K9807115-005 | K9807115-006 |
|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-10 | HC-S-11 | HC-S-12 | HC-S-13 | HC-S-14 | HC-S-15 |
| Sampling Date | | | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 |
| Depth in Feet | SL | ML | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 |
| **Conventionals in mg/kg** | | | | | | | | |
| Ammonia as Nitrogen | | | | 99.2 | | 85.9 | 29.9 | |
| Sulfide, Total | | | | 65.5 J | | 102 J | 34.9 J | |
| **Conventionals in %** | | | | | | | | |
| Carbon, Total Organic (TOC) | | | | 2.71 | | 1.85 | 0.42 | |
| Solids, Total | | | 30.1 | 36.9 | 35.5 | 41 | 72.4 | 71.5 |
| Solids, Total Volatile | | | | 8.41 | | 7.15 | 1.76 | |
| Gravel | | | | 0 | | 0.1 | | |
| Sand | | | | 13.4 | | 39.1 | | |
| Silt | | | | 69.8 | | 46.4 | | |
| Clay | | | | 16.8 | | 14.4 | | |
| **Metals in mg/kg** | | | | | | | | |
| Antimony, Total | 150 | 200 | | 0.6 J | | 0.2 J | 0.1 UJ | |
| Arsenic, Total | 57 | 700 | | 9 | | 5 | 3 | |
| Cadmium, Total | 5.1 | 14 | | 1.9 J | | 2 J | 0.5 J | |
| Chromium, Total | | | | 31.2 | | 24.6 | 35.3 | |
| Copper, Total | 390 | 1300 | | 70.4 | | 45.3 | 15.3 | |
| Lead, Total | 450 | 1200 | | 357 J | | 289 J | 174 J | |
| Mercury, Total | 0.41 | 2.3 | | 0.13 | | 0.06 | 0.02 U | |
| Nickel, Total | 140 | 370 | | 27 | | 21 | 12 | |
| Silver, Total | 6.1 | 8.4 | | 0.7 | | 0.4 | 0.6 | |
| Zinc, Total | 410 | 3800 | | 397 J | | 798 J | 109 J | |
| **Volatiles in µg/kg** | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | | 25 U | | 10 U | 5 U | |
| 1,3-Dichlorobenzene | 170 | | | 25 U | | 10 U | 5 U | |
| 1,4-Dichlorobenzene | 110 | 120 | | 25 U | | 10 U | 5 U | |
| Benzene | | | | 25 U | | 10 U | 5 U | |
| Ethylbenzene | 10 | 50 | | 25 U | | 10 U | 5 U | |
| Tetrachloroethene (PCE) | 57 | 210 | | 25 U | | 10 U | 5 U | |
| Toluene | | | | 25 U | | 10 U | 5 U | |
| Total Xylenes | 40 | 160 | | 25 U | | 10 U | 5 U | |
| Trichloroethene (TCE) | 160 | 1600 | | 25 U | | 10 U | 5 U | |
| m- & p-Xylenes | | | | 25 U | | 10 U | 5 U | |
| o-Xylene | | | | 25 U | | 10 U | 5 U | |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-001 | | K9807115-002 | | K9807115-003 | | K9807115-004 | | K9807115-005 | | K9807115-006 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-10 | | HC-S-11 | | HC-S-12 | | HC-S-13 | | HC-S-14 | | HC-S-15 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 100 | U | 100 | U | 77 | | 100 | U | 100 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 7.4 | | 6.6 | | 14 | | 4.1 | | 7.2 | | 5.8 | |
| Lube Oil | | | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U |
| Pencil Pitch | | | 960 | | 1230 | | 643 | | 551 | | 630 | | 350 | |
| Phytane | | | 0.5 | U | 0.5 | U | 0.5 | | 0.5 | U | 0.5 | U | 0.5 | U |
| Pristane | | | 0.5 | U | 0.5 | U | 0.8 | | 0.5 | U | 0.5 | U | 0.5 | U |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | | | 940 | | | | 270 | | 54 | | | |
| Acenaphthylene | 560 | 1300 | | | 200 | | | | 140 | | 350 | | | |
| Anthracene | 960 | 13000 | | | 1700 | | | | 600 | | 590 | | | |
| Fluorene | 540 | 3600 | | | 590 | | | | 250 | | 250 | | | |
| Naphthalene | 2100 | 2400 | | | 250 | | | | 140 | | 220 | | | |
| Phenanthrene | 1500 | 21000 | | | 5700 | | | | 2100 | | 2700 | | | |
| Total LPAHs | 5200 | 29000 | | | 9380 | | | | 3500 | | 4164 | | | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | | | 11000 | | | | 4600 | | 4800 | | | |
| Benzo(a)pyrene | 1600 | 3600 | | | 13000 | | | | 5500 | | 5400 | | | |
| Benzo(b)fluoranthene | | | | | 10000 | | | | 4100 | | 3200 | | | |
| Benzo(g,h,i)perylene | 670 | 3200 | | | 8900 | | | | 3900 | | 4000 | | | |
| Benzo(k)fluoranthene | | | | | 8400 | | | | 3400 | | 3300 | | | |
| Chrysene | 1400 | 21000 | | | 11000 | | | | 4500 | | 4500 | | | |
| Dibenz(a,h)anthracene | 230 | 1900 | | | 2200 | | | | 870 | | 570 | | | |
| Fluoranthene | 1700 | 30000 | | | 21000 | | | | 9600 | | 13000 | | | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | | | 14000 | | | | 7100 | | 6600 | | | |
| Pyrene | 2600 | 16000 | | | 22000 | | | | 11000 | | 17000 | | | |
| Total HPAHs | 12000 | 69000 | | | 121500 | | | | 54570 | | 62370 | | | |
| Total Benzofluoranthenes | 3200 | 9900 | | | 18400 | | | | 7500 | | 6500 | | | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | | | 6 | U | | | 6 | UJ | 6 | UJ | | |
| 2-Methylphenol | 63 | 77 | | | 6 | U | | | 6 | UJ | 6 | UJ | | |
| 4-Methylphenol | 670 | 3600 | | | 20 | U | | | 20 | UJ | 20 | UJ | | |
| Pentachlorophenol (PCP) | 400 | 690 | | | 60 | U | | | 60 | UJ | 60 | UJ | | |
| Phenol | 420 | 1200 | | | 20 | U | | | 20 | UJ | 20 | UJ | | |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-001 | K9807115-002 | | K9807115-003 | K9807115-004 | | K9807115-005 | | K9807115-006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-10 | HC-S-11 | | HC-S-12 | HC-S-13 | | HC-S-14 | | HC-S-15 |
| Sampling Date | | | Oct 14,1998 | Oct 14,1998 | | Oct 14,1998 | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 |
| Depth in Feet | SL | ML | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 |
| **Phthalates in µg/kg** | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | | 450 | | | 360 | | 51 | | |
| Butyl Benzyl Phthalate | 970 | | | 36 | | | 20 | U | 20 | U | |
| Di-n-butyl Phthalate | 5100 | | | 20 | U | | 20 | U | 20 | U | |
| Di-n-octyl Phthalate | 6200 | | | 20 | U | | 20 | U | 20 | U | |
| Diethyl Phthalate | 1200 | | | 20 | U | | 20 | U | 20 | U | |
| Dimethyl Phthalate | 1400 | | | 20 | U | | 20 | U | 20 | U | |
| **Semivolatiles in µg/kg** | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | | 100 | U | | 100 | U | 100 | U | |
| Benzyl Alcohol | 57 | 870 | | 6 | U | | 6 | U | 6 | U | |
| Dibenzofuran | 540 | 1700 | | 200 | | | 20 | U | 33 | | |
| Hexachlorobenzene | 22 | 230 | | 20 | U | | 20 | U | 20 | U | |
| Hexachlorobutadiene | 29 | 290 | | 20 | U | | 20 | U | 20 | U | |
| N-Nitrosodiphenylamine | 28 | 130 | | 12 | U | | 12 | U | 12 | U | |

**Notes:**
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-007 | | K9807115-008 | K9807169-012 | K9807169-013 | | K9807169-014 | | K9807169-015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-16 | | HC-S-17 | HC-S-18 | HC-S-19 | | HC-S-20 | | HC-S-21 |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | Oct 15,1998 | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 |
| **Conventionals in mg/kg** | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 74.7 | | | | 44.8 | | 86.8 | | |
| Sulfide, Total | | | 96.3 | J | | | 9.2 | | 11.1 | | |
| **Conventionals in %** | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 2.5 | | | | 1.24 | | 2.54 | | |
| Solids, Total | | | 43.3 | | 45.1 | 47 | 78 | | 42.2 | | 41.3 |
| Solids, Total Volatile | | | 7.75 | | | | 3.44 | | 7.34 | | |
| Gravel | | | 0 | | | | 3.7 | | | | |
| Sand | | | 29.6 | | | | 64.4 | | | | |
| Silt | | | 55.3 | | | | 24.4 | | | | |
| Clay | | | 15.1 | | | | 7.5 | | | | |
| **Metals in mg/kg** | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.4 | J | | | 4.4 | J | | | |
| Arsenic, Total | 57 | 700 | 6 | | | | 11 | | | | |
| Cadmium, Total | 5.1 | 14 | 1.3 | J | | | 5.6 | | | | |
| Chromium, Total | | | 29.4 | | | | 18.3 | | | | |
| Copper, Total | 390 | 1300 | 52.2 | | | | 62.9 | | | | |
| Lead, Total | 450 | 1200 | 210 | J | | | 1160 | | | | |
| Mercury, Total | 0.41 | 2.3 | 0.25 | | | | 0.07 | | | | |
| Nickel, Total | 140 | 370 | 27 | | | | 16 | | | | |
| Silver, Total | 6.1 | 8.4 | 0.1 | | | | 1.9 | | | | |
| Zinc, Total | 410 | 3800 | 306 | J | | | 1020 | J | | | |
| **Volatiles in µg/kg** | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 5 | U | | | 5 | U | 10 | U | |
| 1,3-Dichlorobenzene | 170 | | 5 | U | | | 5 | U | 10 | U | |
| 1,4-Dichlorobenzene | 110 | 120 | 5 | U | | | 5 | U | 10 | U | |
| Benzene | | | 5 | U | | | 5 | U | 10 | U | |
| Ethylbenzene | 10 | 50 | 5 | U | | | 5 | U | 10 | U | |
| Tetrachloroethene (PCE) | 57 | 210 | 5 | U | | | 5 | U | 10 | U | |
| Toluene | | | 5 | U | | | 5 | U | 10 | U | |
| Total Xylenes | 40 | 160 | 5 | U | | | 5 | U | 10 | U | |
| Trichloroethene (TCE) | 160 | 1600 | 5 | U | | | 5 | U | 10 | U | |
| m- & p-Xylenes | | | 5 | U | | | 5 | U | 10 | U | |
| o-Xylene | | | 5 | U | | | 5 | U | 10 | U | |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-007 | | K9807115-008 | | K9807169-012 | | K9807169-013 | | K9807169-014 | | K9807169-015 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-16 | | HC-S-17 | | HC-S-18 | | HC-S-19 | | HC-S-20 | | HC-S-21 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 115 | | 100 | U | 100 | U | 50 | U | 100 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 26 | | 9.3 | | 26 | J | 180 | J | 36 | J | 10 | J |
| Lube Oil | | | 100 | U | 100 | U | 100 | UJ | 100 | UJ | 100 | UJ | 100 | UJ |
| Pencil Pitch | | | 1130 | | 1100 | | 2600 | | 8650 | | 1600 | | 1800 | |
| Phytane | | | 0.6 | | 0.5 | U | 0.5 | UJ | 1 | UJ | 0.5 | J | 0.5 | UJ |
| Pristane | | | 0.7 | | 0.5 | U | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 630 | | | | | | 6100 | | 1500 | | | |
| Acenaphthylene | 560 | 1300 | 480 | | | | | | 71 | | 160 | | | |
| Anthracene | 960 | 13000 | 1900 | | | | | | 5900 | | 2000 | | | |
| Fluorene | 540 | 3600 | 620 | | | | | | 2500 | | 700 | | | |
| Naphthalene | 2100 | 2400 | 450 | | | | | | 1400 | | 370 | | | |
| Phenanthrene | 1500 | 21000 | 4900 | | | | | | 26000 | | 7900 | | | |
| Total LPAHs | 5200 | 29000 | 8980 | | | | | | 41971 | | 12630 | | | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 9000 | | | | | | 44000 | | 14000 | | | |
| Benzo(a)pyrene | 1600 | 3600 | 11000 | | | | | | 55000 | | 18000 | | | |
| Benzo(b)fluoranthene | | | 7600 | | | | | | 44000 | | 13000 | | | |
| Benzo(g,h,i)perylene | 670 | 3200 | 7600 | | | | | | 38000 | | 13000 | | | |
| Benzo(k)fluoranthene | | | 7000 | | | | | | 35000 | | 11000 | | | |
| Chrysene | 1400 | 21000 | 8900 | | | | | | 46000 | | 14000 | | | |
| Dibenz(a,h)anthracene | 230 | 1900 | 1700 | | | | | | 11000 | | 3100 | | | |
| Fluoranthene | 1700 | 30000 | 21000 | | | | | | 70000 | J | 26000 | | | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 13000 | | | | | | 60000 | | 21000 | | | |
| Pyrene | 2600 | 16000 | 25000 | | | | | | 68000 | | 25000 | | | |
| Total HPAHs | 12000 | 69000 | 111800 | | | | | | 471000 | | 158100 | | | |
| Total Benzofluoranthenes | 3200 | 9900 | 14600 | | | | | | 79000 | | 24000 | | | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 6 | U | | | | | 31 | | 7 | | | |
| 2-Methylphenol | 63 | 77 | 6 | U | | | | | 51 | | 6 | U | | |
| 4-Methylphenol | 670 | 3600 | 20 | U | | | | | 130 | | 24 | | | |
| Pentachlorophenol (PCP) | 400 | 690 | 60 | U | | | | | 60 | U | 60 | U | | |
| Phenol | 420 | 1200 | 20 | U | | | | | 110 | | 20 | U | | |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-007 | | K9807115-008 | K9807169-012 | K9807169-013 | | K9807169-014 | | K9807169-015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-16 | | HC-S-17 | HC-S-18 | HC-S-19 | | HC-S-20 | | HC-S-21 |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | Oct 15,1998 | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 |
| **Phthalates in µg/kg** | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | 420 | | | | 360 | | 430 | | |
| Butyl Benzyl Phthalate | 970 | | 47 | | | | 20 | U | 56 | | |
| Di-n-butyl Phthalate | 5100 | | 20 | U | | | 20 | U | 43 | | |
| Di-n-octyl Phthalate | 6200 | | 20 | U | | | 20 | U | 20 | U | |
| Diethyl Phthalate | 1200 | | 20 | U | | | 20 | U | 20 | U | |
| Dimethyl Phthalate | 1400 | | 20 | U | | | 20 | U | 20 | U | |
| **Semivolatiles in µg/kg** | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 100 | U | | | 110 | | 100 | U | |
| Benzyl Alcohol | 57 | 870 | 6 | U | | | 6 | U | 6 | U | |
| Dibenzofuran | 540 | 1700 | 160 | | | | 660 | | 260 | | |
| Hexachlorobenzene | 22 | 230 | 20 | U | | | 20 | U | 20 | U | |
| Hexachlorobutadiene | 29 | 290 | 20 | U | | | 20 | U | 20 | U | |
| N-Nitrosodiphenylamine | 28 | 130 | 12 | U | | | 12 | U | 12 | U | |

Notes:
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-009 | | K9807115-010 | K9807115-011 | | K9807115-012 | | K9807115-013 | | K9807115-014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-22 | | HC-S-23 | HC-S-24 | | HC-S-102 (DUP) | | HC-S-25 | | HC-S-26 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 76.9 | | | 84.2 | | 70.5 | | 189 | | 39.1 | |
| Sulfide, Total | | | 17.5 | J | | 181 | J | 130 | J | 1830 | J | 7.8 | J |
| **Conventionals in %** | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 1.89 | | | 1.67 | | 1.98 | | 2.48 | | 0.78 | |
| Solids, Total | | | 44.1 | | 36.8 | 50 | | 61.6 | | 50.7 | | 60.5 | |
| Solids, Total Volatile | | | 6.34 | | | 6.3 | | 4.78 | | 7.21 | | 3.63 | |
| Gravel | | | 0 | | | 0.7 | | | | | | | |
| Sand | | | 39 | | | 58.5 | | | | | | | |
| Silt | | | 46.9 | | | 30.4 | | | | | | | |
| Clay | | | 14.1 | | | 10.4 | | | | | | | |
| **Metals in mg/kg** | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.2 | J | | 0.3 | J | 0.1 | J | 0.8 | J | 0.2 | J |
| Arsenic, Total | 57 | 700 | 5 | | | 5 | | 5 | | 12 | | 4 | |
| Cadmium, Total | 5.1 | 14 | 1 | J | | 1.5 | J | 1.2 | J | 6.6 | J | 2.5 | J |
| Chromium, Total | | | 23.1 | | | 23 | | 18.7 | | 30.1 | | 14.3 | |
| Copper, Total | 390 | 1300 | 44.1 | | | 41.4 | | 35.9 | | 84.4 | | 26 | |
| Lead, Total | 450 | 1200 | 125 | J | | 118 | J | 101 | J | 644 | J | 68.4 | J |
| Mercury, Total | 0.41 | 2.3 | 0.09 | | | 0.08 | | 0.08 | | 0.34 | | 0.04 | |
| Nickel, Total | 140 | 370 | 23 | | | 36 | | 30 | | 56 | | 22 | |
| Silver, Total | 6.1 | 8.4 | 0.3 | | | 0.3 | | 0.2 | | 1 | | 0.1 | |
| Zinc, Total | 410 | 3800 | 225 | J | | 279 | J | 216 | J | 1330 | J | 435 | J |
| **Volatiles in µg/kg** | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| 1,3-Dichlorobenzene | 170 | | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Benzene | | | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Ethylbenzene | 10 | 50 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Toluene | | | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Total Xylenes | 40 | 160 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| Trichloroethene (TCE) | 160 | 1600 | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| m- & p-Xylenes | | | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |
| o-Xylene | | | 10 | U | | 10 | U | 5 | U | 5 | U | 5 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-009 | K9807115-010 | K9807115-011 | K9807115-012 | K9807115-013 | K9807115-014 |
|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-22 | HC-S-23 | HC-S-24 | HC-S-102 (DUP) | HC-S-25 | HC-S-26 |
| Sampling Date | | | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 | Oct 14,1998 |
| Depth in Feet | SL | ML | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 | 0 to 0.3 |
| **TPH in mg/kg** | | | | | | | | |
| Diesel | | | 100 U | 58 | 77 | 25 U | 962 | 100 U |
| Fluoranthene | 1700 | 30000 | 7.4 | 14 | 100 | 33 | 4.1 | 5 |
| Lube Oil | | | 100 U | 100 U | 100 U | 100 U | 1100 J | 100 U |
| Pencil Pitch | | | 449 | 591 | 4320 | 1930 | 157 | 289 |
| Phytane | | | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 6.1 | 0.5 U |
| Pristane | | | 0.5 U | 0.5 | 0.5 | 0.5 U | 7 | 0.5 U |
| **LPAHs in µg/kg** | | | | | | | | |
| Acenaphthene | 500 | 2000 | 310 | | 410 | 420 | 210 | 73 |
| Acenaphthylene | 560 | 1300 | 110 | | 3600 | 2000 | 100 | 140 |
| Anthracene | 960 | 13000 | 560 | | 6600 | 4600 | 270 | 350 |
| Fluorene | 540 | 3600 | 230 | | 1200 | 1200 | 230 | 100 |
| Naphthalene | 2100 | 2400 | 20 U | | 2200 | 980 | 140 | 100 |
| Phenanthrene | 1500 | 21000 | 1900 | | 15000 | 9900 | 1100 | 1000 |
| Total LPAHs | 5200 | 29000 | 3120 | | 29010 | 19100 | 2050 | 1763 |
| **HPAHs in µg/kg** | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 4000 | | 37000 | 14000 | 1300 | 2300 |
| Benzo(a)pyrene | 1600 | 3600 | 4900 | | 39000 | 17000 | 1400 | 2700 |
| Benzo(b)fluoranthene | | | 3700 | | 23000 | 8800 | 880 | 1600 |
| Benzo(g,h,i)perylene | 670 | 3200 | 3300 | | 27000 | 13000 | 1000 | 1900 |
| Benzo(k)fluoranthene | | | 3300 | | 24000 | 11000 | 600 | 1800 |
| Chrysene | 1400 | 21000 | 3800 | | 38000 | 14000 | 1500 | 2200 |
| Dibenz(a,h)anthracene | 230 | 1900 | 800 | | 4700 | 2100 | 170 | 350 |
| Fluoranthene | 1700 | 30000 | 7200 | | 84000 | 40000 | 3100 | 5500 |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 6000 | | 41000 | 21000 | 1800 | 3400 |
| Pyrene | 2600 | 16000 | 7500 | | 110000 | 50000 | 3700 | 6800 |
| Total HPAHs | 12000 | 69000 | 44500 | | 427700 | 190900 | 15450 | 28550 |
| Total Benzofluoranthenes | 3200 | 9900 | 7000 | | 47000 | 19800 | 1480 | 3400 |
| **Phenols in µg/kg** | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 6 U | | 6 U | 6 U | 6 U | 6 U |
| 2-Methylphenol | 63 | 77 | 6 U | | 6 U | 6 U | 6 U | 6 U |
| 4-Methylphenol | 670 | 3600 | 20 U | | 20 U | 20 U | 20 U | 20 U |
| Pentachlorophenol (PCP) | 400 | 690 | 60 U | | 60 U | 60 U | 60 U | 60 U |
| Phenol | 420 | 1200 | 20 U | | 20 U | 20 U | 20 U | 20 U |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-009 | | K9807115-010 | K9807115-011 | | K9807115-012 | | K9807115-013 | | K9807115-014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-22 | | HC-S-23 | HC-S-24 | | HC-S-102 (DUP) | | HC-S-25 | | HC-S-26 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | 310 | | | 2000 | U | 300 | | 300 | | 110 | |
| Butyl Benzyl Phthalate | 970 | | 24 | | | 2000 | U | 20 | U | 20 | U | 20 | U |
| Di-n-butyl Phthalate | 5100 | | 20 | U | | 20 | U | 20 | U | 20 | U | 20 | U |
| Di-n-octyl Phthalate | 6200 | | 20 | U | | 2000 | U | 20 | U | 20 | U | 20 | U |
| Diethyl Phthalate | 1200 | | 20 | U | | 20 | U | 47 | | 25 | | 20 | U |
| Dimethyl Phthalate | 1400 | | 20 | U | | 20 | U | 20 | U | 20 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 100 | U | | 100 | U | 100 | U | 100 | U | 100 | U |
| Benzyl Alcohol | 57 | 870 | 6 | U | | 6 | U | 6 | U | 6 | U | 6 | U |
| Dibenzofuran | 540 | 1700 | 75 | | | 170 | | 160 | | 48 | | 30 | |
| Hexachlorobenzene | 22 | 230 | 20 | U | | 20 | U | 20 | U | 20 | U | 20 | U |
| Hexachlorobutadiene | 29 | 290 | 20 | U | | 20 | U | 20 | U | 20 | U | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 12 | U | | 12 | U | 12 | U | 12 | U | 12 | U |

