Remedial Action
Record of Decision
Zidell Waterfront Property
ECSI No. 689

June 2005

DEQ Northwest Region
Voluntary Cleanup Program
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1 Introduction and Purpose

This document presents the selected remedial action for the waterfront property owned by ZRZ Realty Company (Zidell) in Portland, Oregon (ECXI No. 689). The final remedial action was selected by the Oregon Department of Environmental Quality (DEQ) in accordance with Oregon Revised Statutes (ORS) 465.200 through 465.380, and Oregon Administrative Rules (OAR) Chapter 340, Division 122, Section 0090. The selected remedial action is based on the administrative record for the site. A copy of the Administrative Record Index is attached as Appendix A.

The selected remedy is based on the Final Remedial Investigation and Feasibility Study Reports (RI/FS), and DEQ modifications to the remedial action recommended in the FS Report. The RI and FS were conducted pursuant to a voluntary agreement between Zidell and the DEQ, effective April 14, 1995 (WMCVC-NWR-94-23). The RI/FS was performed pursuant to DEQ approved work plans consistent with U.S. Environmental Protection Agency (USEPA) guidance for conducting remedial investigation and feasibility studies (RI/FSs) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (USEPA, 1988) and Oregon Administrative Rule (OAR) 340-122-0080.

1.1 Scope and Role of the Recommended Remedial Action

The selected remedial action addresses the presence of metals, petroleum hydrocarbons and associated polycyclic aromatic hydrocarbons (PAHs), polychlorinated-biphenyls (PCBs), and tributyl tin (TBT) and its degradation products in contaminated soil and/or sediment at the Zidell site.

The selected remedial action for contaminated soil is Soil Alternative 6, which generally consists of the following elements:

- Interim source control measures to prevent releases of hazardous substances to the Willamette River from upland and bank soils through stormwater runoff;
- Excavation and off-site disposal of up to 8,000 cubic yards of contaminated soil exceeding hot spot concentrations, and asbestos containing material;
- On-site consolidation of soil exceeding cleanup levels from Greenway Area or future public right-of-ways to non-Greenway area of the site prior to capping;
- Re-grading the Greenway shoreline to facilitate placement of a soil cap above an elevation of 13 feet, and upgrading existing armoring of the riverbank from 13 feet to the Willamette River sediment surface to minimize future releases of hazardous substances.
in soil to the Willamette River;
• Engineering controls involving placement of a cap over residual soil contamination exceeding risk-based concentrations; and
• Institutional controls involving inspection and maintenance of the soil cap and protocols for future sub-surface maintenance activities.

The selected remedial action for contaminated sediments is Sediment Alternative 3, which consists of the following elements:

• Engineering controls to include placement of a clean sand/rock cap over up to 17 acres of contaminated sediment along the Zidell shoreline;
• Institutional controls involving inspection and maintenance of the sediment cap;
• Periodic reviews by DEQ; and
• Selective sediment dredging/capping of the barge launchway to facilitate continued site operations or possible future use of the area for public access for river-related activities.

1.2 Report Organization

This document includes the following sections:

• **Section 2: Site Background.** This section provides a description of the facility and overview of the history of plant operations and environmental investigations performed for the RI/FS.

• **Section 3: Remedial Investigation Summary.** This section summarizes the nature and extent of contamination, contaminant fate and transport, human health and ecological baseline risk assessments, and identification of potential hot spots of contamination.

• **Section 4: Remedial Action Objectives & Cleanup Levels.** This section identifies the remedial action objectives (RAOs) and associated risk-based concentrations (RBCs) for affected media. The information presented in this section provides the key information for development of remedial action alternatives in Section 5, and evaluation of the alternatives in Section 6 of the report.

• **Section 5: Description of Remedial Action Alternatives.** This section provides a description of the remedial alternatives identified in the FS.
• **Section 6: Evaluation of Remedial Action Alternatives.** This section summarizes DEQ’s evaluation