Notes:
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-015 | | K9807115-016 | | K9807115-017 | K9807169-017 | | K9807169-016 | K9807115-020 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-27 | | HC-S-28 | | HC-S-29 | HC-S-30 | | HC-S-31 | HC-S-32 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | Oct 15,1998 | | Oct 15,1998 | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | | | 110 | | | 67 | | | 87.2 | |
| Sulfide, Total | | | | | 65.8 | J | | 12.6 | | | 9.6 | J |
| **Conventionals in %** | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | | | 2.35 | | | 1.28 | | | 1.43 | |
| Solids, Total | | | 40.5 | | 42.2 | | 44.8 | 52.8 | | 48 | 46.4 | |
| Solids, Total Volatile | | | | | 7.89 | | | 4.19 | | | 6.11 | |
| Gravel | | | | | 0 | | | 0 | | | 0 | |
| Sand | | | | | 16 | | | 59.2 | | | 43.8 | |
| Silt | | | | | 65 | | | 30.6 | | | 38.6 | |
| Clay | | | | | 19 | | | 10.2 | | | 17.6 | |
| **Metals in mg/kg** | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | | | 0.2 | J | | 0.2 | UJ | | 0.1 | J |
| Arsenic, Total | 57 | 700 | | | 5 | | | 4 | | | 4 | |
| Cadmium, Total | 5.1 | 14 | | | 0.9 | J | | 0.6 | | | 0.5 | J |
| Chromium, Total | | | | | 28.4 | | | 21.1 | | | 21.8 | |
| Copper, Total | 390 | 1300 | | | 50.4 | | | 62 | | | 34.6 | |
| Lead, Total | 450 | 1200 | | | 87.6 | J | | 80.7 | | | 51.6 | J |
| Mercury, Total | 0.41 | 2.3 | | | 0.1 | | | 0.06 | | | 0.07 | |
| Nickel, Total | 140 | 370 | | | 25 | | | 22 | | | 22 | |
| Silver, Total | 6.1 | 8.4 | | | 0.3 | | | 0.3 | | | 0.2 | |
| Zinc, Total | 410 | 3800 | | | 220 | J | | 167 | J | | 146 | J |
| **Volatiles in µg/kg** | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | | | 10 | U | | 5 | U | | 10 | U |
| 1,3-Dichlorobenzene | 170 | | | | 10 | U | | 5 | U | | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | | | 10 | U | | 5 | U | | 10 | U |
| Benzene | | | | | 10 | U | | 5 | U | | 10 | U |
| Ethylbenzene | 10 | 50 | | | 10 | U | | 5 | U | | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | | | 10 | U | | 5 | U | | 10 | U |
| Toluene | | | | | 10 | U | | 5 | U | | 10 | U |
| Total Xylenes | 40 | 160 | | | 10 | U | | 5 | U | | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | | | 10 | U | | 5 | U | | 10 | U |
| m- & p-Xylenes | | | | | 10 | U | | 5 | U | | 10 | U |
| o-Xylene | | | | | 10 | U | | 5 | U | | 10 | U |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-015 | | K9807115-016 | | K9807115-017 | | K9807169-017 | | K9807169-016 | | K9807115-020 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-27 | | HC-S-28 | | HC-S-29 | | HC-S-30 | | HC-S-31 | | HC-S-32 | |
| Sampling Date | | | Oct 14,1998 | | Oct 14,1998 | | Oct 14,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 100 | U | 100 | U | 100 | U | 50 | U | 50 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 8.1 | | 6.1 | | 3.8 | | 6.5 | J | 1.1 | J | 2.8 | |
| Lube Oil | | | 100 | U | 100 | U | 100 | U | 100 | UJ | 310 | J | 100 | U |
| Pencil Pitch | | | 1400 | | 384 | | 910 | | 319 | | 58.8 | | 130 | |
| Phytane | | | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | UJ | 0.5 | UJ | 0.5 | U |
| Pristane | | | 0.5 | U | 0.5 | | 0.5 | U | 0.5 | UJ | 0.5 | UJ | 0.5 | U |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | | | 260 | | | | 260 | | | | 120 | |
| Acenaphthylene | 560 | 1300 | | | 120 | | | | 44 | | | | 35 | |
| Anthracene | 960 | 13000 | | | 510 | | | | 370 | | | | 210 | |
| Fluorene | 540 | 3600 | | | 200 | | | | 160 | | | | 82 | |
| Naphthalene | 2100 | 2400 | | | 100 | | | | 64 | | | | 36 | |
| Phenanthrene | 1500 | 21000 | | | 1700 | | | | 1600 | | | | 900 | |
| Total LPAHs | 5200 | 29000 | | | 2890 | | | | 2498 | | | | 1383 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | | | 3200 | | | | 2700 | | | | 1100 | |
| Benzo(a)pyrene | 1600 | 3600 | | | 4000 | | | | 3300 | | | | 1600 | |
| Benzo(b)fluoranthene | | | | | 2900 | | | | 2400 | | | | 1400 | |
| Benzo(g,h,i)perylene | 670 | 3200 | | | 2800 | | | | 2500 | | | | 1200 | |
| Benzo(k)fluoranthene | | | | | 2700 | | | | 2400 | | | | 1100 | |
| Chrysene | 1400 | 21000 | | | 3200 | | | | 3000 | | | | 1200 | |
| Dibenz(a,h)anthracene | 230 | 1900 | | | 630 | | | | 540 | | | | 290 | |
| Fluoranthene | 1700 | 30000 | | | 6500 | | | | 5200 | | | | 2000 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | | | 5100 | | | | 4600 | | | | 1300 | |
| Pyrene | 2600 | 16000 | | | 7000 | | | | 5000 | | | | 1700 | |
| Total HPAHs | 12000 | 69000 | | | 38030 | | | | 31640 | | | | 12890 | |
| Total Benzofluoranthenes | 3200 | 9900 | | | 5600 | | | | 4800 | | | | 2500 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | | | 6 | U | | | 6 | U | | | 6 | U |
| 2-Methylphenol | 63 | 77 | | | 6 | U | | | 6 | U | | | 6 | U |
| 4-Methylphenol | 670 | 3600 | | | 20 | U | | | 20 | U | | | 20 | U |
| Pentachlorophenol (PCP) | 400 | 690 | | | 60 | U | | | 60 | U | | | 60 | U |
| Phenol | 420 | 1200 | | | 20 | U | | | 20 | U | | | 20 | U |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-015 | K9807115-016 | | K9807115-017 | K9807169-017 | | K9807169-016 | K9807115-020 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-27 | HC-S-28 | | HC-S-29 | HC-S-30 | | HC-S-31 | HC-S-32 | |
| Sampling Date | | | Oct 14,1998 | Oct 14,1998 | | Oct 14,1998 | Oct 15,1998 | | Oct 15,1998 | Oct 14,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | | 370 | | | 300 | | | 250 | |
| Butyl Benzyl Phthalate | 970 | | | 20 | U | | 20 | U | | 20 | U |
| Di-n-butyl Phthalate | 5100 | | | 20 | U | | 20 | U | | 20 | U |
| Di-n-octyl Phthalate | 6200 | | | 20 | U | | 20 | U | | 20 | U |
| Diethyl Phthalate | 1200 | | | 20 | U | | 20 | U | | 20 | U |
| Dimethyl Phthalate | 1400 | | | 20 | U | | 20 | U | | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | | 100 | U | | 100 | U | | 100 | U |
| Benzyl Alcohol | 57 | 870 | | 6 | U | | 6 | U | | 6 | U |
| Dibenzofuran | 540 | 1700 | | 62 | | | 52 | | | 29 | |
| Hexachlorobenzene | 22 | 230 | | 20 | U | | 20 | U | | 20 | U |
| Hexachlorobutadiene | 29 | 290 | | 20 | U | | 20 | U | | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | | 12 | U | | 12 | U | | 12 | U |

**Notes:**
= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-021 | | K9807169-002 | | K9807115-018 | | K9807169-001 | | K9807115-019 | | K9807169-005 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-33 | | HC-S-34 | | HC-S-35 | | HC-S-36 | | HC-S-37 | | HC-S-38 | |
| Sampling Date | | | Oct 14,1998 | | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | | | 142 | | 68.2 | | 12.2 | | 82.7 | | 80.6 | |
| Sulfide, Total | | | | | 704 | | 10.8 | J | 13.4 | | 8.6 | J | 7.3 | |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | | | 2.12 | | 1.59 | | 0.69 | | 1.68 | | 1.63 | |
| Solids, Total | | | 46.3 | | 57.3 | | 46.9 | | 68.9 | | 42 | | 44.3 | |
| Solids, Total Volatile | | | | | 5.24 | | 6.34 | | 2.3 | | 6.62 | | 6.7 | |
| Gravel | | | | | 0.1 | | 0 | | 0.2 | | | | | |
| Sand | | | | | 38.2 | | 35.5 | | 76.4 | | | | | |
| Silt | | | | | 47.2 | | 50.2 | | 17.1 | | | | | |
| Clay | | | | | 14.5 | | 14.3 | | 6.3 | | | | | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | | | 0.2 | J | 0.1 | J | 0.2 | UJ | 0.1 | UJ | 0.2 | UJ |
| Arsenic, Total | 57 | 700 | | | 5 | | 4 | | 3 | | 4 | | 4 | |
| Cadmium, Total | 5.1 | 14 | | | 1.1 | | 0.4 | J | 0.2 | | 0.3 | J | 0.3 | |
| Chromium, Total | | | | | 23.4 | | 23.3 | | 15.2 | | 24.4 | | 28.3 | |
| Copper, Total | 390 | 1300 | | | 37.1 | | 35.5 | | 20.9 | | 37 | | 37.7 | |
| Lead, Total | 450 | 1200 | | | 153 | | 39 | J | 15.2 | | 28.3 | J | 49.9 | |
| Mercury, Total | 0.41 | 2.3 | | | 0.2 | | 0.08 | | 0.05 | | 0.08 | | 0.06 | |
| Nickel, Total | 140 | 370 | | | 24 | | 21 | | 17 | | 22 | | 24 | |
| Silver, Total | 6.1 | 8.4 | | | 0.4 | | 0.2 | | 0.1 | | 0.2 | | 0.2 | |
| Zinc, Total | 410 | 3800 | | | 376 | J | 122 | J | 82 | J | 116 | J | 126 | J |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| 1,3-Dichlorobenzene | 170 | | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Benzene | | | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Ethylbenzene | 10 | 50 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Toluene | | | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Total Xylenes | 40 | 160 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| m- & p-Xylenes | | | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |
| o-Xylene | | | | | 5 | U | 10 | U | 5 | U | 10 | U | 10 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807115-021 | | K9807169-002 | | K9807115-018 | | K9807169-001 | | K9807115-019 | | K9807169-005 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-33 | | HC-S-34 | | HC-S-35 | | HC-S-36 | | HC-S-37 | | HC-S-38 | |
| Sampling Date | | | Oct 14,1998 | | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 212 | | 375 | | 100 | U | 96 | | 100 | U | 50 | U |
| Fluoranthene | 1700 | 30000 | 2.3 | | 1.7 | J | 2.3 | | 0.5 | J | 1.5 | | 26 | J |
| Lube Oil | | | 400 | J | 650 | J | 100 | U | 160 | J | 340 | J | 100 | UJ |
| Pencil Pitch | | | 133 | | 100 | | 170 | | 20.9 | | 88.7 | | 3360 | |
| Phytane | | | 0.5 | U | 2.4 | J | 0.5 | U | 0.5 | UJ | 0.5 | U | 0.5 | UJ |
| Pristane | | | 0.5 | U | 2.6 | J | 0.5 | U | 0.5 | UJ | 0.5 | U | 0.5 | UJ |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | | | 200 | | 120 | | 23 | | 88 | | 4000 | |
| Acenaphthylene | 560 | 1300 | | | 50 | | 30 | | 20 | U | 20 | | 20 | U |
| Anthracene | 960 | 13000 | | | 100 | | 220 | | 27 | | 140 | | 4100 | |
| Fluorene | 540 | 3600 | | | 53 | | 85 | | 20 | U | 75 | | 20 | U |
| Naphthalene | 2100 | 2400 | | | 100 | | 40 | | 33 | | 27 | | 540 | |
| Phenanthrene | 1500 | 21000 | | | 540 | | 730 | | 150 | | 580 | | 23000 | |
| Total LPAHs | 5200 | 29000 | | | 1043 | | 1225 | | 253 | | 930 | | 31660 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | | | 690 | | 1500 | | 170 | | 800 | | 29000 | |
| Benzo(a)pyrene | 1600 | 3600 | | | 490 | | 1800 | | 180 | | 1100 | | 31000 | |
| Benzo(b)fluoranthene | | | | | 540 | | 1500 | | 150 | | 1000 | | 34000 | |
| Benzo(g,h,i)perylene | 670 | 3200 | | | 610 | | 1200 | | 220 | | 610 | | 23000 | |
| Benzo(k)fluoranthene | | | | | 340 | | 1300 | | 98 | | 510 | | 21000 | |
| Chrysene | 1400 | 21000 | | | 730 | | 1500 | | 170 | | 900 | | 31000 | |
| Dibenz(a,h)anthracene | 230 | 1900 | | | 110 | | 280 | | 50 | | 170 | | 7200 | |
| Fluoranthene | 1700 | 30000 | | | 2300 | | 2700 | | 310 | | 1500 | | 58000 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | | | 1300 | | 2300 | | 340 | | 900 | | 53000 | |
| Pyrene | 2600 | 16000 | | | 2800 | | 2700 | | 380 | | 1300 | | 46000 | |
| Total HPAHs | 12000 | 69000 | | | 9910 | | 16780 | | 2068 | | 8790 | | 333200 | |
| Total Benzofluoranthenes | 3200 | 9900 | | | 880 | | 2800 | | 248 | | 1510 | | 55000 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | | | 6 | U | 6 | U | 6 | U | 6 | U | 9 | |
| 2-Methylphenol | 63 | 77 | | | 6 | U | 6 | U | 6 | U | 6 | U | 17 | |
| 4-Methylphenol | 670 | 3600 | | | 20 | U | 20 | U | 20 | U | 20 | U | 51 | |
| Pentachlorophenol (PCP) | 400 | 690 | | | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U |
| Phenol | 420 | 1200 | | | 20 | U | 20 | U | 20 | U | 20 | U | 55 | |

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807115-021 | K9807169-002 | | K9807115-018 | | K9807169-001 | | K9807115-019 | | K9807169-005 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-33 | HC-S-34 | | HC-S-35 | | HC-S-36 | | HC-S-37 | | HC-S-38 | |
| Sampling Date | | | Oct 14,1998 | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | | Oct 14,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | | 80 | | 260 | | 50 | | 290 | | 310 | |
| Butyl Benzyl Phthalate | 970 | | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Di-n-butyl Phthalate | 5100 | | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Di-n-octyl Phthalate | 6200 | | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Diethyl Phthalate | 1200 | | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Dimethyl Phthalate | 1400 | | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U |
| Benzyl Alcohol | 57 | 870 | | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| Dibenzofuran | 540 | 1700 | | 23 | | 31 | | 20 | U | 30 | | 860 | |
| Hexachlorobenzene | 22 | 230 | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Hexachlorobutadiene | 29 | 290 | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U |

**Notes:**
[ ] = Indicates Exceedence of Screening Level (SL)
[ ] = Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Undetected at or above Method Reporting Limit (MRL)
J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

**Analytical Results for Surface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807169-004 | | K9807169-003 | | K9807169-009 | | K9807169-008 | | K9807169-007 | | K9807169-006 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-39 | | HC-S-40 | | HC-S-41 | | HC-S-42 | | HC-S-43 | | HC-S-44 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 96.8 | | 85 | | 90.2 | | 84.8 | | 85.8 | | 99.9 | |
| Sulfide, Total | | | 6.2 | | 1.6 | | 8.8 | | 3.3 | | 2.4 | | 2.1 | |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 1.87 | | 1.74 | | 1.91 | | 1.93 | | 2.26 | | 2.11 | |
| Solids, Total | | | 43.9 | | 42.6 | | 48.4 | | 43.2 | | 39.2 | | 44.1 | |
| Solids, Total Volatile | | | 6.09 | | 6.37 | | 5.95 | | 6.28 | | 6.35 | | 5.97 | |
| Gravel | | | 0 | | | | | | 0 | | | | 0 | |
| Sand | | | 14.9 | | | | | | 7.1 | | | | 11.2 | |
| Silt | | | 69.4 | | | | | | 78.3 | | | | 72 | |
| Clay | | | 15.7 | | | | | | 14.6 | | | | 16.8 | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.2 | UJ | | | 0.2 | UJ | 0.2 | UJ | | | | |
| Arsenic, Total | 57 | 700 | 4 | | | | 4 | | 4 | | | | | |
| Cadmium, Total | 5.1 | 14 | 0.2 | | | | 0.3 | | 0.3 | | | | | |
| Chromium, Total | | | 26.4 | | | | 25.5 | | 27.3 | | | | | |
| Copper, Total | 390 | 1300 | 38 | | | | 37.2 | | 40.7 | | | | | |
| Lead, Total | 450 | 1200 | 30.1 | | | | 30.3 | | 36 | | | | | |
| Mercury, Total | 0.41 | 2.3 | 0.08 | | | | 0.11 | | 0.07 | | | | | |
| Nickel, Total | 140 | 370 | 22 | | | | 23 | | 22 | | | | | |
| Silver, Total | 6.1 | 8.4 | 0.2 | | | | 0.2 | | 0.2 | | | | | |
| Zinc, Total | 410 | 3800 | 104 | J | | | 133 | J | 124 | J | | | | |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| 1,3-Dichlorobenzene | 170 | | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Benzene | | | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Ethylbenzene | 10 | 50 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Toluene | | | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Total Xylenes | 40 | 160 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| m- & p-Xylenes | | | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |
| o-Xylene | | | 10 | U | 10 | U | 10 | U | 10 | U | 25 | U | 10 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807169-004 | | K9807169-003 | | K9807169-009 | | K9807169-008 | | K9807169-007 | | K9807169-006 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-39 | | HC-S-40 | | HC-S-41 | | HC-S-42 | | HC-S-43 | | HC-S-44 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | 50 | U | 50 | U | 100 | U | 100 | U | 100 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 9.8 | J | 4.4 | J | 23 | J | 15 | J | 3.2 | J | 1.6 | J |
| Lube Oil | | | 100 | UJ | 100 | UJ | 100 | UJ | 100 | UJ | 100 | UJ | 390 | J |
| Pencil Pitch | | | 727 | | 197 | | 1710 | | 1220 | | 101 | | 84.1 | |
| Phytane | | | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ |
| Pristane | | | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ | 0.5 | UJ |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 520 | | 130 | | 1600 | | 920 | | 60 | | 150 | |
| Acenaphthylene | 560 | 1300 | 20 | U | 20 | U | 20 | U | 23 | | 20 | U | 20 | U |
| Anthracene | 960 | 13000 | 600 | | 170 | | 2000 | | 1500 | | 99 | | 170 | |
| Fluorene | 540 | 3600 | 390 | | 20 | U | 650 | | 420 | | 42 | | 180 | |
| Naphthalene | 2100 | 2400 | 49 | | 23 | | 160 | | 92 | | 20 | U | 39 | |
| Phenanthrene | 1500 | 21000 | 4700 | | 1000 | | 7800 | | 5300 | | 430 | | 970 | |
| Total LPAHs | 5200 | 29000 | 6269 | | 1343 | | 12220 | | 8255 | | 651 | | 1519 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 6200 | | 1300 | | 15000 | | 11000 | | 830 | | 640 | |
| Benzo(a)pyrene | 1600 | 3600 | 6700 | | 1700 | | 20000 | | 14000 | | 1100 | | 670 | |
| Benzo(b)fluoranthene | | | 6500 | | 1500 | | 15000 | | 11000 | | 820 | | 670 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 5400 | | 1300 | | 16000 | | 11000 | | 580 | | 520 | |
| Benzo(k)fluoranthene | | | 5500 | | 690 | | 12000 | | 8900 | | 510 | | 380 | |
| Chrysene | 1400 | 21000 | 7000 | | 1700 | | 16000 | | 11000 | | 1100 | | 610 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 1700 | | 290 | | 3900 | | 2600 | | 170 | | 140 | |
| Fluoranthene | 1700 | 30000 | 13000 | | 3000 | | 24000 | | 17000 | | 1700 | | 1800 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 10000 | | 2600 | | 25000 | | 18000 | | 1700 | | 1400 | |
| Pyrene | 2600 | 16000 | 10000 | | 2500 | | 22000 | | 16000 | | 1500 | | 1500 | |
| Total HPAHs | 12000 | 69000 | 72000 | | 16580 | | 168900 | | 120500 | | 10010 | | 8330 | |
| Total Benzofluoranthenes | 3200 | 9900 | 12000 | | 2190 | | 27000 | | 19900 | | 1330 | | 1050 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| 2-Methylphenol | 63 | 77 | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| 4-Methylphenol | 670 | 3600 | 20 | U | 20 | U | 24 | | 20 | U | 20 | U | 20 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U | 60 | U |
| Phenol | 420 | 1200 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |

## Analytical Results for Surface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807169-004 | | K9807169-003 | | K9807169-009 | | K9807169-008 | | K9807169-007 | | K9807169-006 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-S-39 | | HC-S-40 | | HC-S-41 | | HC-S-42 | | HC-S-43 | | HC-S-44 | |
| Sampling Date | | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | | Oct 15,1998 | |
| Depth in Feet | SL | ML | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | | 0 to 0.3 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl) Phthalate | 8300 | | 290 | | 350 | | 220 | | 500 | | 550 | | 270 | |
| Butyl Benzyl Phthalate | 970 | | 20 | U | 20 | U | 110 | | 37 | | 20 | | 20 | U |
| Di-n-butyl Phthalate | 5100 | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Di-n-octyl Phthalate | 6200 | | 20 | U | 20 | U | 20 | U | 100 | | 40 | | 20 | U |
| Diethyl Phthalate | 1200 | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Dimethyl Phthalate | 1400 | | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U | 100 | U |
| Benzyl Alcohol | 57 | 870 | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U | 6 | U |
| Dibenzofuran | 540 | 1700 | 160 | | 43 | | 270 | | 170 | | 20 | U | 91 | |
| Hexachlorobenzene | 22 | 230 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| Hexachlorobutadiene | 29 | 290 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U | 12 | U |

**Notes:**

= Indicates Exceedence of Screening Level (SL)

= Indicates Exceedence of Maximum Level (ML)

DUP = Duplicate

U = Undetected at or above Method Reporting Limit (MRL)

J = Estimated concentration - the value is less than MRL, but greater than Method Detection Limit (MDL).

# SUBSURFACE SEDIMENT

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-004 | | K9807097-005 | | K9807097-013 | | K9807097-014 | | K9807097-007 | | K9807097-008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-7-S1 | | HC-VC-7-S2 | | HC-VC-11-S1 | | HC-VC-11-S2 | | HC-VC-13-S1 | | HC-VC-13-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | | 2.0 to 4.2 | | 0 to 2.1 | | 2.1 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 301 | | 239 | | 201 | | 159 | | 22.9 | | 16.9 | |
| Sulfide, Total | | | 161 | J | 796 | J | 276 | J | 228 | J | 21 | J | 9.4 | J |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 2.36 | | 1.38 | | 2.09 | | 1.69 | | 0.08 | | 0.09 | |
| Solids, Total | | | 51.3 | | 61.7 | | 49 | | 59.2 | | 75.9 | | 75.7 | |
| Solids, Total Volatile | | | 7.93 | | 5.62 | | 10.5 | | 6.13 | | 1.82 | | 1.77 | |
| Gravel | | | | | 0.1 | | | | 0 | | | | 0.1 | |
| Sand | | | | | 47.8 | | | | 47.8 | | | | 96.9 | |
| Silt | | | | | 36.3 | | | | 39.7 | | | | 2.1 | |
| Clay | | | | | 15.8 | | | | 12.5 | | | | 0.9 | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.6 | J | 1.4 | J | 0.3 | J | 1.1 | J | 0.1 | UJ | 0.1 | UJ |
| Arsenic, Total | 57 | 700 | 8 | | 15 | | 7 | | 12 | | 2 | | 2 | |
| Cadmium, Total | 5.1 | 14 | 2.4 | | 3.3 | | 1.2 | | 3.2 | | 0.2 | | 0.2 | |
| Chromium, Total | | | 27.3 | | 23.2 | | 25.3 | | 22.6 | | 9 | | 10.7 | |
| Copper, Total | 390 | 1300 | 62.8 | | 83.2 | | 52.1 | | 78.3 | | 13.3 | | 15.2 | |
| Lead, Total | 450 | 1200 | 361 | | 576 | | 169 | | 527 | | 25.8 | | 23.9 | |
| Mercury, Total | 0.41 | 2.3 | 0.15 | | 0.18 | | 0.09 | | 0.12 | | 0.03 | | 0.02 | U |
| Nickel, Total | 140 | 370 | 26 | | 25 | | 24 | | 24 | | 15 | | 17 | |
| Silver, Total | 6.1 | 8.4 | 0.9 | | 1.4 | | 0.6 | | 1.2 | | 0.1 | U | 0.1 | U |
| Zinc, Total | 410 | 3800 | 469 | | 650 | | 273 | | 656 | | 61 | | 65 | |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| 1,3-Dichlorobenzene | 170 | | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Benzene | | | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Ethylbenzene | 10 | 50 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Toluene | | | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Total Xylenes | 40 | 160 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| Trichloroethene (TCE) | 160 | 1600 | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| m- & p-Xylenes | | | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |
| o-Xylene | | | 5 | U | 5 | U | 10 | U | 5 | U | 5 | U | 5 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-004 | | K9807097-005 | | K9807097-013 | | K9807097-014 | | K9807097-007 | | K9807097-008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-7-S1 | | HC-VC-7-S2 | | HC-VC-11-S1 | | HC-VC-11-S2 | | HC-VC-13-S1 | | HC-VC-13-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | | 2.0 to 4.2 | | 0 to 2.1 | | 2.1 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | | | | | 100 | U | 100 | U | 25 | U | | |
| Fluoranthene | 1700 | 30000 | | | | | 11 | | 24 | | 0.5 | U | | |
| Lube Oil | | | | | | | 100 | U | 100 | U | 100 | U | | |
| Pencil Pitch | | | 1920 | | 938 | | 703 | | 1400 | | 23 | | 21 | |
| Phytane | | | | | | | 0.5 | U | 0.5 | U | 0.5 | U | | |
| Pristane | | | | | | | 0.5 | U | 0.5 | U | 0.5 | U | | |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Acenaphthylene | 560 | 1300 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Anthracene | 960 | 13000 | 4000 | U | 4000 | U | 1000 | | 4000 | U | 32 | | 21 | |
| Fluorene | 540 | 3600 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Naphthalene | 2100 | 2400 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Phenanthrene | 1500 | 21000 | 4000 | U | 6100 | | 4300 | | 8400 | | 110 | | 87 | |
| Total LPAHs | 5200 | 29000 | 12000 | | 16100 | | 7300 | | 18400 | | 182 | | 148 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 20000 | | 9300 | | 7500 | | 15000 | | 190 | | 210 | |
| Benzo(a)pyrene | 1600 | 3600 | 23000 | | 11000 | | 8200 | | 18000 | | 240 | | 250 | |
| Benzo(b)fluoranthene | | | 19000 | | 9200 | | 7100 | | 13000 | | 180 | | 220 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 14000 | | 6800 | | 5200 | | 9600 | | 120 | | 110 | |
| Benzo(k)fluoranthene | | | 17000 | | 8800 | | 6000 | | 12000 | | 170 | | 180 | |
| Chrysene | 1400 | 21000 | 20000 | | 9800 | | 7300 | | 14000 | | 190 | | 200 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 36 | | 43 | |
| Fluoranthene | 1700 | 30000 | 28000 | | 14000 | | 10000 | | 21000 | | 450 | | 350 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 25000 | | 12000 | | 9200 | | 18000 | | 200 | | 190 | |
| Pyrene | 2600 | 16000 | 24000 | | 12000 | | 9100 | | 18000 | | 480 | | 320 | |
| Total HPAHs | 12000 | 69000 | 192000 | | 94900 | | 70100 | | 140600 | | 2256 | | 2073 | |
| Total Benzofluoranthenes | 3200 | 9900 | 36000 | | 18000 | | 13100 | | 25000 | | 350 | | 400 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 1200 | U | 1200 | U | 300 | U | 1200 | U | 6 | U | 6 | U |
| 2-Methylphenol | 63 | 77 | 1200 | U | 1200 | U | 300 | U | 1200 | U | 6 | U | 6 | U |
| 4-Methylphenol | 670 | 3600 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 12000 | U | 12000 | U | 3000 | U | 12000 | U | 60 | U | 60 | U |
| Phenol | 420 | 1200 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-004 | | K9807097-005 | | K9807097-013 | | K9807097-014 | | K9807097-007 | | K9807097-008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-7-S1 | | HC-VC-7-S2 | | HC-VC-11-S1 | | HC-VC-11-S2 | | HC-VC-13-S1 | | HC-VC-13-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | | 2.0 to 4.2 | | 0 to 2.1 | | 2.1 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | |
| Di-n-octyl Phthalate | 6200 | | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Diethyl Phthalate | 1200 | | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Dimethyl Phthalate | 1400 | | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 20000 | U | 20000 | U | 5000 | U | 20000 | U | 100 | U | 100 | U |
| Benzyl Alcohol | 57 | 870 | 1200 | U | 1200 | U | 300 | U | 1200 | U | 6 | U | 6 | U |
| Dibenzofuran | 540 | 1700 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Hexachlorobenzene | 22 | 230 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| Hexachlorobutadiene | 29 | 290 | 4000 | U | 4000 | U | 1000 | U | 4000 | U | 20 | U | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 2400 | U | 2400 | U | 600 | U | 2400 | U | 12 | U | 12 | U |

= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Not Detected at or above the Method Reporting Limit (MRL)

## Analytical Results for Subsurface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807097-010 | | K9807097-011 | | K9807097-012 | | K9807097-001 | | K9807097-002 | | K9807097-016 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-103 (DUP) | | HC-VC-104 (DUP) | | HC-VC-105 (DUP) | | HC-VC-18-S1 | | HC-VC-18-S2 | | HC-VC-22-S1 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | | 2.0 to 4.0 | | 0 to 2.1 | | 0 to 2.2 | | 2.2 to 4.0 | | 0 to 2.0 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | | | | | 216 | | 75.7 | | 45.2 | | 19.2 | |
| Sulfide, Total | | | 21.7 | J | | | | | 31.4 | J | 2 | J | 6.6 | J |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | | | | | 2.05 | | 0.91 | | 0.29 | | 0.71 | |
| Solids, Total | | | 77.1 | | 74.7 | | 49 | | 68.6 | | 78.3 | | 79.7 | |
| Solids, Total Volatile | | | 1.93 | | 3.19 | | 7.67 | | 4.04 | | 2.14 | | 2.7 | |
| Gravel | | | | | | | | | | | 0 | | | |
| Sand | | | | | | | | | | | 96.8 | | | |
| Silt | | | | | | | | | | | 2.3 | | | |
| Clay | | | | | | | | | | | 0.9 | | | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | | | | | 0.4 | J | | | | | 0.1 | UJ |
| Arsenic, Total | 57 | 700 | | | | | 6 | | | | | | 2 | |
| Cadmium, Total | 5.1 | 14 | | | | | 1.1 | | | | | | 0.1 | |
| Chromium, Total | | | | | | | 25.6 | | | | | | 11.8 | |
| Copper, Total | 390 | 1300 | | | | | 52.4 | | | | | | 17.6 | |
| Lead, Total | 450 | 1200 | | | | | 190 | | | | | | 12.1 | |
| Mercury, Total | 0.41 | 2.3 | | | | | 0.08 | | | | | | 0.02 | |
| Nickel, Total | 140 | 370 | | | | | 24 | | | | | | 17 | |
| Silver, Total | 6.1 | 8.4 | | | | | 0.5 | | | | | | 0.1 | U |
| Zinc, Total | 410 | 3800 | | | | | 267 | | | | | | 55 | |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| 1,3-Dichlorobenzene | 170 | | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Benzene | | | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Ethylbenzene | 10 | 50 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Toluene | | | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Total Xylenes | 40 | 160 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| Trichloroethene (TCE) | 160 | 1600 | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| m- & p-Xylenes | | | 5 | U | | | | | 5 | U | 5 | U | 5 | U |
| o-Xylene | | | 5 | U | | | | | 5 | U | 5 | U | 5 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-010 | | K9807097-011 | | K9807097-012 | | K9807097-001 | | K9807097-002 | | K9807097-016 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-103 (DUP) | | HC-VC-104 (DUP) | | HC-VC-105 (DUP) | | HC-VC-18-S1 | | HC-VC-18-S2 | | HC-VC-22-S1 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | | 2.0 to 4.0 | | 0 to 2.1 | | 0 to 2.2 | | 2.2 to 4.0 | | 0 to 2.0 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | | | | | | | | | | | | |
| Fluoranthene | 1700 | 30000 | | | | | | | | | | | | |
| Lube Oil | | | | | | | | | | | | | | |
| Pencil Pitch | | | | | | | | | 385 | | 166 | | 26 | |
| Phytane | | | | | | | | | | | | | | |
| Pristane | | | | | | | | | | | | | | |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | | | 100 | U | | | 510 | | 200 | U | 30 | |
| Acenaphthylene | 560 | 1300 | | | 100 | U | | | 400 | U | 200 | U | 20 | U |
| Anthracene | 960 | 13000 | | | 100 | U | | | 520 | | 200 | U | 27 | |
| Fluorene | 540 | 3600 | | | 100 | U | | | 400 | U | 200 | U | 20 | U |
| Naphthalene | 2100 | 2400 | | | 100 | U | | | 400 | U | 200 | U | 20 | U |
| Phenanthrene | 1500 | 21000 | | | 280 | | | | 2200 | | 820 | | 150 | |
| Total LPAHs | 5200 | 29000 | | | 530 | | | | 3830 | | 1320 | | 237 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | | | 480 | | | | 4100 | | 1600 | | 250 | |
| Benzo(a)pyrene | 1600 | 3600 | | | 460 | | | | 4800 | | 1900 | | 280 | |
| Benzo(b)fluoranthene | | | | | 470 | | | | 4000 | | 1800 | | 280 | |
| Benzo(g,h,i)perylene | 670 | 3200 | | | 320 | | | | 2600 | | 1300 | | 220 | |
| Benzo(k)fluoranthene | | | | | 410 | | | | 3500 | | 1600 | | 200 | |
| Chrysene | 1400 | 21000 | | | 520 | | | | 4000 | | 1800 | | 240 | |
| Dibenz(a,h)anthracene | 230 | 1900 | | | 100 | U | | | 400 | U | 200 | U | 23 | |
| Fluoranthene | 1700 | 30000 | | | 800 | | | | 5700 | | 2300 | | 370 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | | | 560 | | | | 4400 | | 2200 | | 360 | |
| Pyrene | 2600 | 16000 | | | 680 | | | | 5000 | | 1900 | | 340 | |
| Total HPAHs | 12000 | 69000 | | | 4750 | | | | 38300 | | 16500 | | 2563 | |
| Total Benzofluoranthenes | 3200 | 9900 | | | 880 | | | | 7500 | | 3400 | | 480 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | | | 30 | U | | | 120 | U | 60 | U | 6 | U |
| 2-Methylphenol | 63 | 77 | | | 30 | U | | | 120 | U | 60 | U | 6 | U |
| 4-Methylphenol | 670 | 3600 | | | 100 | U | | | 400 | U | 200 | U | 20 | U |
| Pentachlorophenol (PCP) | 400 | 690 | | | 300 | U | | | 1200 | U | 600 | U | 60 | U |
| Phenol | 420 | 1200 | | | 100 | U | | | 400 | U | 200 | U | 20 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-010 | K9807097-011 | | K9807097-012 | K9807097-001 | | K9807097-002 | | K9807097-016 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-103 (DUP) | HC-VC-104 (DUP) | | HC-VC-105 (DUP) | HC-VC-18-S1 | | HC-VC-18-S2 | | HC-VC-22-S1 | |
| Sampling Date | | | Oct 12,1998 | Oct 12,1998 | | Oct 12,1998 | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 0 to 2.0 | 2.0 to 4.0 | | 0 to 2.1 | 0 to 2.2 | | 2.2 to 4.0 | | 0 to 2.0 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | |
| Di-n-octyl Phthalate | 6200 | | | 100 | U | | 400 | U | 200 | U | 20 | U |
| Diethyl Phthalate | 1200 | | | 100 | U | | 400 | U | 200 | U | 20 | U |
| Dimethyl Phthalate | 1400 | | | 100 | U | | 400 | U | 200 | U | 20 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | | 500 | U | | 2000 | U | 1000 | U | 100 | U |
| Benzyl Alcohol | 57 | 870 | | 30 | U | | 120 | U | 60 | U | 6 | U |
| Dibenzofuran | 540 | 1700 | | 100 | U | | 400 | U | 200 | U | 20 | U |
| Hexachlorobenzene | 22 | 230 | | 100 | U | | 400 | U | 200 | U | 20 | U |
| Hexachlorobutadiene | 29 | 290 | | 100 | U | | 400 | U | 200 | U | 20 | U |
| N-Nitrosodiphenylamine | 28 | 130 | | 60 | U | | 240 | U | 120 | U | 12 | U |

= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Not Detected at or above the Method Reporting Limit (MRL)

## Analytical Results for Subsurface Sediment Samples
## Port of Portland, Terminal 4 - Slip 3 Sediment Characterization
## Portland, Oregon

| Lab ID | | | K9807097-017 | | K9807097-019 | | K9807097-020 | | K9807097-022 | | K9807097-023 | | K9807097-025 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-22-S2 | | HC-VC-27-S1 | | HC-VC-27-S2 | | HC-VC-32-S1 | | HC-VC-32-S2 | | HC-VC-39-S1 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 1.9 | | 1.9 to 3.5 | | 0 to 1.8 | | 1.8 to 4.0 | | 0 to 2.0 | |
| **Conventionals in mg/kg** | | | | | | | | | | | | | | |
| Ammonia as Nitrogen | | | 15.7 | | 185 | | 150 | | 107 | | 1.4 | | 194 | |
| Sulfide, Total | | | 2 | J | 33.5 | J | 50.2 | J | | | | | | |
| **Conventionals in %** | | | | | | | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 0.03 | | 1.67 | | 1.67 | | 1.98 | | 0.04 | | 1.91 | |
| Solids, Total | | | 77.8 | | 55.5 | | 63.7 | | 57.4 | | 81.4 | | 49.1 | |
| Solids, Total Volatile | | | 1.73 | | 7.35 | | 5.02 | | 7.41 | | 1.8 | | 7.87 | |
| Gravel | | | | | | | | | | | 0 | | | |
| Sand | | | | | | | | | | | 96.5 | | | |
| Silt | | | | | | | | | | | 2.6 | | | |
| Clay | | | | | | | | | | | 0.9 | | | |
| **Metals in mg/kg** | | | | | | | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.1 | UJ | 0.3 | J | 0.2 | J | | | | | 0.1 | UJ |
| Arsenic, Total | 57 | 700 | 2 | | 5 | | 5 | | | | | | 3 | |
| Cadmium, Total | 5.1 | 14 | 0.1 | U | 0.8 | | 1.1 | | | | | | 0.2 | |
| Chromium, Total | | | 9.6 | | 22.1 | | 18.5 | | | | | | 23.8 | |
| Copper, Total | 390 | 1300 | 13.4 | | 47.8 | | 43 | | | | | | 38.4 | |
| Lead, Total | 450 | 1200 | 3 | | 116 | | 144 | | | | | | 19.3 | |
| Mercury, Total | 0.41 | 2.3 | 0.02 | U | 0.08 | | 0.08 | | | | | | 0.08 | |
| Nickel, Total | 140 | 370 | 16 | | 22 | | 22 | | | | | | 22 | |
| Silver, Total | 6.1 | 8.4 | 0.1 | U | 0.4 | | 0.4 | | | | | | 0.4 | |
| Zinc, Total | 410 | 3800 | 37 | | 193 | | 245 | | | | | | 89 | |
| **Volatiles in µg/kg** | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| 1,3-Dichlorobenzene | 170 | | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Benzene | | | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Ethylbenzene | 10 | 50 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Toluene | | | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Total Xylenes | 40 | 160 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| Trichloroethene (TCE) | 160 | 1600 | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| m- & p-Xylenes | | | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |
| o-Xylene | | | 5 | U | 5 | U | 5 | U | 5 | U | 5 | U | 10 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-017 | | K9807097-019 | | K9807097-020 | | K9807097-022 | | K9807097-023 | | K9807097-025 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-22-S2 | | HC-VC-27-S1 | | HC-VC-27-S2 | | HC-VC-32-S1 | | HC-VC-32-S2 | | HC-VC-39-S1 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 1.9 | | 1.9 to 3.5 | | 0 to 1.8 | | 1.8 to 4.0 | | 0 to 2.0 | |
| **TPH in mg/kg** | | | | | | | | | | | | | | |
| Diesel | | | | | | | | | | | | | | |
| Fluoranthene | 1700 | 30000 | | | | | | | | | | | | |
| Lube Oil | | | | | | | | | | | | | | |
| Pencil Pitch | | | | | 385 | | 422 | | 48 | | | | 80 | |
| Phytane | | | | | | | | | | | | | | |
| Pristane | | | | | | | | | | | | | | |
| **LPAHs in µg/kg** | | | | | | | | | | | | | | |
| Acenaphthene | 500 | 2000 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Acenaphthylene | 560 | 1300 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Anthracene | 960 | 13000 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Fluorene | 540 | 3600 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Naphthalene | 2100 | 2400 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Phenanthrene | 1500 | 21000 | 20 | U | 2200 | | 2400 | | 280 | | 20 | U | 620 | |
| Total LPAHs | 5200 | 29000 | 60 | | 4700 | | 4900 | | 530 | | 60 | | 870 | |
| **HPAHs in µg/kg** | | | | | | | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 20 | U | 3900 | | 4400 | | 500 | | 20 | U | 790 | |
| Benzo(a)pyrene | 1600 | 3600 | 20 | U | 4300 | | 4800 | | 510 | | 20 | U | 830 | |
| Benzo(b)fluoranthene | | | 20 | U | 3800 | | 3800 | | 470 | | 20 | U | 960 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 20 | U | 3000 | | 3300 | | 380 | | 20 | U | 590 | |
| Benzo(k)fluoranthene | | | 20 | U | 3300 | | 3500 | | 340 | | 20 | U | 560 | |
| Chrysene | 1400 | 21000 | 20 | U | 3800 | | 4200 | | 470 | | 20 | U | 830 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Fluoranthene | 1700 | 30000 | 20 | U | 5500 | | 6200 | | 710 | | 20 | U | 1300 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 20 | U | 5500 | | 6000 | | 690 | | 20 | U | 1100 | |
| Pyrene | 2600 | 16000 | 20 | U | 5000 | | 5600 | | 650 | | 20 | U | 1000 | |
| Total HPAHs | 12000 | 69000 | 100 | | 38600 | | 42300 | | 4770 | | 100 | | 8010 | |
| Total Benzofluoranthenes | 3200 | 9900 | 20 | U | 7100 | | 7300 | | 810 | | 20 | U | 1520 | |
| **Phenols in µg/kg** | | | | | | | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 6 | U | 300 | U | 300 | U | 30 | U | 6 | U | 30 | U |
| 2-Methylphenol | 63 | 77 | 6 | U | 300 | U | 300 | U | 30 | U | 6 | U | 30 | U |
| 4-Methylphenol | 670 | 3600 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 60 | U | 3000 | U | 3000 | U | 300 | U | 60 | U | 300 | U |
| Phenol | 420 | 1200 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-017 | | K9807097-019 | | K9807097-020 | | K9807097-022 | | K9807097-023 | | K9807097-025 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-22-S2 | | HC-VC-27-S1 | | HC-VC-27-S2 | | HC-VC-32-S1 | | HC-VC-32-S2 | | HC-VC-39-S1 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 1.9 | | 1.9 to 3.5 | | 0 to 1.8 | | 1.8 to 4.0 | | 0 to 2.0 | |
| **Phthalates in µg/kg** | | | | | | | | | | | | | | |
| Di-n-octyl Phthalate | 6200 | | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Diethyl Phthalate | 1200 | | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Dimethyl Phthalate | 1400 | | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| **Semivolatiles in µg/kg** | | | | | | | | | | | | | | |
| Benzoic Acid | 650 | 760 | 100 | U | 5000 | U | 5000 | U | 500 | U | 100 | U | 500 | U |
| Benzyl Alcohol | 57 | 870 | 6 | U | 300 | U | 300 | U | 30 | U | 6 | U | 30 | U |
| Dibenzofuran | 540 | 1700 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Hexachlorobenzene | 22 | 230 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| Hexachlorobutadiene | 29 | 290 | 20 | U | 1000 | U | 1000 | U | 100 | U | 20 | U | 100 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 12 | U | 600 | U | 600 | U | 60 | U | 12 | U | 60 | U |

= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Not Detected at or above the Method Reporting Limit (MRL)

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-026 | | K9807097-028 | | K9807097-029 | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-39-S2 | | HC-VC-42-S1 | | HC-VC-42-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **Conventionals in mg/kg** | | | | | | | | |
| Ammonia as Nitrogen | | | 327 | | 120 | | 216 | |
| Sulfide, Total | | | | | | | | |
| **Conventionals in %** | | | | | | | | |
| Carbon, Total Organic (TOC) | | | 2.39 | | 2.11 | | 2.95 | |
| Solids, Total | | | 52.2 | | 49.5 | | 53.3 | |
| Solids, Total Volatile | | | 7.95 | | 7.65 | | 8.7 | |
| Gravel | | | | | | | | |
| Sand | | | | | | | | |
| Silt | | | | | | | | |
| Clay | | | | | | | | |
| **Metals in mg/kg** | | | | | | | | |
| Antimony, Total | 150 | 200 | 0.1 | UJ | 0.1 | UJ | 0.2 | J |
| Arsenic, Total | 57 | 700 | 4 | | 4 | | 5 | |
| Cadmium, Total | 5.1 | 14 | 0.2 | | 0.2 | | 0.7 | |
| Chromium, Total | | | 27.4 | | 25.5 | | 29.4 | |
| Copper, Total | 390 | 1300 | 44.4 | | 40.4 | | 54.6 | |
| Lead, Total | 450 | 1200 | 27.6 | | 23.9 | | 79.1 | |
| Mercury, Total | 0.41 | 2.3 | 0.08 | | 0.07 | | 0.13 | |
| Nickel, Total | 140 | 370 | 24 | | 23 | | 23 | |
| Silver, Total | 6.1 | 8.4 | 0.4 | | 0.2 | | 0.4 | |
| Zinc, Total | 410 | 3800 | 109 | | 100 | | 207 | |
| **Volatiles in µg/kg** | | | | | | | | |
| 1,2-Dichlorobenzene | 35 | 110 | 5 | U | 10 | U | 5 | U |
| 1,3-Dichlorobenzene | 170 | | 5 | U | 10 | U | 5 | U |
| 1,4-Dichlorobenzene | 110 | 120 | 5 | U | 10 | U | 5 | U |
| Benzene | | | 5 | U | 10 | U | 5 | U |
| Ethylbenzene | 10 | 50 | 5 | U | 10 | U | 5 | U |
| Tetrachloroethene (PCE) | 57 | 210 | 5 | U | 10 | U | 5 | U |
| Toluene | | | 5 | U | 10 | U | 5 | U |
| Total Xylenes | 40 | 160 | 5 | U | 10 | U | 5 | U |
| Trichloroethene (TCE) | 160 | 1600 | 5 | U | 10 | U | 5 | U |
| m- & p-Xylenes | | | 5 | U | 10 | U | 5 | U |
| o-Xylene | | | 5 | U | 10 | U | 5 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

| Lab ID | | | K9807097-026 | | K9807097-028 | | K9807097-029 | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-39-S2 | | HC-VC-42-S1 | | HC-VC-42-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **TPH in mg/kg** | | | | | | | | |
| Diesel | | | | | | | | |
| Fluoranthene | 1700 | 30000 | | | | | | |
| Lube Oil | | | | | | | | |
| Pencil Pitch | | | 54 | | 906 | | 2000 | |
| Phytane | | | | | | | | |
| Pristane | | | | | | | | |
| **LPAHs in µg/kg** | | | | | | | | |
| Acenaphthene | 500 | 2000 | 100 | U | 4000 | U | 4000 | U |
| Acenaphthylene | 560 | 1300 | 100 | U | 4000 | U | 4000 | U |
| Anthracene | 960 | 13000 | 100 | U | 4000 | U | 4000 | U |
| Fluorene | 540 | 3600 | 100 | U | 4000 | U | 4000 | U |
| Naphthalene | 2100 | 2400 | 100 | U | 4000 | U | 4000 | U |
| Phenanthrene | 1500 | 21000 | 370 | | 4500 | | 10000 | |
| Total LPAHs | 5200 | 29000 | 620 | | 14500 | | 20000 | |
| **HPAHs in µg/kg** | | | | | | | | |
| Benz(a)anthracene | 1300 | 5100 | 530 | | 9400 | | 20000 | |
| Benzo(a)pyrene | 1600 | 3600 | 540 | | 11000 | | 24000 | |
| Benzo(b)fluoranthene | | | 600 | | 9900 | | 21000 | |
| Benzo(g,h,i)perylene | 670 | 3200 | 370 | | 7300 | | 16000 | |
| Benzo(k)fluoranthene | | | 350 | | 7200 | | 15000 | |
| Chrysene | 1400 | 21000 | 550 | | 8900 | | 19000 | |
| Dibenz(a,h)anthracene | 230 | 1900 | 100 | U | 4000 | U | 4000 | U |
| Fluoranthene | 1700 | 30000 | 910 | | 11000 | | 27000 | |
| Indeno(1,2,3-cd)pyrene | 600 | 4400 | 730 | | 15000 | | 32000 | |
| Pyrene | 2600 | 16000 | 750 | | 10000 | | 24000 | |
| Total HPAHs | 12000 | 69000 | 5380 | | 91700 | | 200000 | |
| Total Benzofluoranthenes | 3200 | 9900 | 950 | | 17100 | | 36000 | |
| **Phenols in µg/kg** | | | | | | | | |
| 2,4-Dimethylphenol | 29 | 210 | 30 | U | 1200 | U | 1200 | U |
| 2-Methylphenol | 63 | 77 | 30 | U | 1200 | U | 1200 | U |
| 4-Methylphenol | 670 | 3600 | 100 | U | 4000 | U | 4000 | U |
| Pentachlorophenol (PCP) | 400 | 690 | 300 | U | 12000 | U | 12000 | U |
| Phenol | 420 | 1200 | 100 | U | 4000 | U | 4000 | U |

**Analytical Results for Subsurface Sediment Samples**
**Port of Portland, Terminal 4 - Slip 3 Sediment Characterization**
**Portland, Oregon**

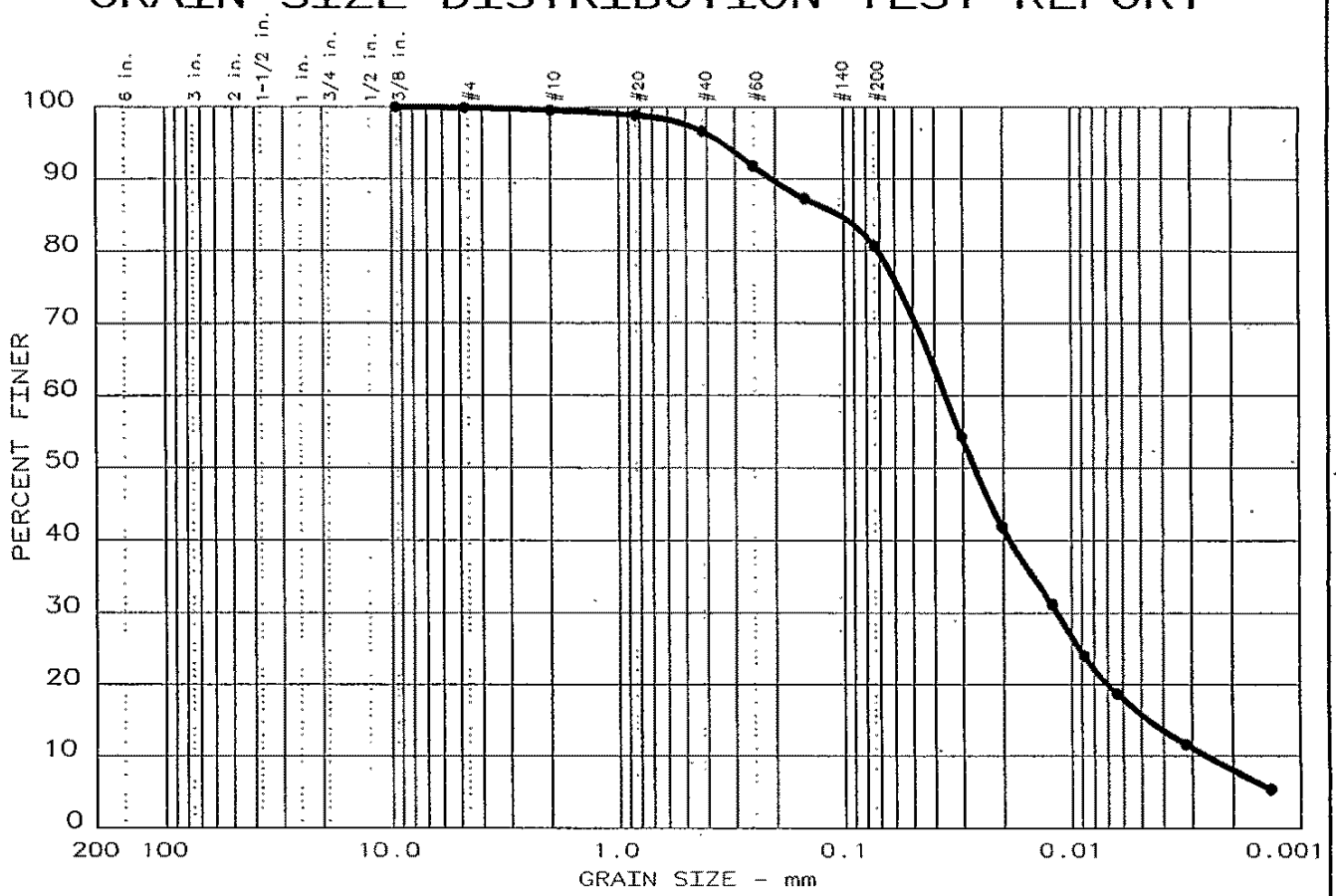
| Lab ID | | | K9807097-026 | | K9807097-028 | | K9807097-029 | |
|---|---|---|---|---|---|---|---|---|
| Sample ID | | | HC-VC-39-S2 | | HC-VC-42-S1 | | HC-VC-42-S2 | |
| Sampling Date | | | Oct 12,1998 | | Oct 12,1998 | | Oct 12,1998 | |
| Depth in Feet | SL | ML | 2.0 to 4.0 | | 0 to 2.0 | | 2.0 to 4.0 | |
| **Phthalates in µg/kg** | | | | | | | | |
| Di-n-octyl Phthalate | 6200 | | 100 | U | 4000 | U | 4000 | U |
| Diethyl Phthalate | 1200 | | 100 | U | 4000 | U | 4000 | U |
| Dimethyl Phthalate | 1400 | | 100 | U | 4000 | U | 4000 | U |
| **Semivolatiles in µg/kg** | | | | | | | | |
| Benzoic Acid | 650 | 760 | 500 | U | 20000 | U | 20000 | U |
| Benzyl Alcohol | 57 | 870 | 30 | U | 1200 | U | 1200 | U |
| Dibenzofuran | 540 | 1700 | 100 | U | 4000 | U | 4000 | U |
| Hexachlorobenzene | 22 | 230 | 100 | U | 4000 | U | 4000 | U |
| Hexachlorobutadiene | 29 | 290 | 100 | U | 4000 | U | 4000 | U |
| N-Nitrosodiphenylamine | 28 | 130 | 60 | U | 2400 | U | 2400 | U |

= Indicates Exceedence of Screening Level (SL)
= Indicates Exceedence of Maximum Level (ML)
DUP = Duplicate
U = Not Detected at or above the Method Reporting Limit (MRL)

Appendix D

# APPENDIX D
# SEDIMENT GRAIN SIZE DATA

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.1 | 19.1 | 65.0 | 15.8 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.10 | | 0.03 | 0.012 | 0.0046 | 0.0026 | 1.42 | 13.7 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-01

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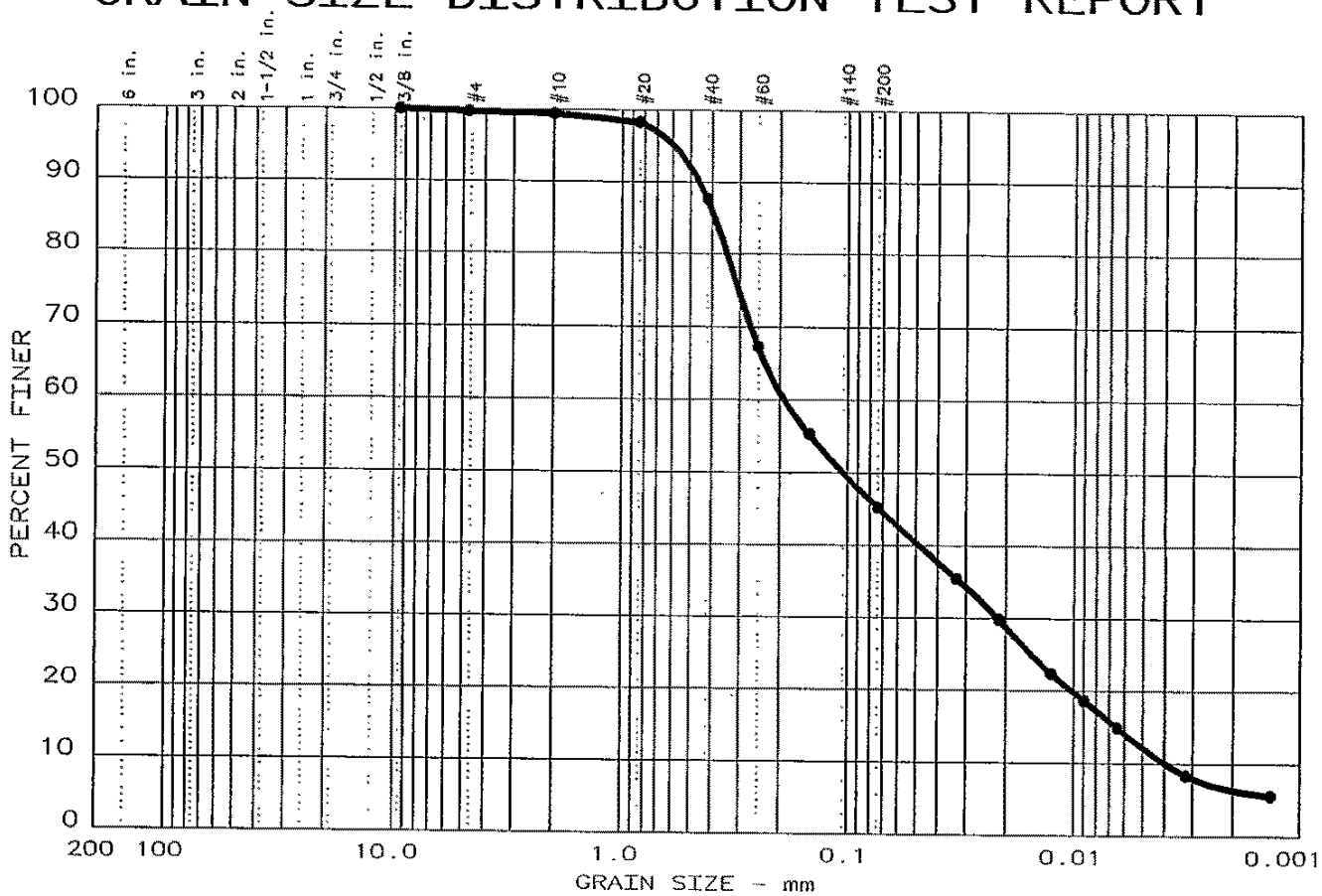
J-5624-10 1/29/99

Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.3 | 54.5 | 33.1 | 12.1 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.39 | 0.19 | 0.10 | 0.022 | 0.0065 | 0.0040 | 0.62 | 47.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-02

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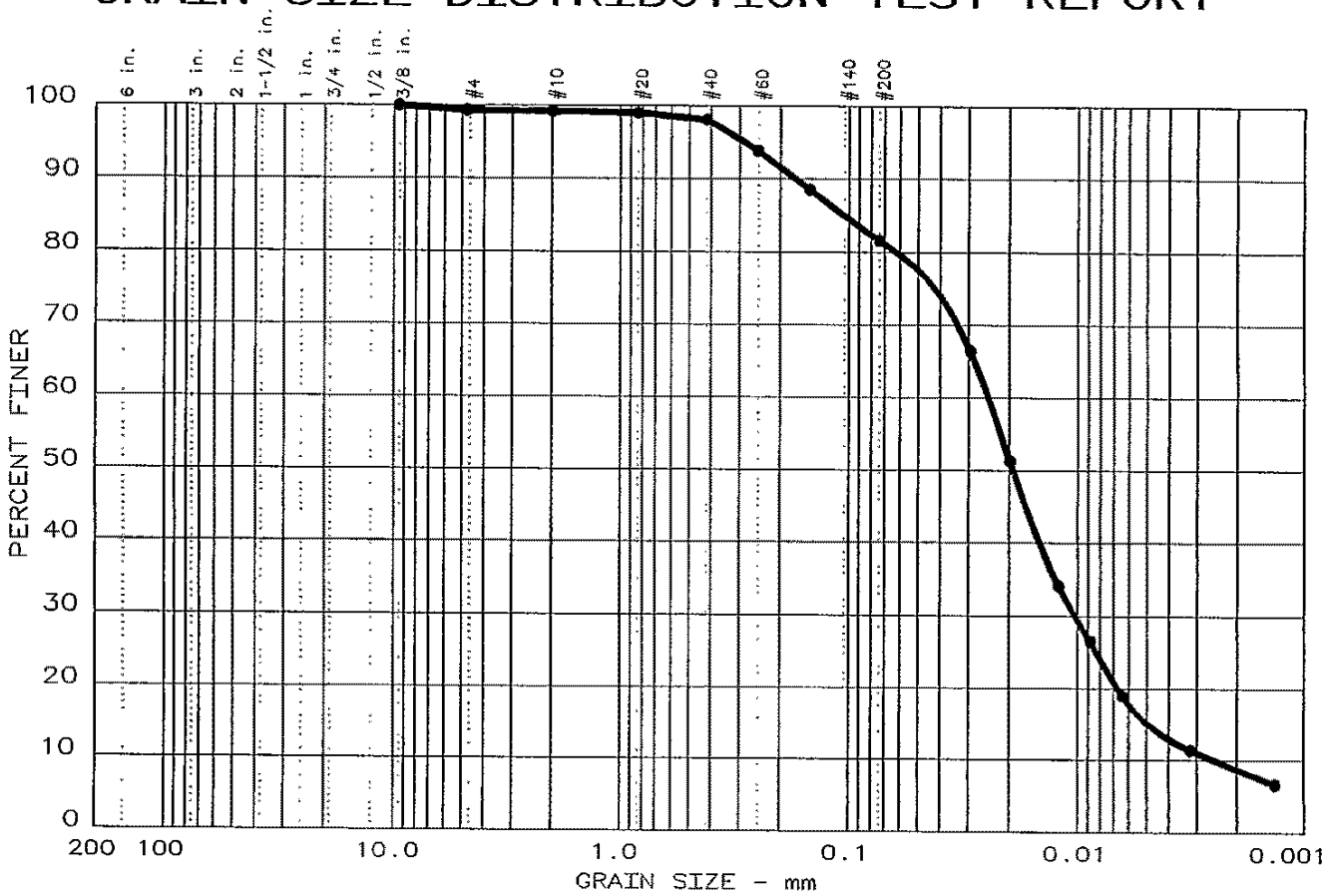
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.7 | 17.7 | 66.6 | 15.0 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.10 | | 0.02 | 0.010 | 0.0049 | 0.0025 | 1.69 | 9.8 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-04

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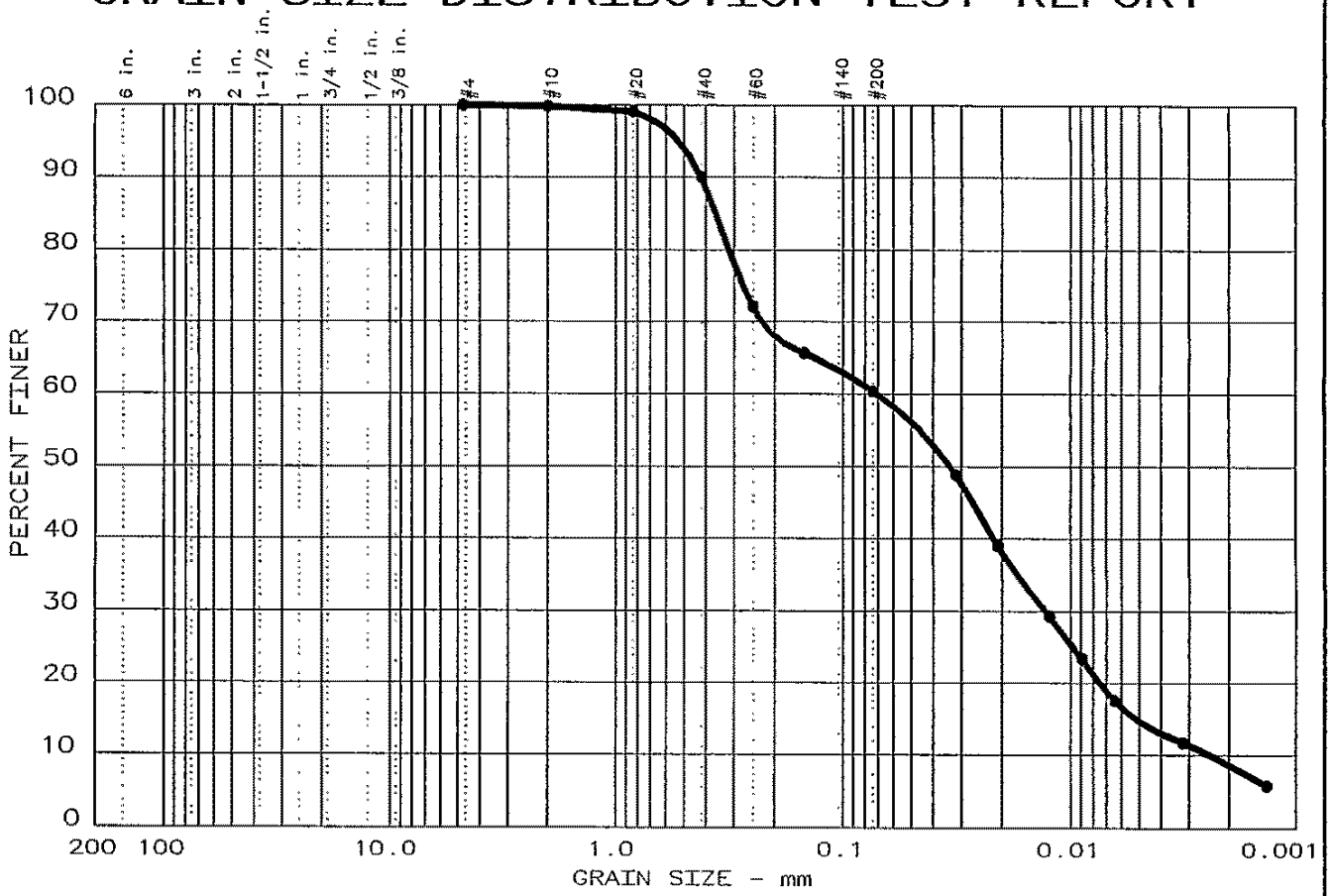
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 39.6 | 45.8 | 14.6 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.36 | | 0.03 | 0.013 | 0.0051 | 0.0024 | 0.97 | 29.2 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-05

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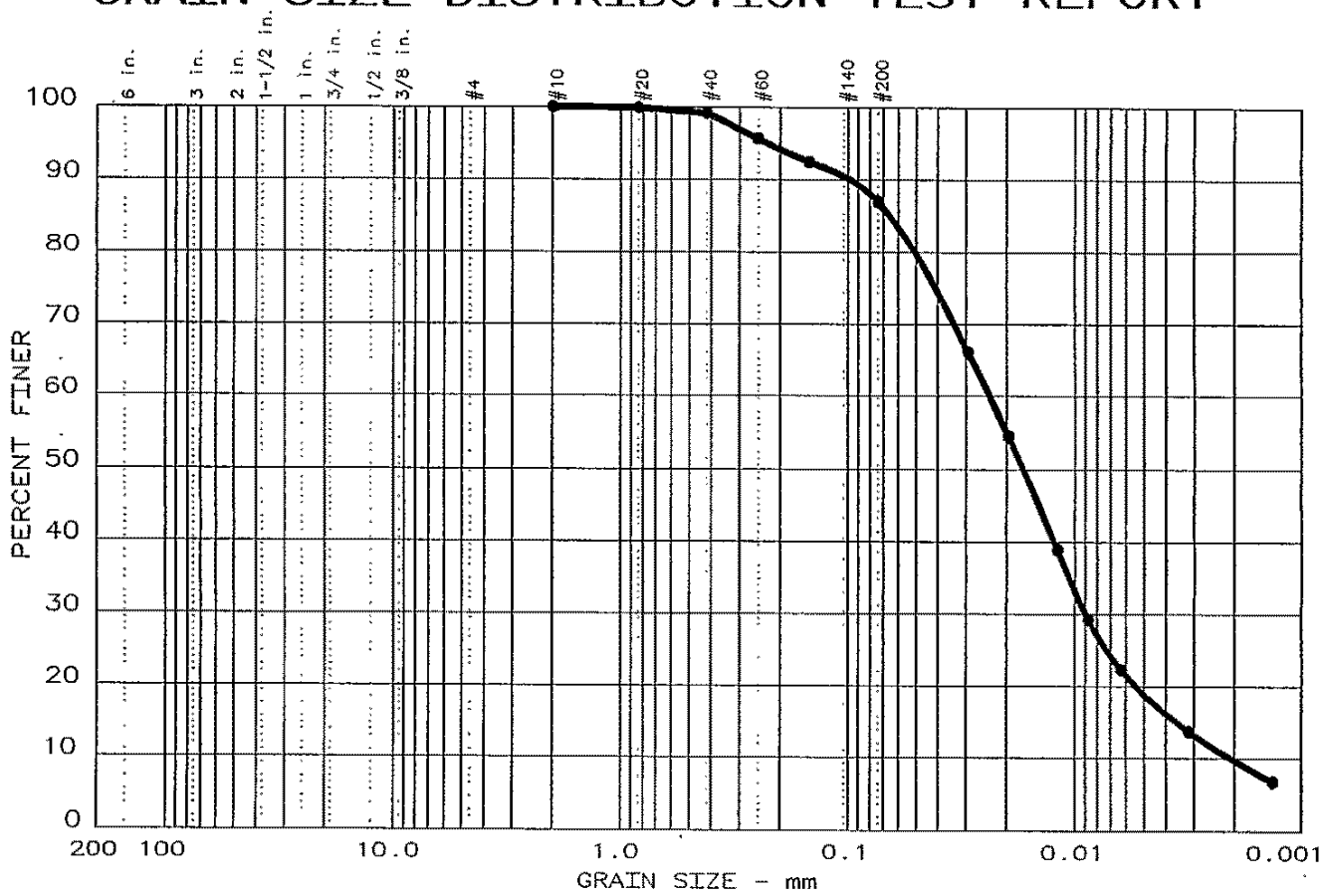
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 12.9 | 68.3 | 18.8 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.02 | 0.009 | 0.0036 | 0.0021 | 1.64 | 11.4 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-07

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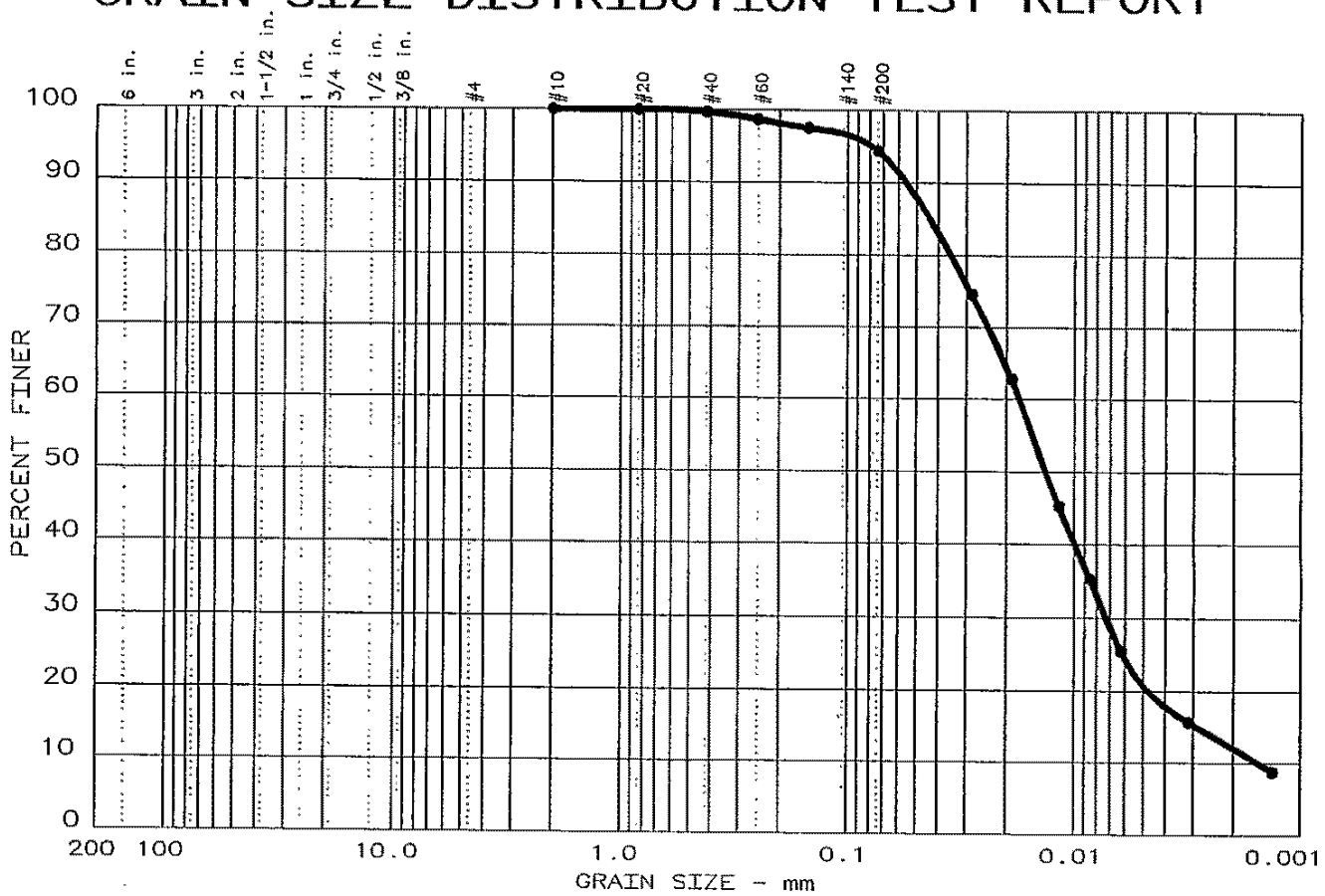
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 5.6 | 73.7 | 20.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.01 | 0.007 | 0.0029 | 0.0016 | 1.94 | 11.3 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-08

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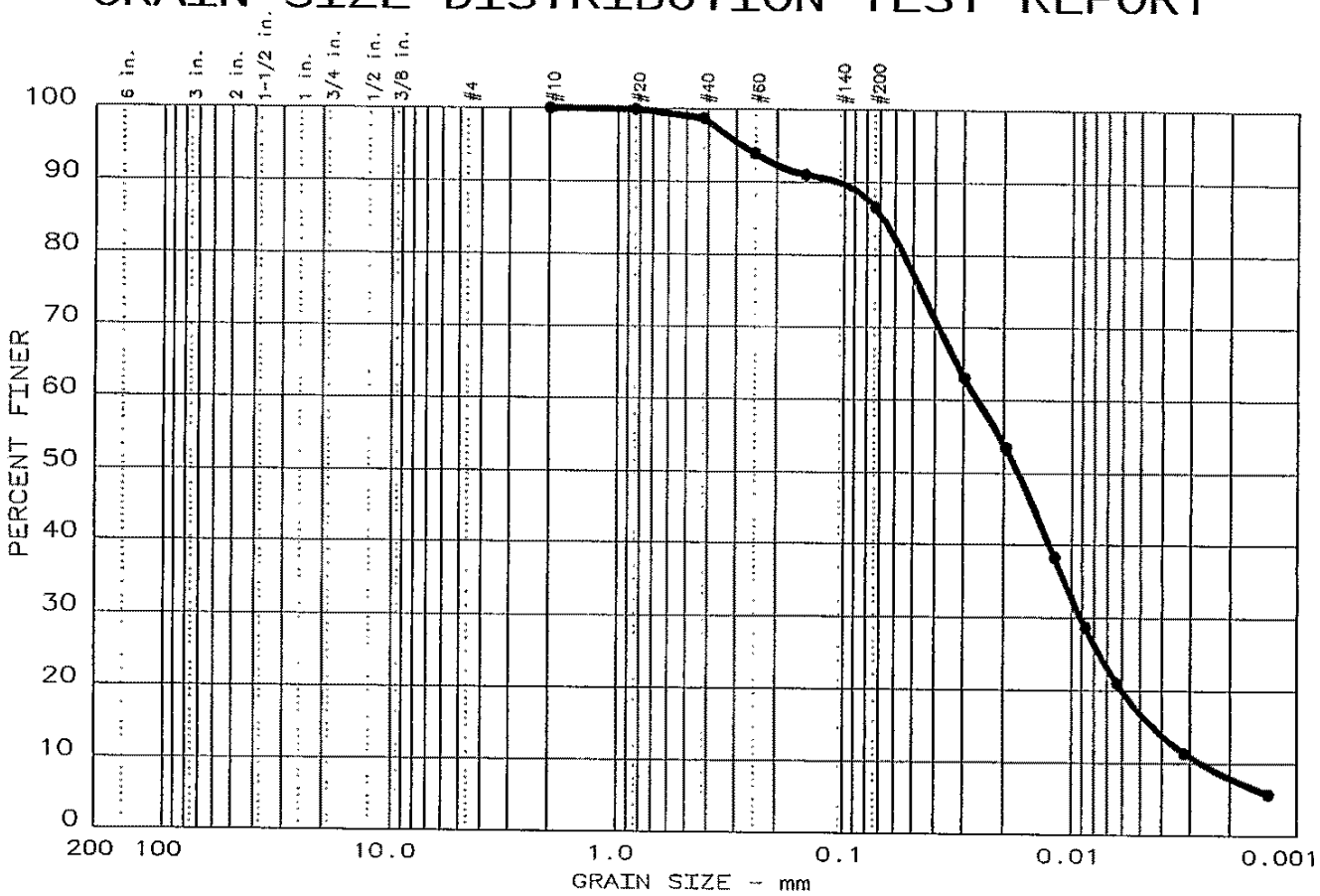
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 13.4 | 69.8 | 16.8 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.02 | 0.009 | 0.0044 | 0.0027 | 1.19 | 9.7 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-11

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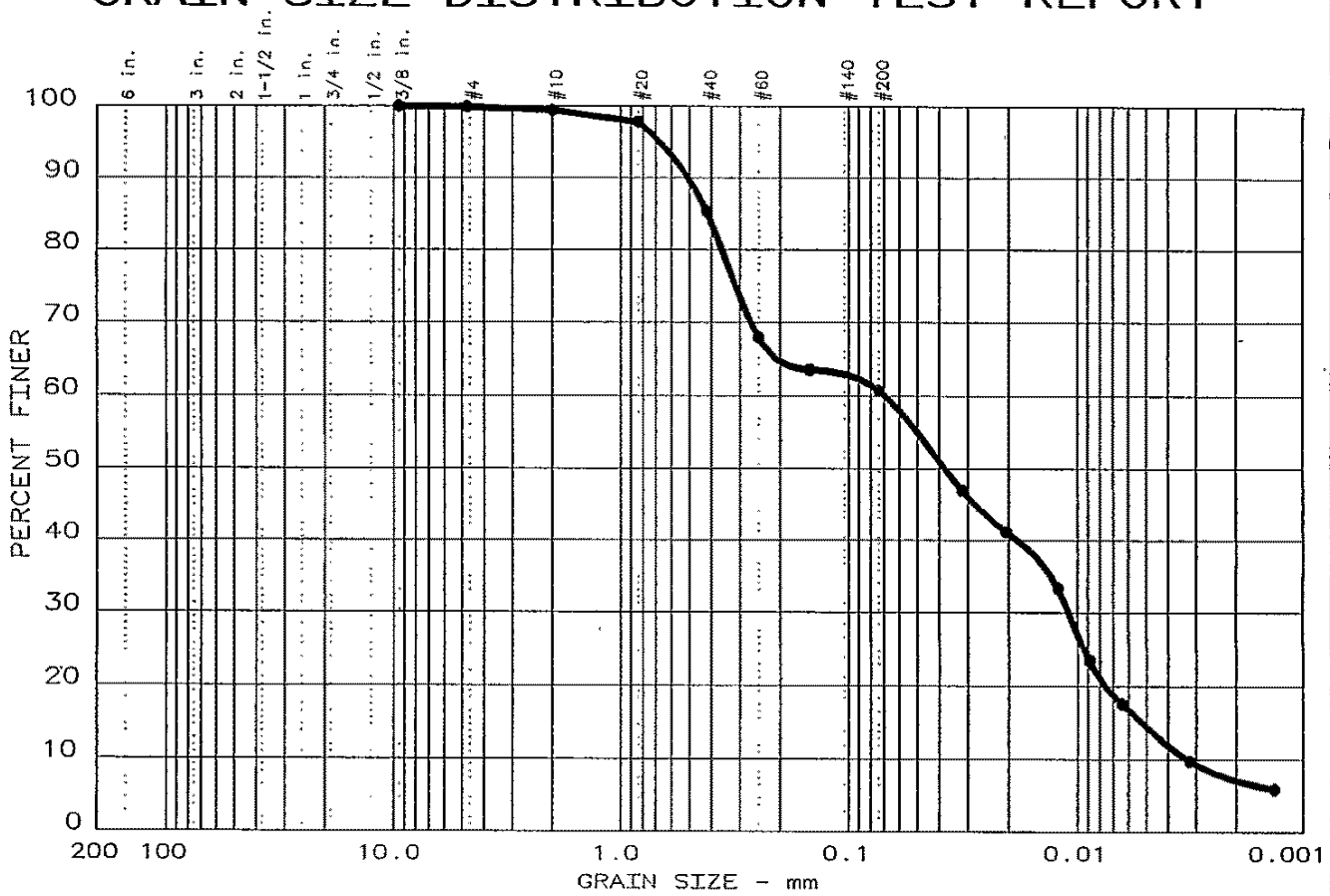
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.1 | 39.1 | 46.4 | 14.4 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.42 | | 0.04 | 0.011 | 0.0052 | 0.0033 | 0.54 | 20.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-13

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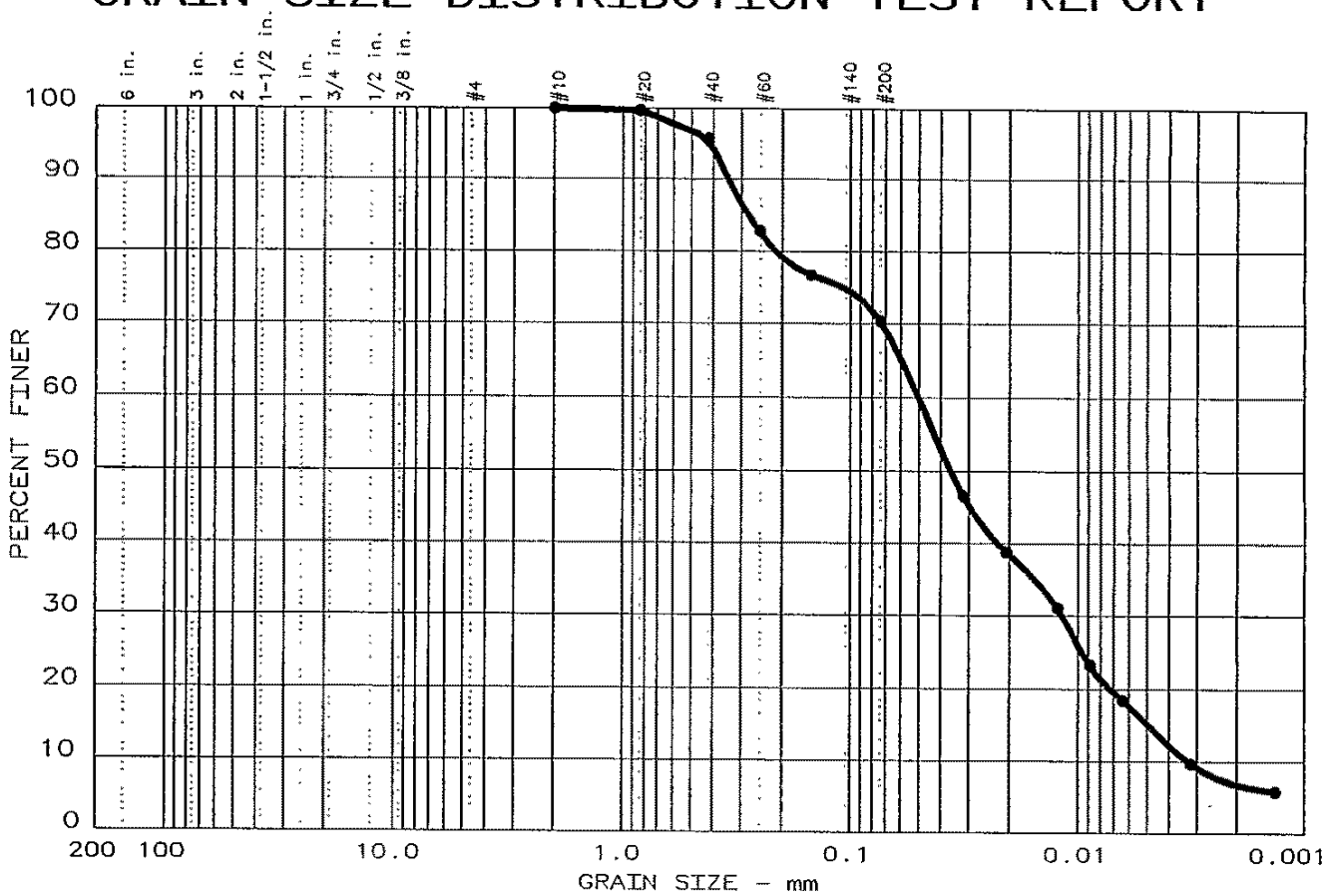
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 29.6 | 55.3 | 15.1 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.28 | | 0.04 | 0.012 | 0.0049 | 0.0033 | 0.83 | 15.2 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-16

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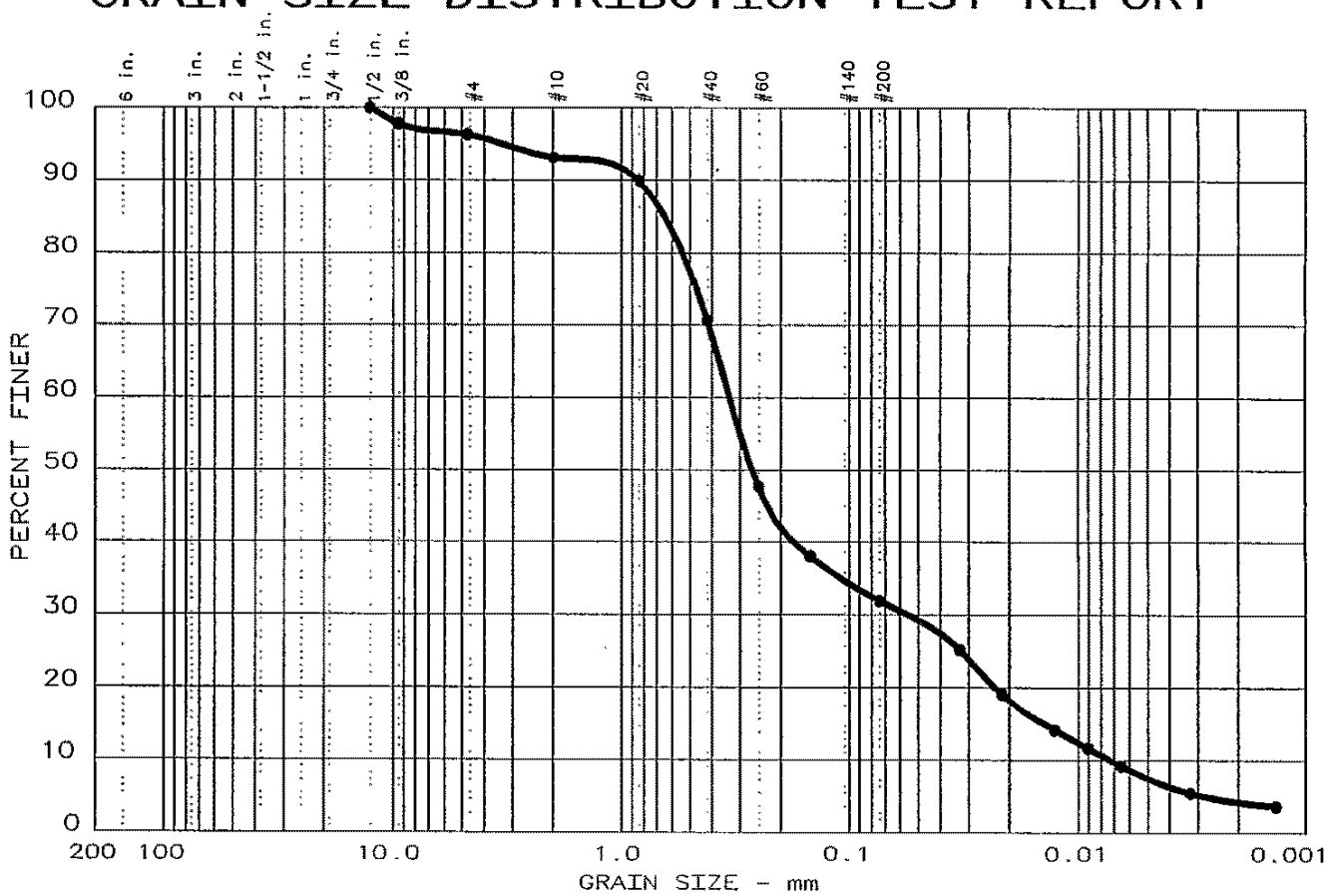
J-5624-06 11/11/98

Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 3.7 | 64.4 | 24.4 | 7.5 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.64 | 0.33 | 0.27 | 0.055 | 0.0142 | 0.0072 | 1.27 | 46.5 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly clayey, silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-19

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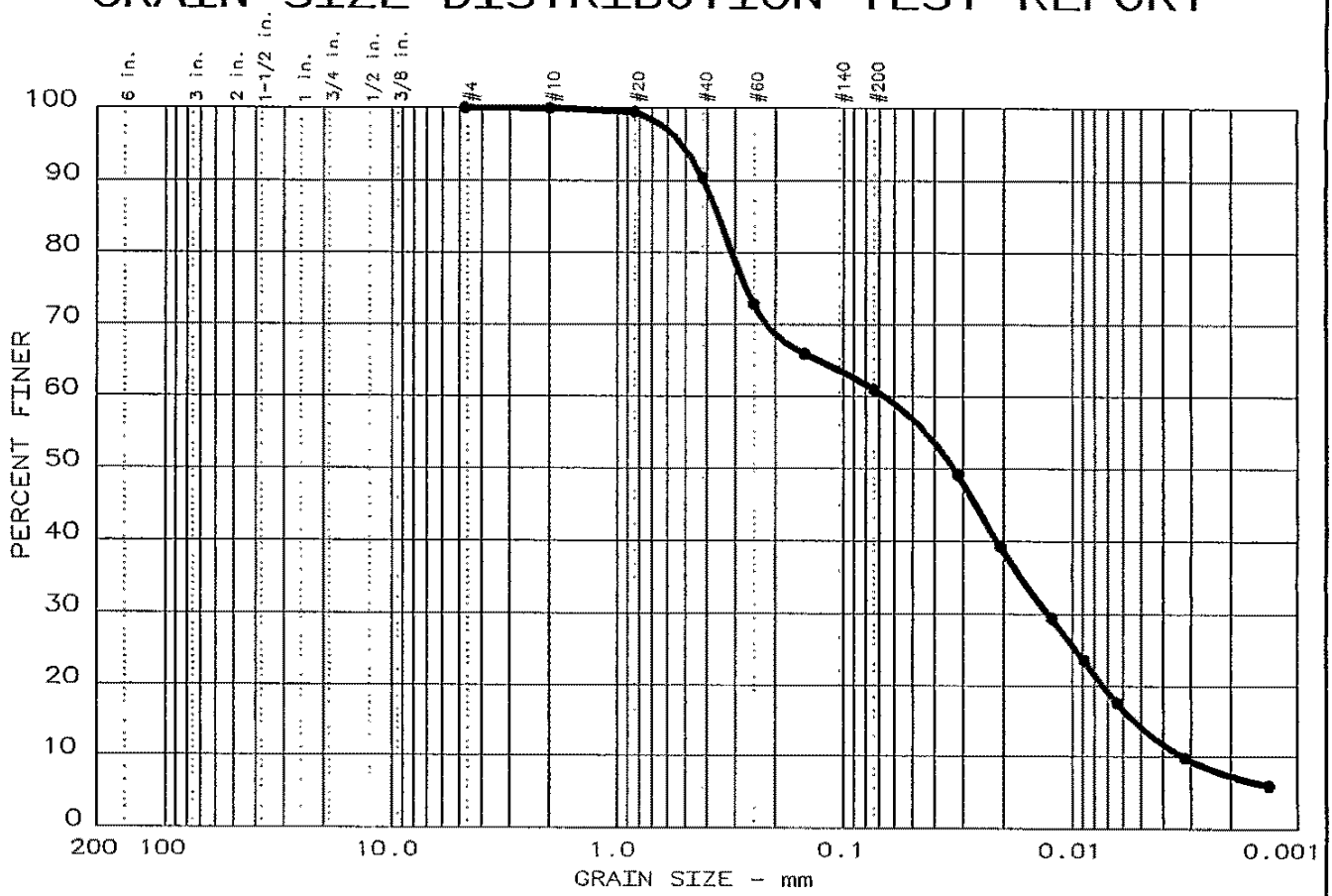
J-5624-06 11/11/98

Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 39.0 | 46.9 | 14.1 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.35 | | 0.03 | 0.013 | 0.0053 | 0.0033 | 0.76 | 20.0 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-22

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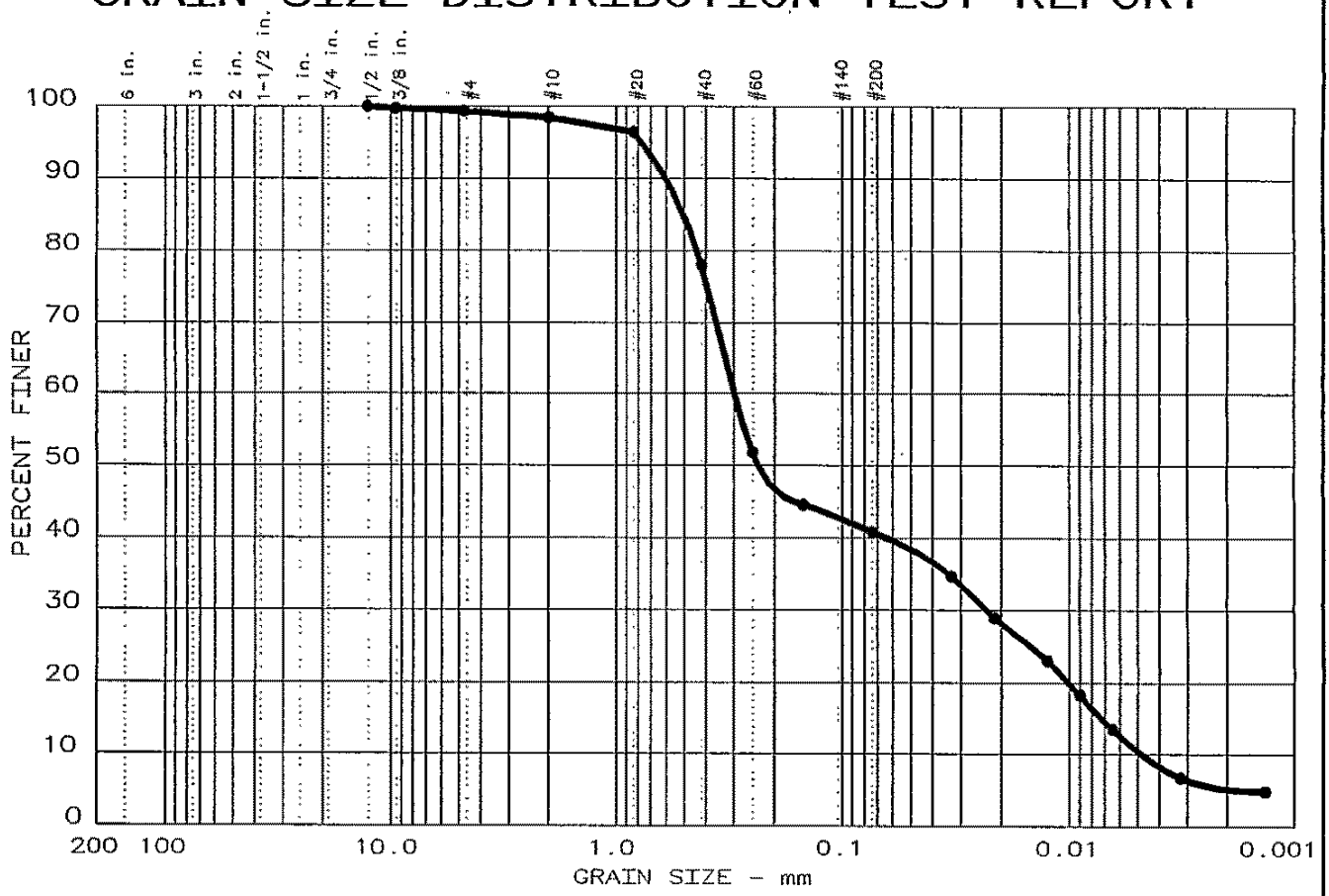
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.7 | 58.5 | 30.4 | 10.4 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.50 | 0.30 | 0.24 | 0.023 | 0.0072 | 0.0048 | 0.38 | 62.4 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly clayey, silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-24

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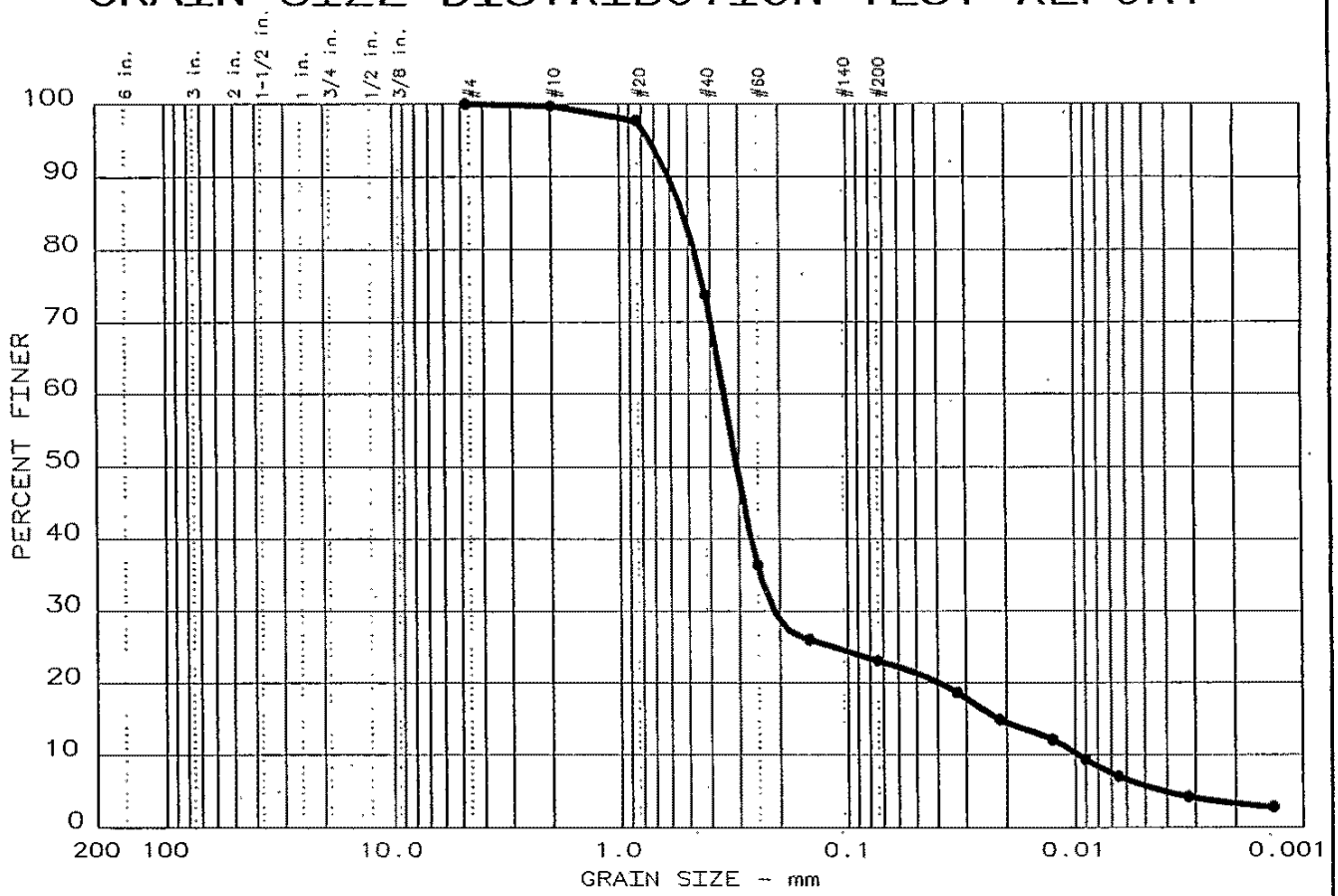
J-5624-06 11/11/98

Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 76.9 | 17.4 | 5.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.52 | 0.35 | 0.31 | 0.210 | 0.0215 | 0.0097 | 13.03 | 35.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly clayey, silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-26

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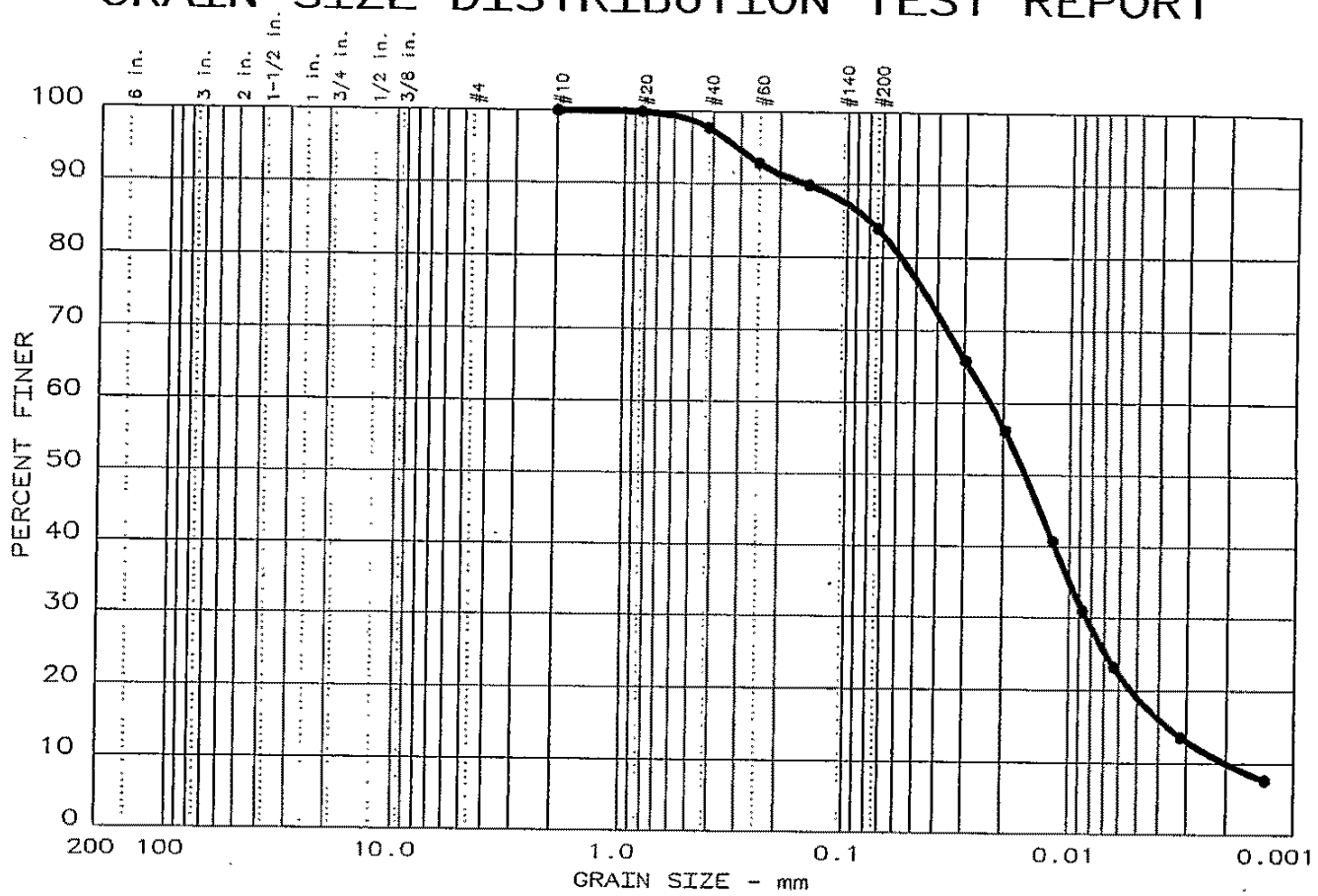
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 16.0 | 65.0 | 19.0 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.08 | | 0.02 | 0.008 | 0.0037 | 0.0020 | 1.56 | 11.4 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-28

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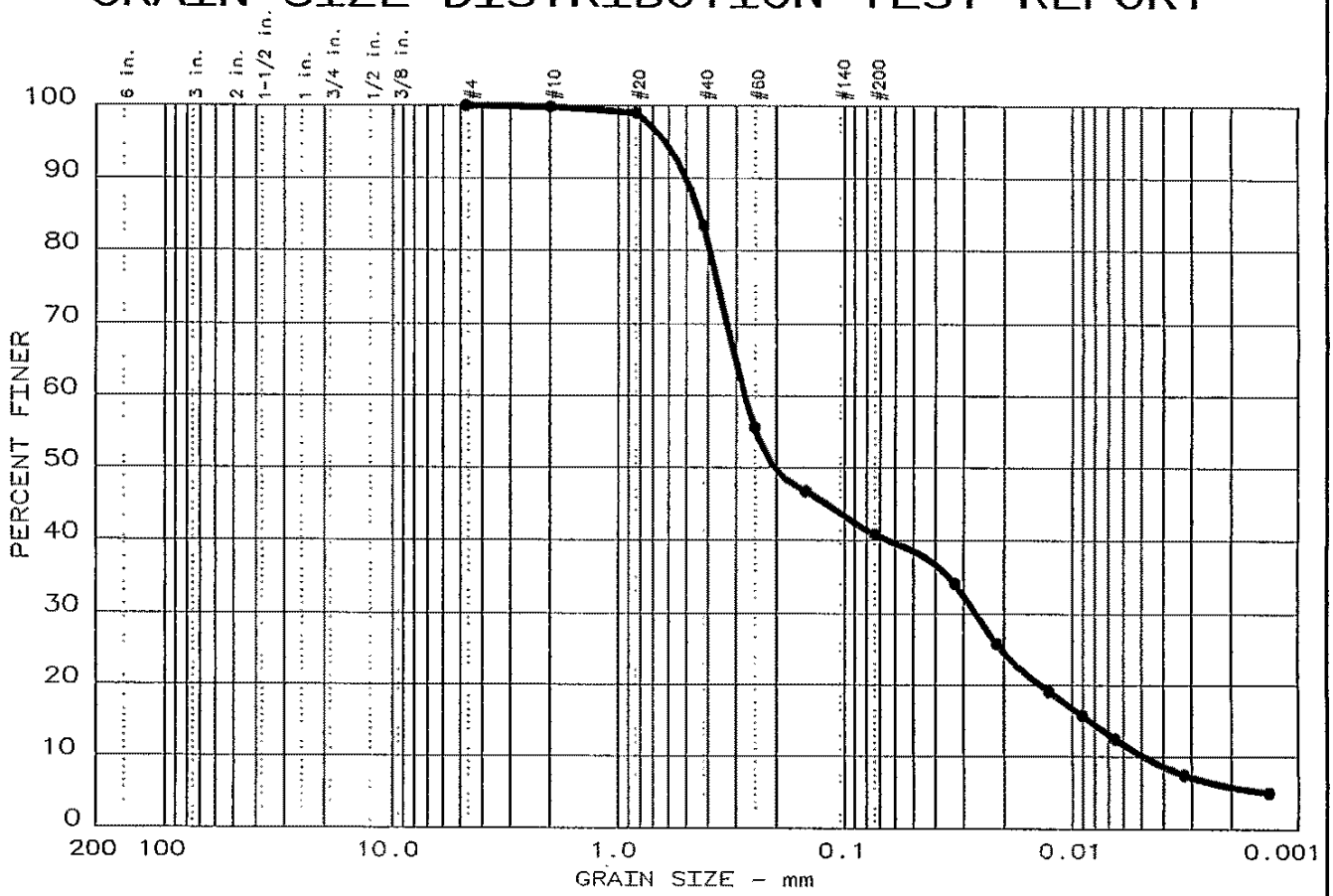
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 59.2 | 30.6 | 10.2 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.44 | 0.27 | 0.20 | 0.027 | 0.0084 | 0.0048 | 0.53 | 56.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly clayey, very silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-30

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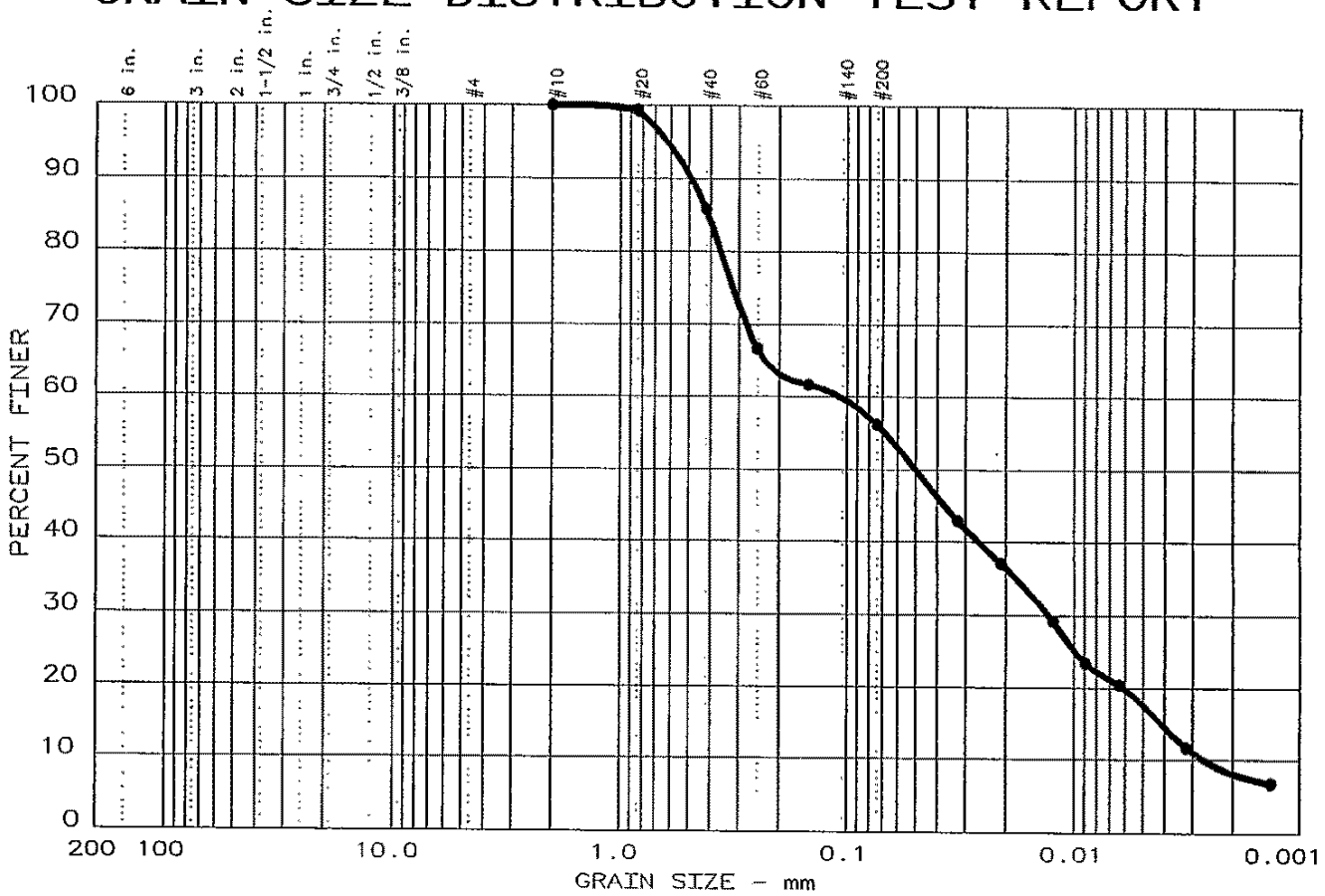
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 43.8 | 38.6 | 17.6 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.41 | 0.11 | 0.05 | 0.013 | 0.0041 | 0.0027 | 0.59 | 39.8 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very silty SAND | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-32

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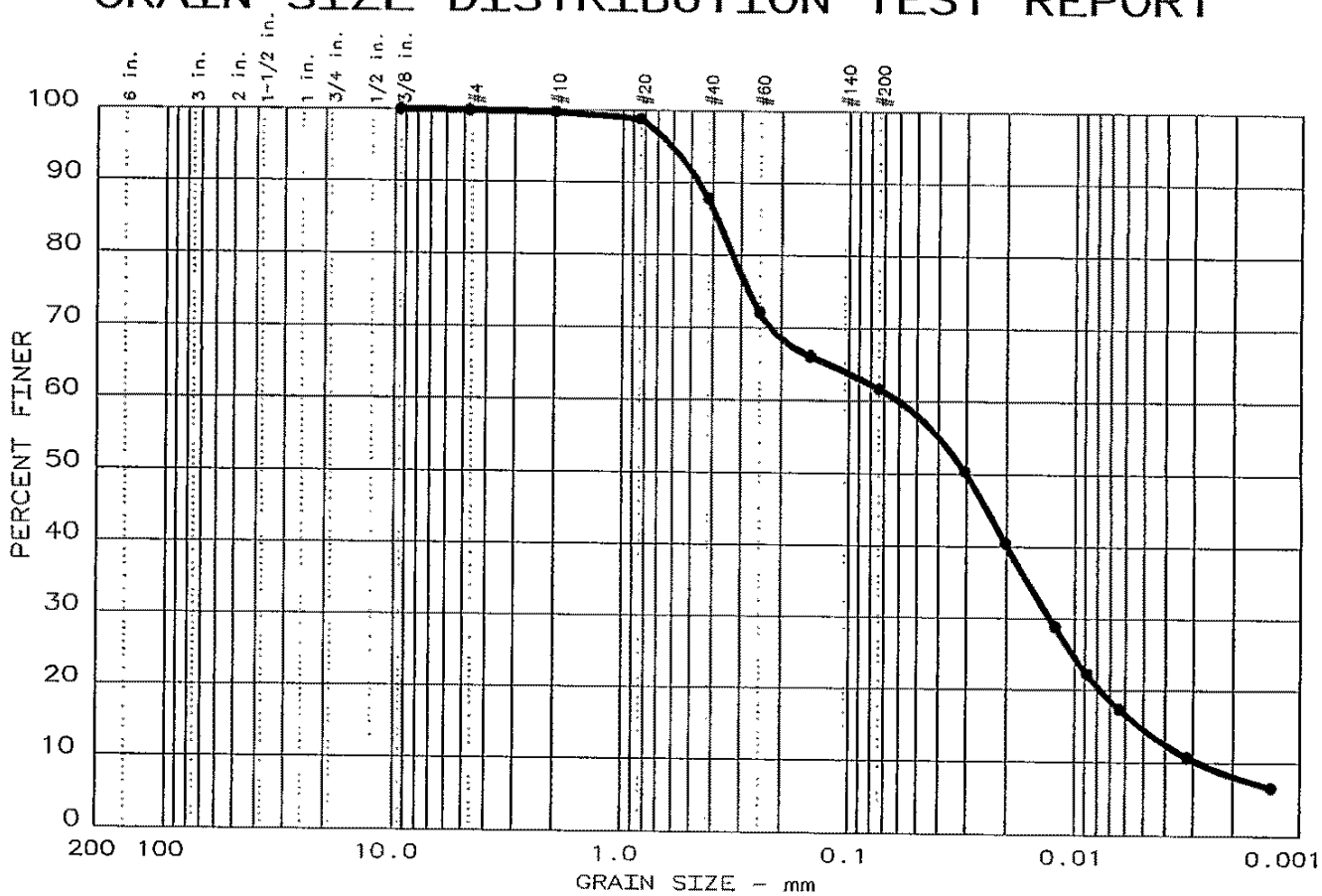
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.1 | 38.2 | 47.2 | 14.5 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.38 | | 0.03 | 0.013 | 0.0052 | 0.0028 | 0.98 | 20.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-34

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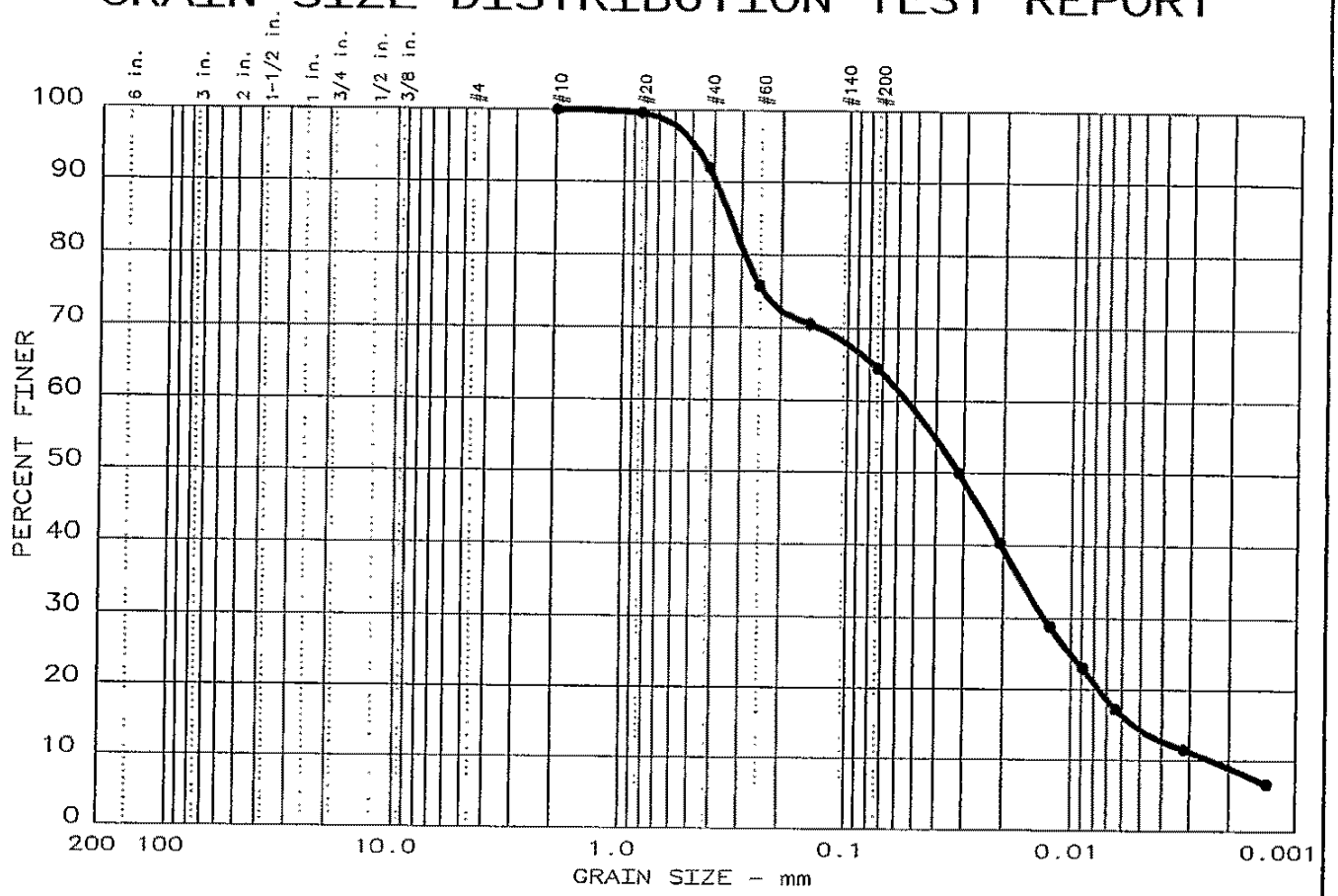
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 35.5 | 50.2 | 14.3 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.34 | | 0.03 | 0.013 | 0.0054 | 0.0024 | 1.34 | 22.5 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very sandy SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-35

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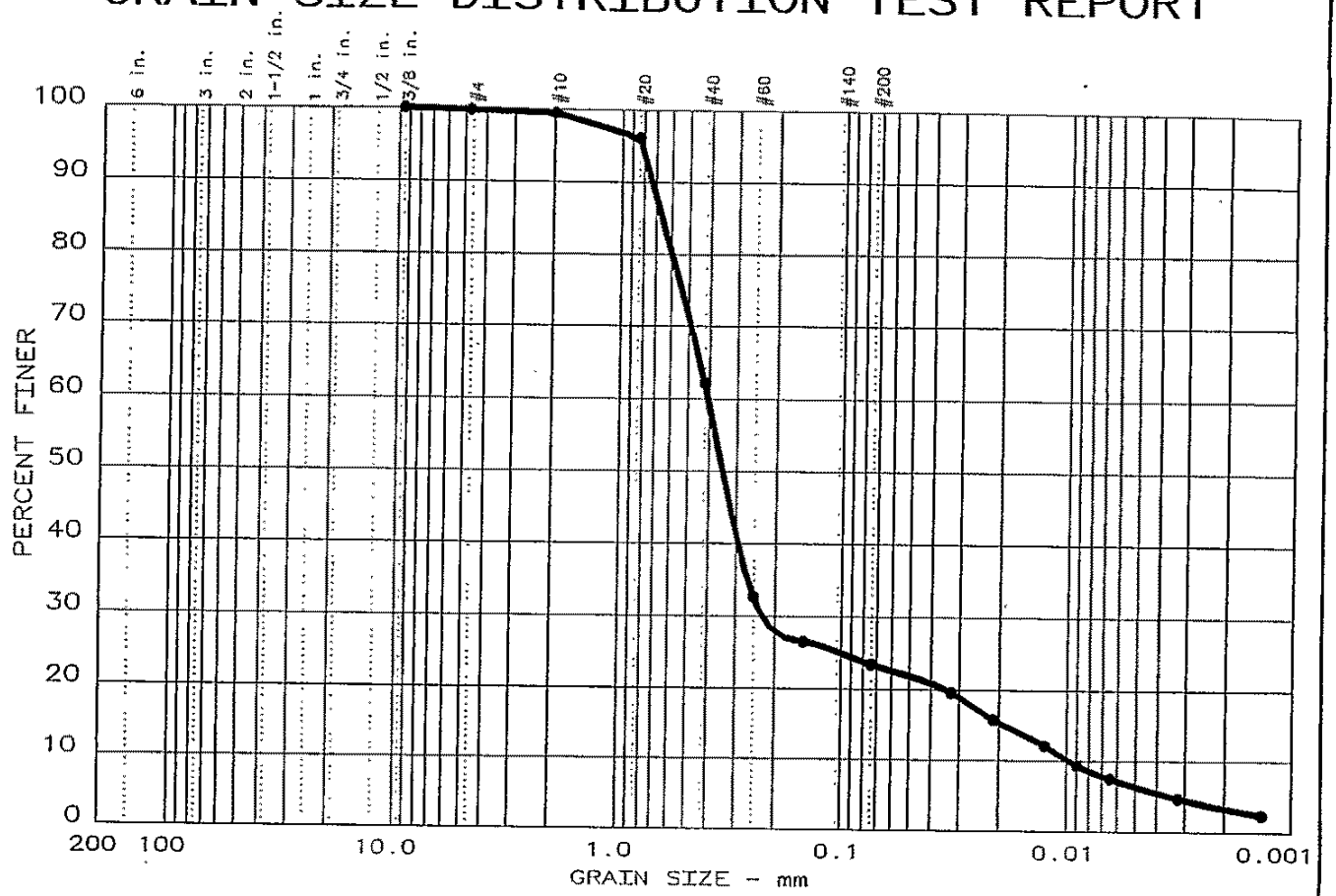
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.2 | 76.4 | 17.1 | 6.3 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.66 | 0.41 | 0.35 | 0.227 | 0.0189 | 0.0098 | 12.97 | 41.4 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly clayey, silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-36

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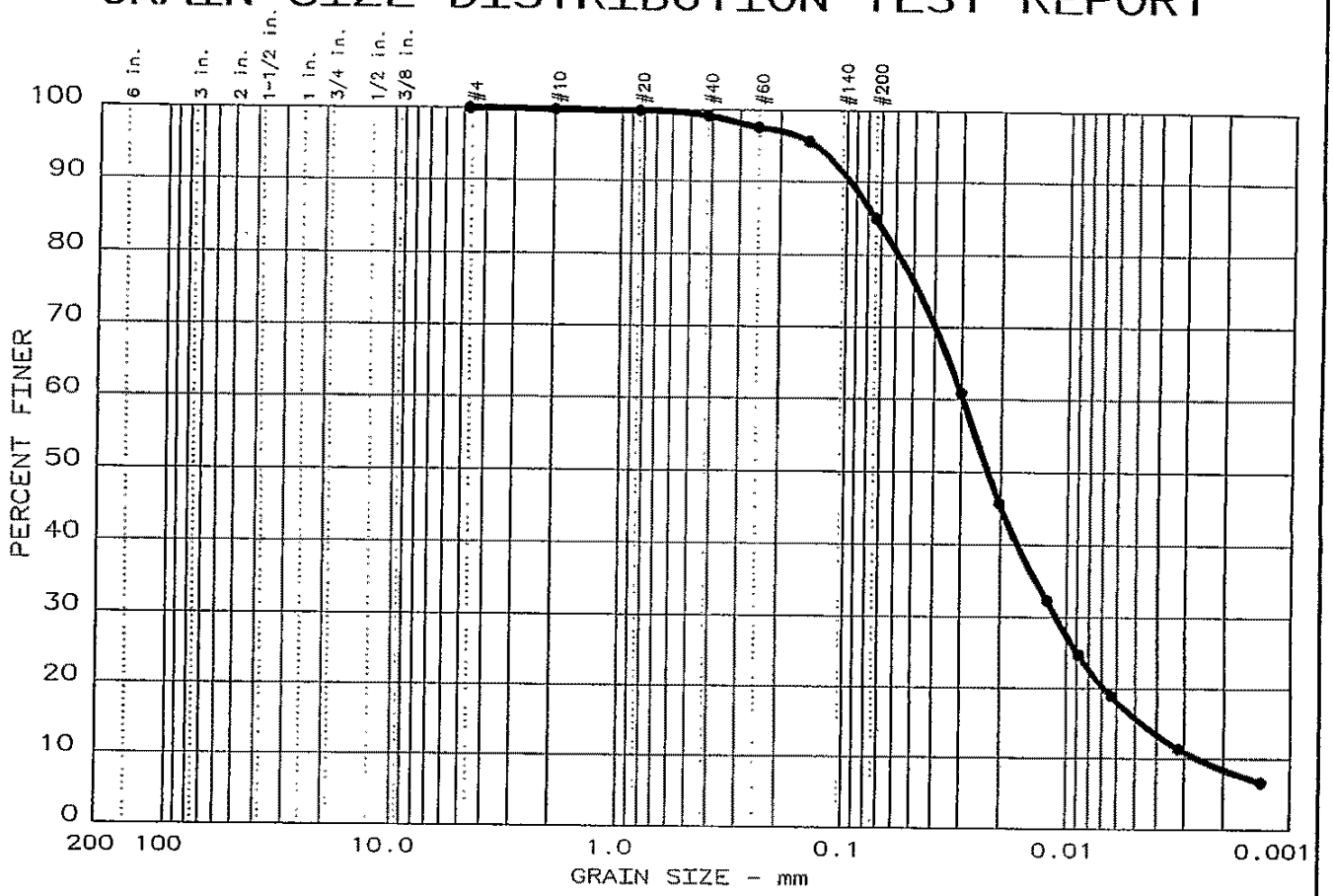
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 14.9 | 69.4 | 15.7 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.02 | 0.011 | 0.0047 | 0.0026 | 1.58 | 11.2 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-39

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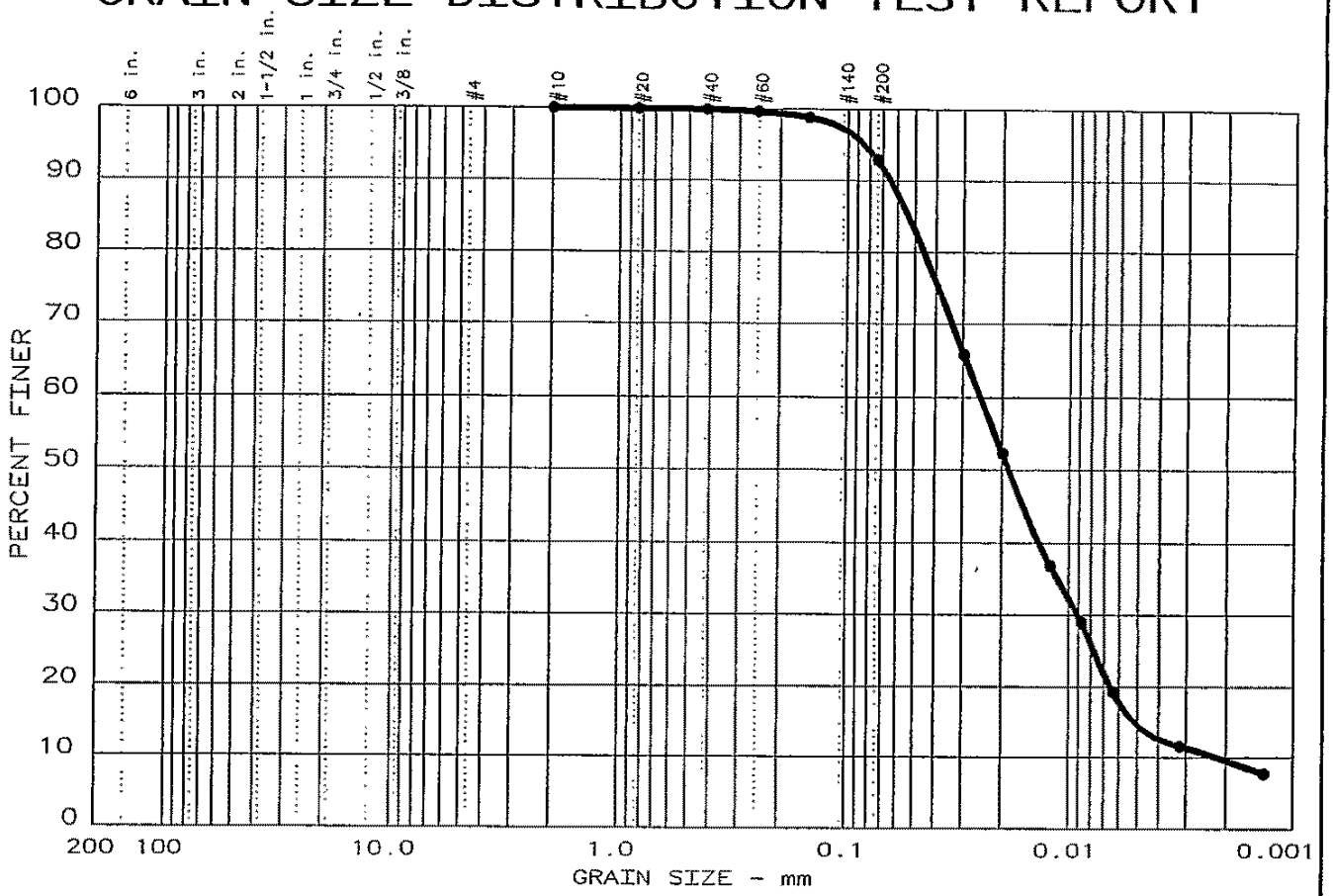
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 7.1 | 78.3 | 14.6 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.02 | 0.009 | 0.0051 | 0.0022 | 1.51 | 11.5 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-42

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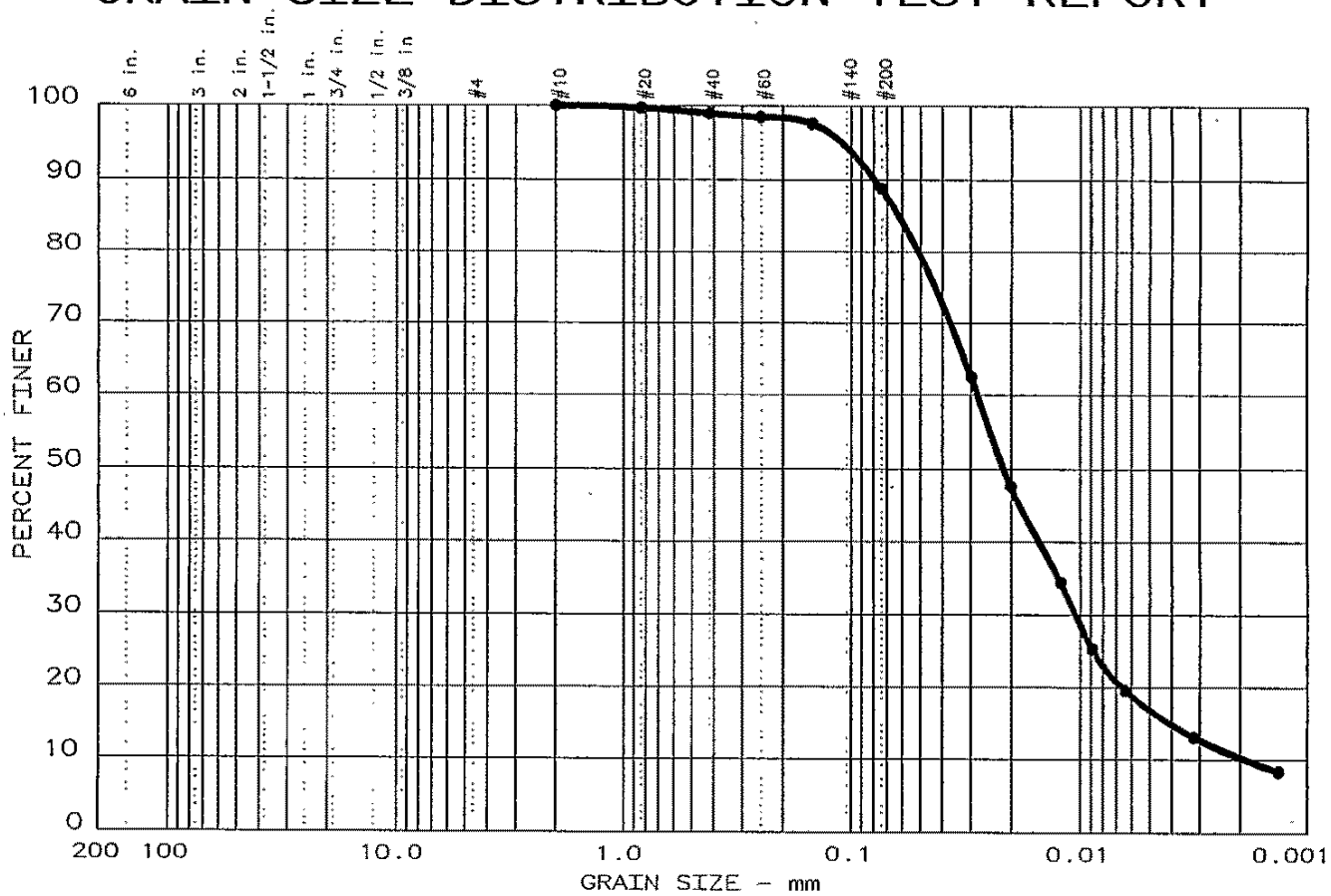
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 11.2 | 72.0 | 16.8 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.02 | 0.011 | 0.0040 | 0.0019 | 2.08 | 14.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Slightly sandy, clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-S-44

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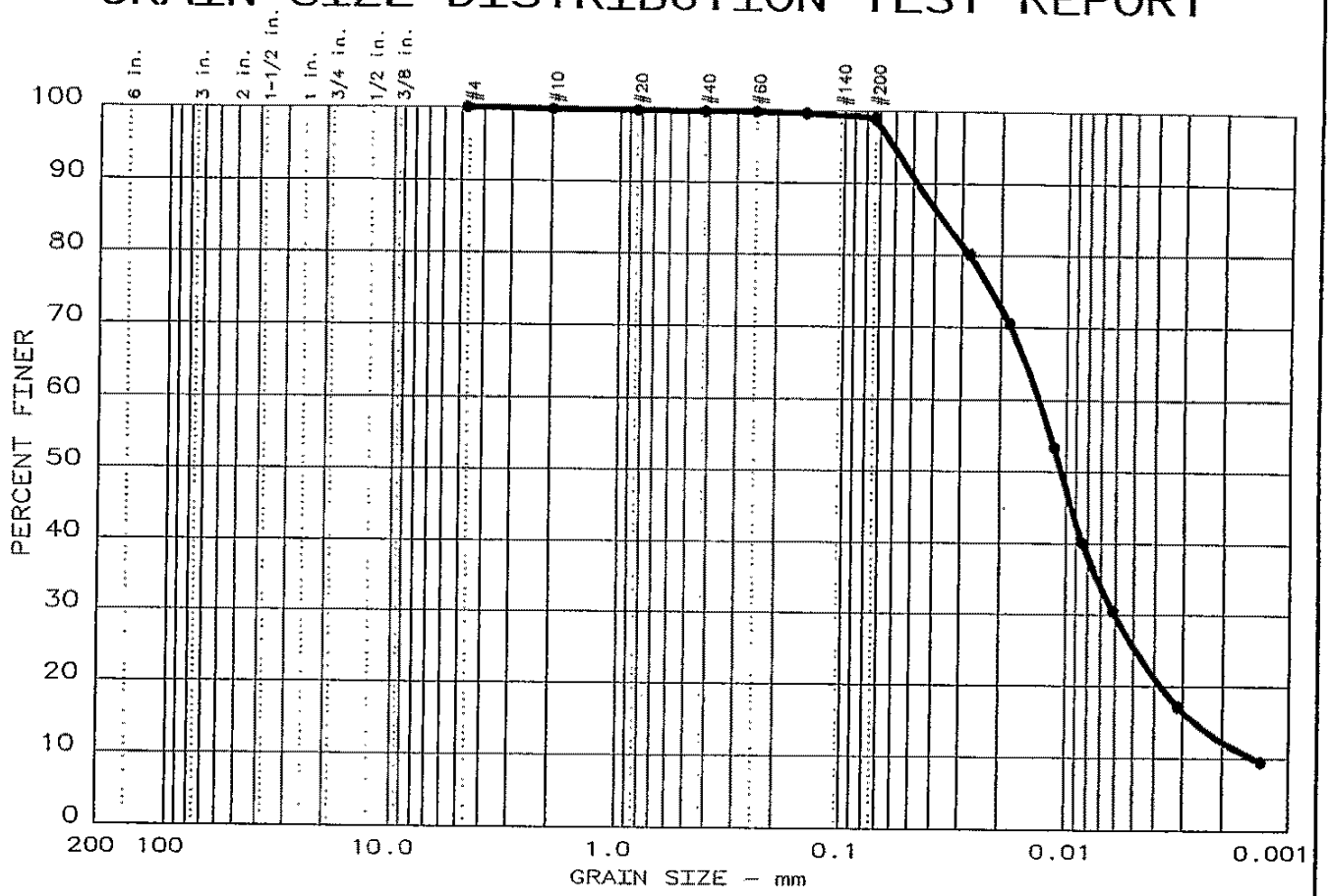
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 0.9 | 73.6 | 25.5 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | | | 0.01 | 0.006 | 0.0027 | 0.0014 | 1.88 | 9.2 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey SILT | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-REF-B

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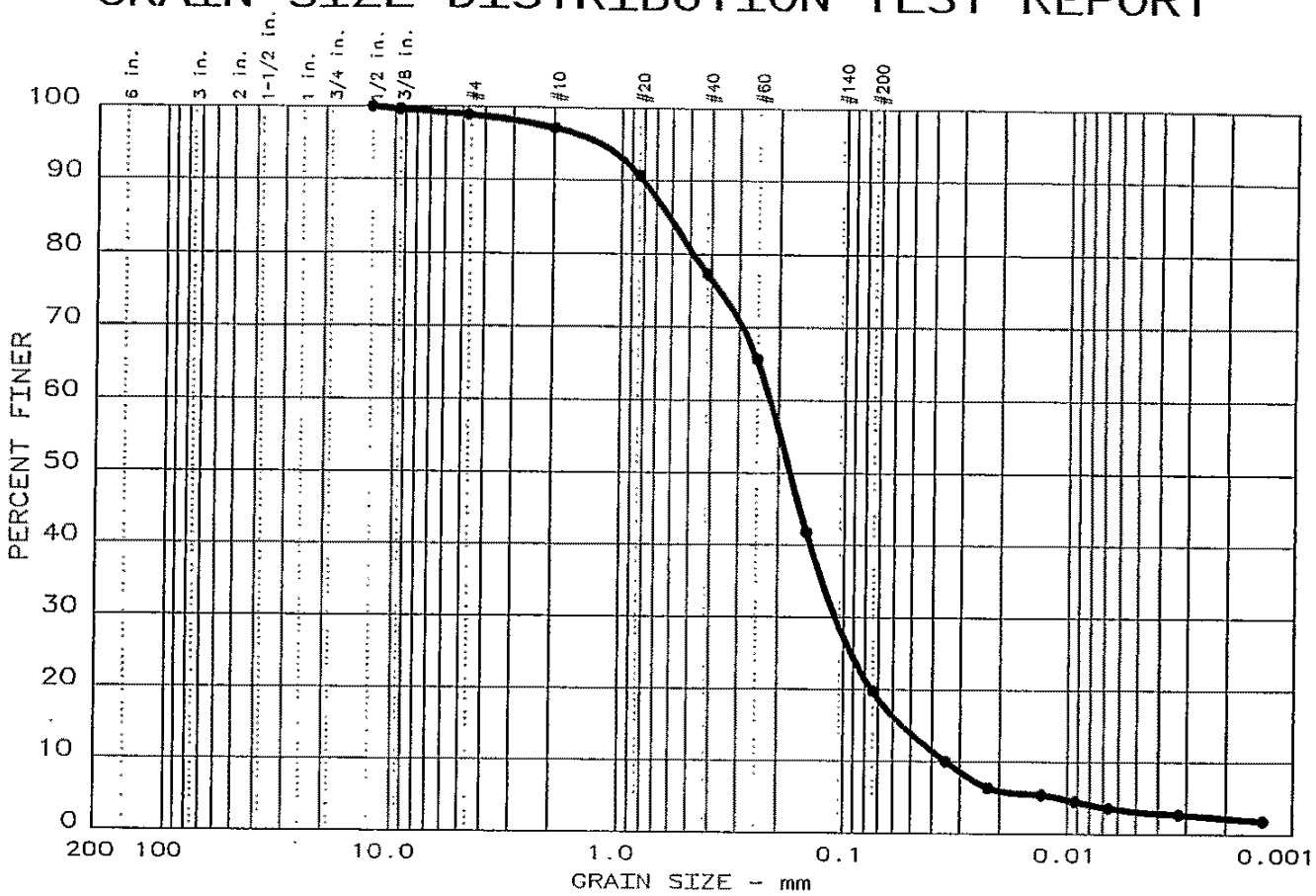
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 1.1 | 79.1 | 16.6 | 3.2 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.62 | 0.22 | 0.18 | 0.110 | 0.0545 | 0.0348 | 1.60 | 6.3 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Silty SAND | SM | |

Remarks:

Project: Port of Portland T-4

● Location: HC-REF-C

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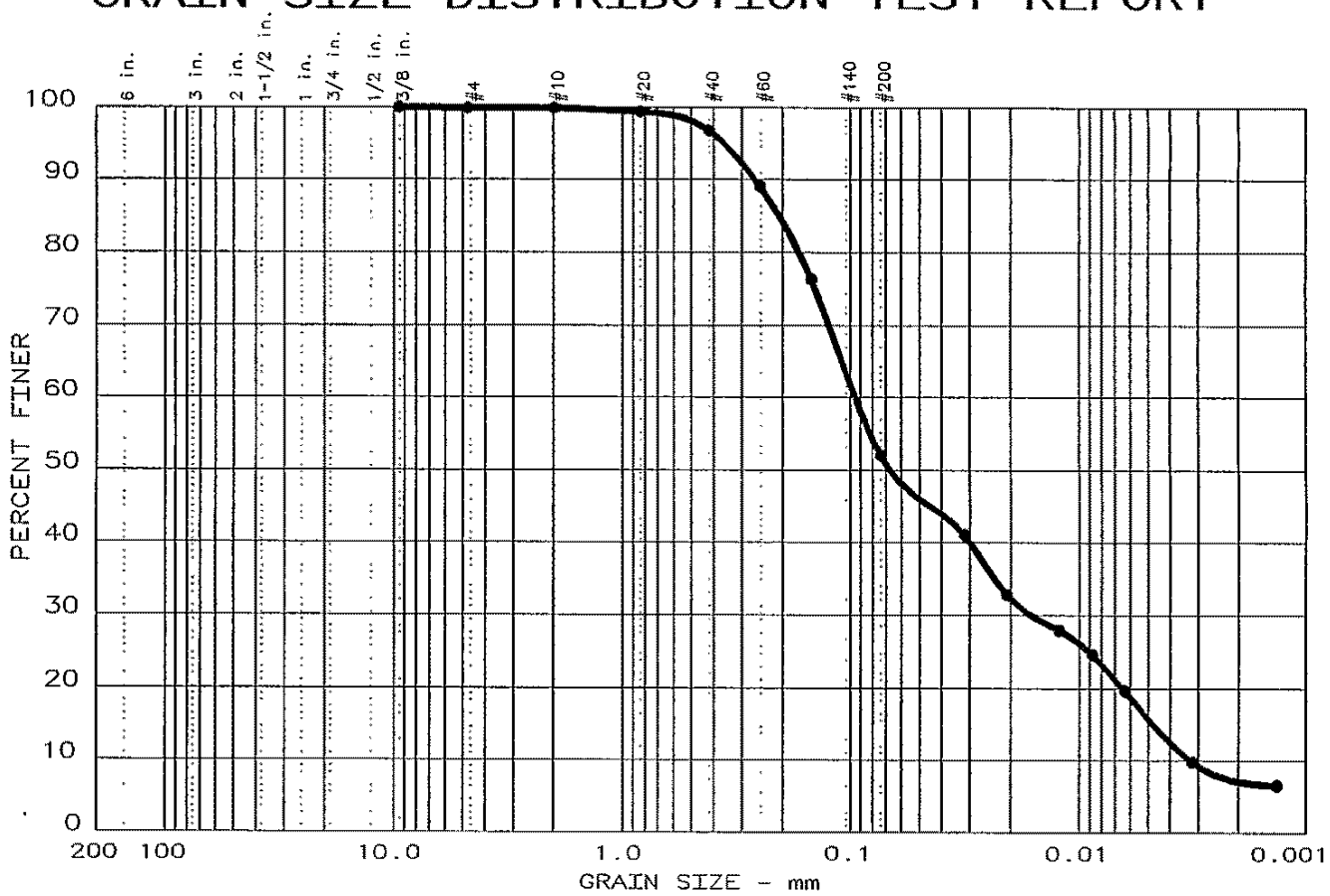
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.1 | 47.8 | 36.3 | 15.8 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.20 | 0.10 | 0.07 | 0.016 | 0.0047 | 0.0032 | 0.87 | 29.5 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, vey silty SAND | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-VC-7-S2

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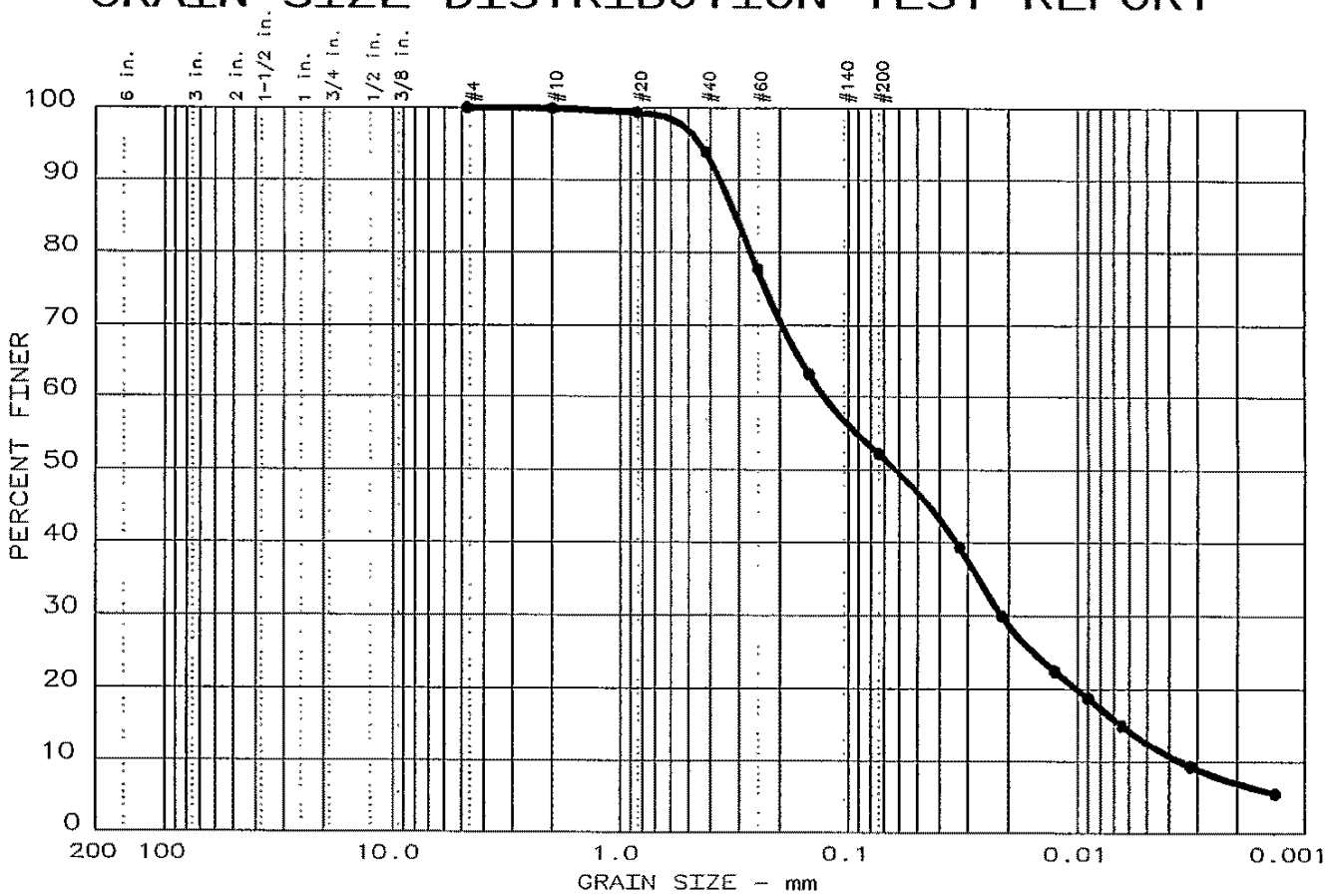
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 47.8 | 39.7 | 12.5 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.31 | 0.13 | 0.06 | 0.021 | 0.0065 | 0.0035 | 1.01 | 35.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● Clayey, very silty SAND | ML | |

Remarks:

Project: Port of Portland T-4

● Location: HC-VC-11-S2

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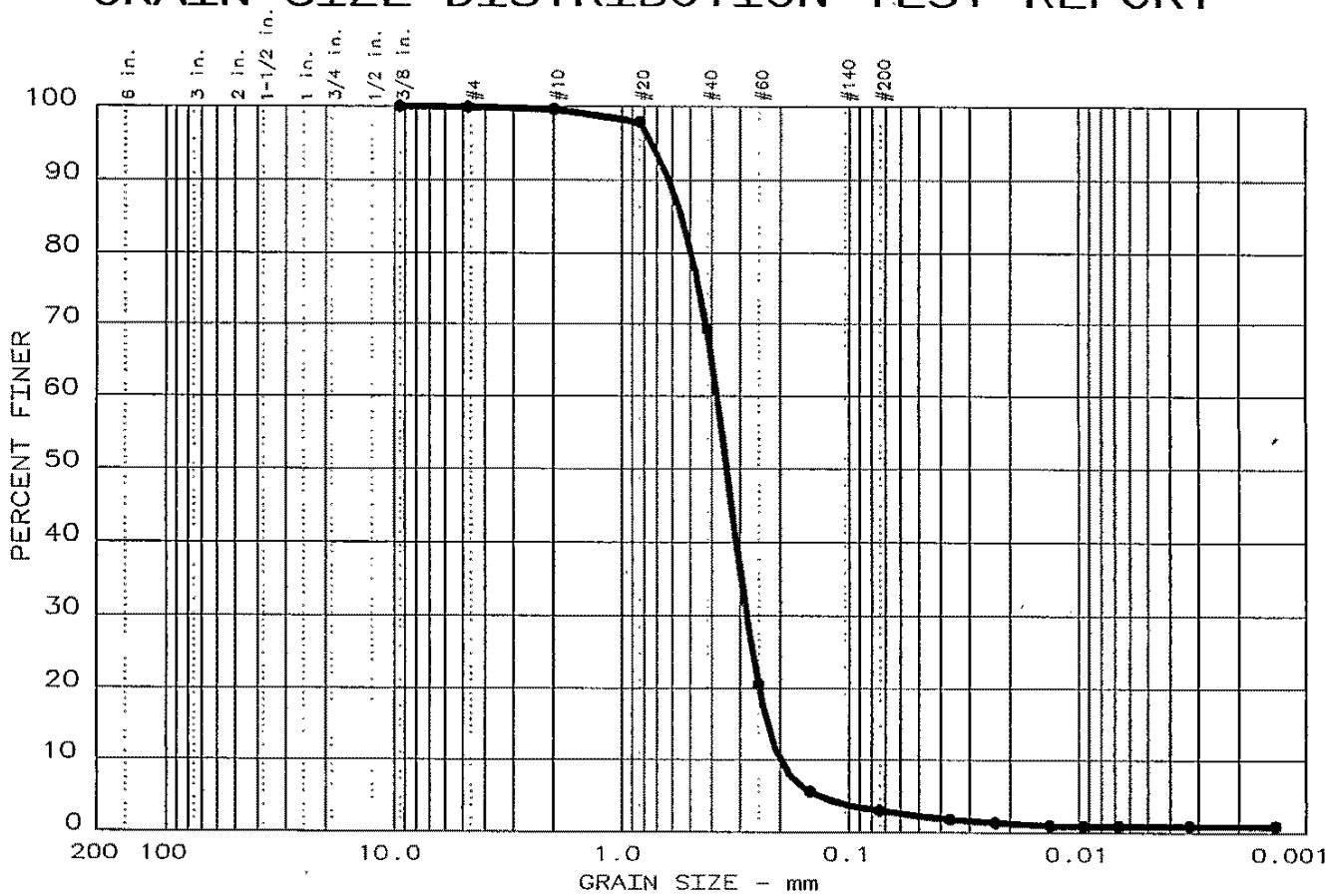
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.1 | 96.9 | 2.1 | 0.9 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.54 | 0.38 | 0.34 | 0.281 | 0.2272 | 0.1995 | 1.04 | 1.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● SAND | SP | |

Remarks:

Project: Port of Portland T-4

● Location: HC-VC-13-S2

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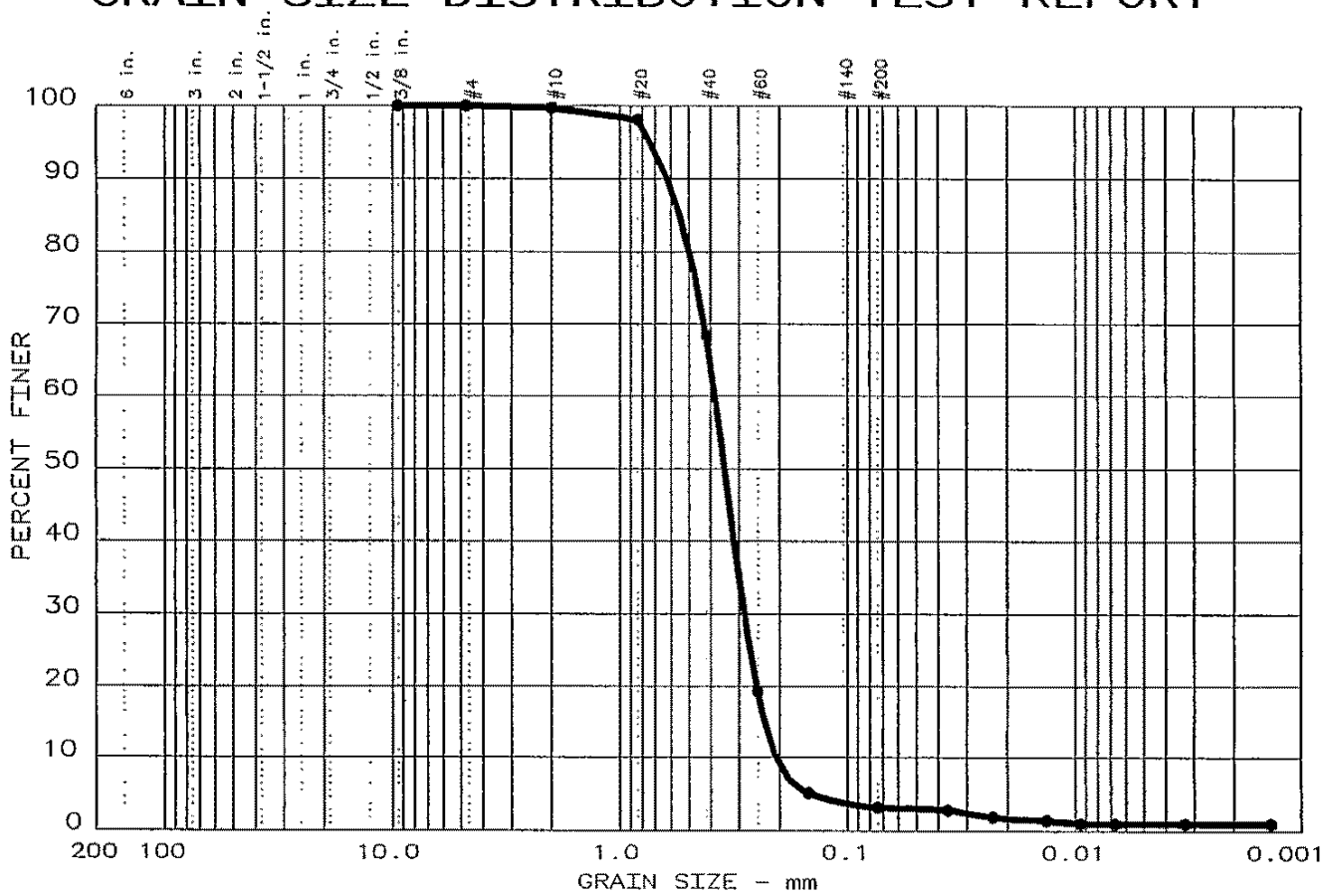
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 96.8 | 2.3 | 0.9 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.55 | 0.38 | 0.35 | 0.285 | 0.2328 | 0.2065 | 1.02 | 1.9 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● SAND | SP | |

Remarks:

Project: Port of Portland T-4

● Location: HC-VC-18-S2

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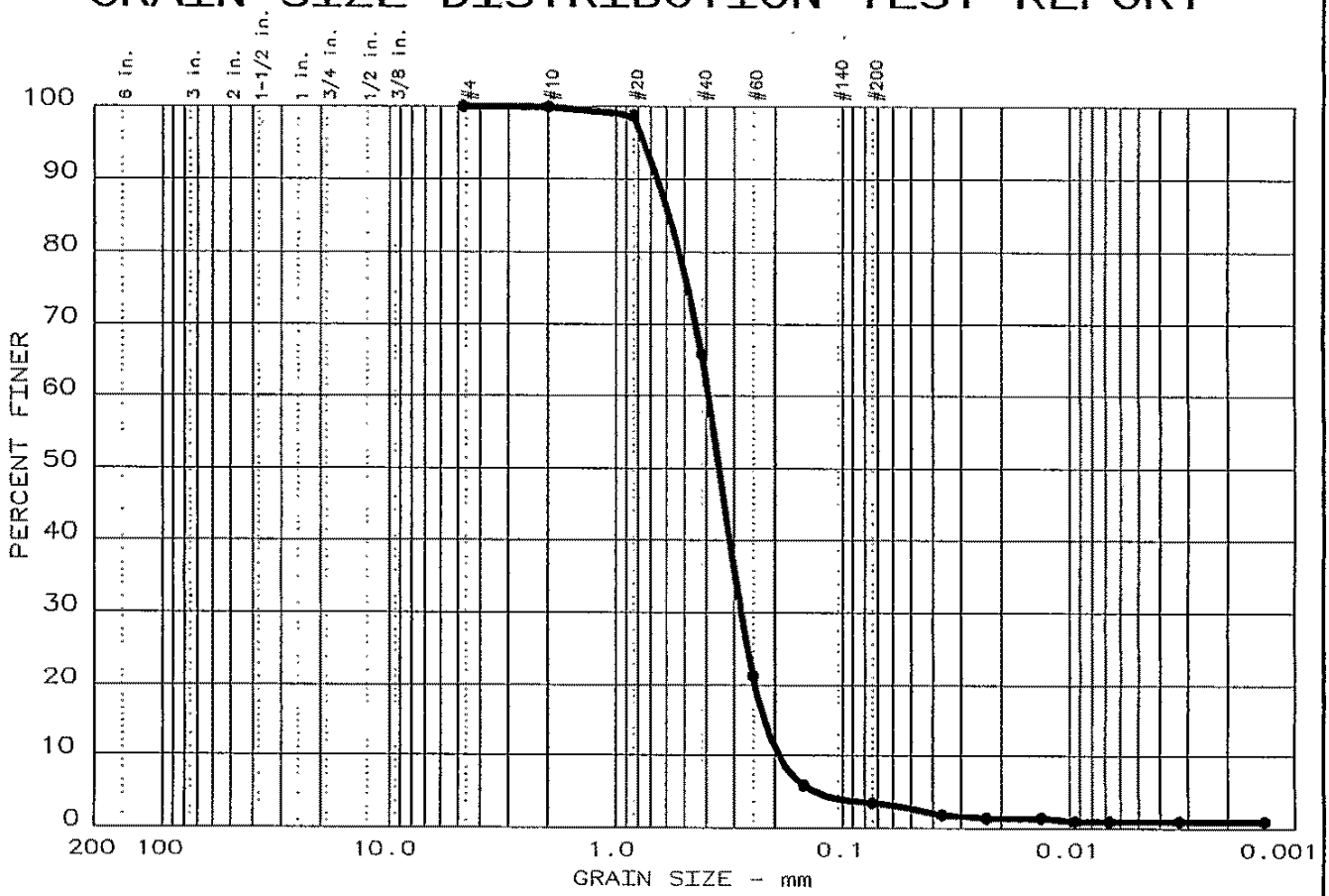
Figure

# GRAIN SIZE DISTRIBUTION TEST REPORT




| | %+75mm | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|---|
| ● | 0.0 | 0.0 | 96.5 | 2.6 | 0.9 |
| | | | | | |
| | | | | | |

| | LL | PI | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | | | 0.58 | 0.39 | 0.35 | 0.281 | 0.2223 | 0.1914 | 1.05 | 2.0 |
| | | | | | | | | | | |
| | | | | | | | | | | |

| MATERIAL DESCRIPTION | USCS | NAT. MOIST. |
|---|---|---|
| ● SAND | SP | |

Remarks:

Project: Port of Portland T-4

● Location: HC-VC-32-S2

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Figure

# Appendix E

# APPENDIX E
# DATA VALIDATION SUMMARY AND CERTIFICATES OF ANALYSIS SEDIMENT AND WATER SAMPLES

# APPENDIX E
# DATA VALIDATION SUMMARY AND CERTIFICATES OF ANALYSIS SEDIMENT AND WATER SAMPLES

## *Summary of Data Validation Effort*

This appendix provides the quality assurance review of 64 sediment and eight water samples, including five field duplicates and two rinseate blanks collected in accordance with the Remedial Investigation/Feasibility Study (RI/FS) Work Plan for the Port of Portland (Port) Terminal 4 (T-4).

Chemical analyses were performed by Columbia Analytical Services of Kelso, Washington. The laboratory-submitted data packages were reviewed by Hart Crowser. The following criteria were evaluated in the standard validation process:

- Holding Times;
- Method Blanks;
- Surrogate Recoveries;
- Blank Spike and Laboratory Control Sample (LCS) Recoveries;
- Matrix Spike/Matrix Spike Duplicate(MS/MSD) Recoveries and Relative Percent Differences (RPD);
- Laboratory and Field Duplicate Relative Percent Differences (RPDs); and
- Reported Detection Limits.

## *Overall Data Quality*

The overall data quality objectives (DQOs), as set forth in the Quality Assurance Project Plan (QAPP) have been met, and the data for this site are acceptable for use as qualified. The completeness for the associated data is 99.9 percent. Detailed discussions are presented below.

### ***Quality Assurance Objectives***

**Precision.** Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values. Precision is generally evaluated using both matrix spike/matrix spike duplicate (MS/MSD) (or lab duplicate) results and field duplicate results. MS/MSD and lab duplicate

results provide information on laboratory (only) precision, while field duplicates provide information on field and lab precision combined.

Analytical precision is measured through MS/MSD samples for organics analyses and for lab duplicate samples for metals and other inorganic analyses. Analytical precision is quantitatively expressed as the relative percent difference (RPD) between the MS/MSD or lab duplicates. Analytical precision measurements were carried out on project-specific sediment samples at a minimum frequency of one in 20 samples. Data qualifiers were assigned to metals results for sediment samples due to low laboratory duplicate RPDs.

Five sets of field duplicates were collected and analyzed for this site. The project-specific precision acceptance criteria for field duplicates is 75 percent for sediment samples. The field duplicate precision for all analyses were generally acceptable. RPDs for polynuclear aromatic hydrocarbons (PAHs) exceeded the criteria of 75 percent for field duplicates HC-S-102/HC-S-24 and HC-VC-104/HC-VC-13-S2. However, no qualifiers were assigned based on RPD results alone.

**Accuracy.** Accuracy measures the closeness of the measured value to the true value. The accuracy of chemical test results was assessed by analyzing standard reference materials or by "spiking" samples with known standards (surrogates, laboratory control samples, blank spikes, and/or MS) and measuring the percent recovery.

Accuracy measurements for all fractions were carried out in accordance with method requirements for organic and inorganic analyses and at a minimum frequency of one in 20 samples. Recoveries of surrogates, MS/MSDs, and laboratory control samples (LCSs) were generally acceptable. Data qualifiers were assigned to semivolatile and NWTPH-Dx results for sediment samples due to low surrogate recoveries. Sulfide, metals, and NWTPH-Dx results were qualified due to low LCS and/or MS/MSD recoveries.

**Completeness.** Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness of the data is the ratio of acceptable data points to the total number of data points (expressed as a percent). A target completeness goal for this work was 100 percent. There were 4,148 data points and five data were rejected; therefore, the completeness of the data for this project was 99.9 percent.

**Comparability.** Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Because of the use of standard techniques for both sample collection and laboratory

analysis, the data collected from same sampling locations and depths should be comparable to both internal and other data generated.

### *Some Semivolatile Organics Data Rejected*

**Semivolatile Organic Analyses.** Surrogate recoveries in acid fraction were below laboratory control limits in HC-VC-32-S2. Non-detected results in acid fraction were rejected (R).

### *Other Qualifications of Data*

**Volatile Organic Analyses.** Toluene was detected in rinseate blanks HC-RB-100 and HC-RB-101. Surrogate recoveries of toluene in sediment samples were slightly above laboratory control limits in six samples. No qualifiers were assigned since remaining recoveries were acceptable. The detection limits in several sediment samples were elevated due to low percent solids.

**Semivolatile Organic Analyses.** Laboratory reextracted and reanalyzed sediment samples outside the holding time due to poor surrogate recoveries on method blanks. Since the samples in the batch showed acceptable surrogate recoveries, it was determined that the blank problem was an isolated occurrence. Thus, the sample results from initial analysis were used. Fluoranthene was analyzed outside the holding time in HC-S-19. The sample result was qualified as estimated (J). Bis(2-ethylhexyl)phthalate was detected in the water method blank. Associated sample results were qualified as not detected (U). Di-n-butylphthalate and diethylphthalate were detected in rinseate blanks. Surrogate recoveries of 2-fluorophenol, phenol, and nitrobenzene were below laboratory control limits in the method blank, HC-S-13, and HC-S-14. The sample results were qualified as estimated (UJ/J). No qualifiers were assigned to sample results where only one recovery was below control limits or where samples were diluted due to high concentrations. LCS recoveries of pentachlorophenol in several samples were below laboratory control limits. No qualifiers were assigned since remaining recoveries were acceptable. MS/MSD recoveries of acenaphthene and pyrene were outside laboratory control limits. No qualifiers were assigned since sample concentrations were greater than four times spike concentrations. The detection limits in several sediment samples were elevated due to matrix interference and/or sample dilution.

**NWTPH-Dx Analyses.** Surrogate recoveries of terphenyl and chlorohexadecane were outside laboratory control limits in HC-S-08. The sample results were qualified as estimated (UJ/J). These LCS and MS/MSD recoveries were below laboratory control limits. Associated sample results were qualified as estimated (UJ/J). Laboratory duplicate RPD for fluoranthene was above laboratory control

limits. No qualifiers were assigned since remaining RPDs were acceptable. The detection limits in several sediment samples were elevated due to matrix interference.

**Pesticide/PCB Analyses.** Surrogate recovery of decachlorobiphenyl was outside laboratory control limits in several samples. No qualifiers were assigned since remaining recovery was acceptable. The detection limits in several sediment samples were elevated due to matrix interference.

**Metals Analyses.** Matrix spike recoveries of antimony, lead, and zinc were outside laboratory control limits. Associated sample results were qualified as estimated (UJ/J). Laboratory duplicate RPDs for cadmium and zinc were above control limits. Associated sample results were qualified as estimated (UJ/J).

**Conventional Analyses.** Sulfide and total organic carbon (TOC) analysis exceeded the holding times in several samples. Associated sample results were qualified as estimated (J). Both LCS and MS/MSD recoveries for sulfide analysis were below laboratory control limits. Associated sample results were qualified as estimated (J).

Appendix F

# APPENDIX F
# SEDIMENT BIOASSAY DATA QUALITY REVIEW

# APPENDIX F
# SEDIMENT BIOASSAY DATA QUALITY REVIEW
# TERMINAL 4, SLIP 3 SEDIMENT CHARACTERIZATION

## *Introduction*

This appendix summarizes the sediment bioassay data quality review of the amphipod, *Hyalella azteca,* and the midge, *Chironomus tentans,* sediment bioassays conducted by Northwestern Aquatic Sciences (NAS) of Newport, Oregon. These sediment bioassays were conducted as part of the Terminal 4, Slip 3 (Slip 3) Remedial Investigation (RI).

The sediment bioassay tests were conducted in two phases. In Phase I, sediment samples HC-S-26, HC-S-28, HC-S-35, HC-S-36, HC-S-39, and HC-S-42 were tested and the results were compared against reference sediments, HC-Ref-B and HC-Ref-C. In Phase II, sediment samples HC-S-01, HC-S-04, HC-S-05, HC-S-07, HC-S-11, HC-S-16, HC-S-19, HC-S-22, and HC-S-30 were tested and results were compared against reference sediments, HC-Ref-B and HC-Ref-C. The reference sediment selected for comparison with each test sediment was based on grain size characteristics of the sediment. The results of the sediment bioassays were interpreted in accordance with the criteria presented in the "Draft Dredge Material Evaluation Framework; Lower Columbia River Management Area" (LCRMA) (Corps *et al.,* 1998) and in the DEQ-approved work plan (Hart Crowser, 1998a).

This data quality review was conducted to ensure that the results of the sediment bioassays were of sufficient quality for use in this RI.

## *Sediment Bioassay Data Quality Review*

The test sediment samples were collected by Hart Crowser on October 13 through 15, 1998, and were submitted for toxicity testing to NAS Laboratory on October 17, 1998. Reference Sediments B and C were collected by Hart Crowser on October 15, 1998, and were submitted for toxicity testing to NAS Laboratory on October 17, 1998. The Phase I negative control sediment was collected on October 19, 1998, from an area adjacent to the Hwy 101 bridge at Beaver Creek, approximately 8 miles south of Newport, Oregon. The Phase II negative control sediment was collected on December 3, 1998, from the same location as the Phase I negative control.

The following three sediment toxicity tests were used in this study:

- Acute 10-Day Amphipod Survival Test *(Hyalella azteca)*;
- Acute 10-Day Midge Survival Test *(Chironomus tentans)*; and
- Chronic 10-Day Midge Growth Test *(Chironomus tentans)*.

These freshwater sediment toxicity tests were conducted in accordance with available standard protocols (EPA, 1994 and ASTM, 1995) by NAS. Sediment toxicity test results were interpreted against the decision criteria provided in the LCRMA (Corps *et al.*,1998).

The following criteria were evaluated as part of this data quality review:

- Holding times;
- Bioassay performance in negative control and reference sediments;
- Bioassay performance in positive control tests; and
- Bioassay test conditions.

***Phase I Amphipod, Hyalella Azteca, 10-day Survival Test***

The amphipod bioassay was initiated on October 20, 1998, which was within the 56-day LCRMA holding time limit. The sediments were held in the dark at 4°C during the holding period. Nitrogen was added to sediment sample jars with headspace prior to storage.

The water quality observations of overlying water temperature, pH, and dissolved oxygen were within the protocol-specified ranges. The range of dilution water alkalinity (70 to 80 mg/L as $CaCO_3$) slightly exceeded the specified range of 60 to 70 mg/L. This minor deviation is unlikely to have affected the test results. Sulfides were not detected in the overlying water (detection limit 0.02 mg/L) at either the beginning or end of the test. Ammonia-N in the overlying water ranged from <0.5 mg/L (detection limit) to 1.0 mg/L.

The reference toxicant test 96-hour 50% Lethal Concentration (96-h $LC_{50}$) of 17.0 µg/L $CdCl_2$ was within the laboratory's control chart warning limits (2.65 to 22.9 µg/L) obtained by NAS.

The reported mean mortality of 1.2% in the negative control for this bioassay was well within the LCRMA performance standard of 20%. The mean mortality

responses from the Reference Sediment B (3.7%) and Reference Sediment C (1.2%) were well within the LCRMA performance standard of 30%.

**Final QA Determination.** The Phase I *Hyalella azteca* data are of acceptable quality and fully usable.

## ***Phase I Midge, Chironomus Tentans, 10-Day Survival and Growth Test***

The midge bioassay was initiated on October 20, 1998, which was within the 56-day LCRMA holding time limit. The sediments were held in the dark at 4°C during the holding period. Nitrogen was added to sediment sample jars with headspace prior to storage.

The water quality observations of overlying water temperature and pH were within the protocol-specified ranges. Dissolved oxygen dropped slightly below the specified range (40 to 100% saturation) on day 7 in three test chambers. This minor deviation is unlikely to have affected the test results. The range of dilution water alkalinity (70 to 80 mg/L as $CaCO_3$) slightly exceeded the specified range of 60 to 70 mg/L. This minor deviation is unlikely to have affected the test results. Sulfides were not detected in the overlying water (detection limit 0.02 mg/L) at either the beginning or end of the test. Ammonia-N in the overlying water ranged from <0.5 mg/L (detection limit) to 1.5 mg/L.

The reference toxicant test 96-h $LC_{50}$ of 6.35 g/L KCl was within the laboratory's control chart warning limits (2.54 to 6.82 g/L) obtained by NAS.

The reported mean mortality of 15.0% in the negative control for this bioassay was within the LCRMA performance standard of 30%. The mean mortality responses from the Reference Sediment B (28.7%) and Reference Sediment C (20.0%) were within the LCRMA performance standard of 35%.

The mean growth response in the negative control (1.69 mg), reference sediment B (1.60 mg), and reference sediment C (1.73 mg) were within LCRMA performance criteria of 0.6 mg minimum mean growth per midge.

**Final QA Determination.** The Phase I *Chironomus tentans* data are of acceptable quality and fully usable.

## ***Phase II Amphipod,* Hyalella Azteca, *10-day Survival Test***

The amphipod bioassay was initiated on December 8, 1998, which was within the 56-day LCRMA holding time limit. The sediments were held in the dark at

4°C during the holding period. Nitrogen was added to sediment sample jars with headspace prior to storage.

The water quality observations of overlying water temperature, pH, and dissolved oxygen were within the protocol specified ranges. The range of dilution water alkalinity (80 mg/L as $CaCO_3$) slightly exceeded the specified range of 60 to 70 mg/L. This minor deviation is unlikely to have affected the test results. Ammonia-N in the overlying water ranged from <0.5 mg/L (detection limit) to 0.5 mg/L.

The reference toxicant test 96-h $LC_{50}$ of 15.2 µg/L $CdCl_2$ was within the laboratory's control chart warning limits (2.86 to 23.3 µg/L) obtained by NAS.

The reported mean mortality of 15.0% in the negative control for this bioassay was within the LCRMA performance standard of 20%. The mean mortality responses from the Reference Sediment B (13.7%) and Reference Sediment C (26.2%) were within the LCRMA performance standard of 30%.

**Final QA Determination.** The Phase II *Hyalella azteca* data are of acceptable quality and fully usable.

***Phase II Midge*, Chironomus Tentans, *10-Day Survival and Growth Test***

The midge bioassay was initiated on December 20, 1998, which was within the 56-day LCRMA holding time limit. The sediments were held in the dark at 4°C during the holding period. Nitrogen was added to sediment sample jars with headspace prior to storage.

The water quality observations of overlying water temperature, pH, and dissolved oxygen were within the protocol specified ranges. The range of dilution water alkalinity (80 mg/L as $CaCO_3$) slightly exceeded the specified range of 60 to 70 mg/L. This minor deviation is unlikely to have affected the test results. Ammonia-N in the overlying water ranged from <0.5 mg/L (detection limit) to 0.5 mg/L.

The reference toxicant test 96-h $LC_{50}$ of 3.14 g/L KCl was within the laboratory's control chart warning limits (2.65 to 7.12 g/L) obtained by NAS.

The reported mean mortality of 3.7% in the negative control for this bioassay was well within the LCRMA performance standard of 30%. The mean mortality responses from the Reference Sediment B (12.5%) and Reference Sediment C (21.2%) were within the LCRMA performance standard of 35%.

The mean growth response in the negative control (1.46 mg) and reference sediment B (1.15 mg) and reference sediment C (1.37 mg) were within LCRMA performance criteria of 0.6 mg minimum mean growth per midge.

**Final QA Determination.** The Phase II *Chironomus tentans* data are of acceptable quality and fully usable.

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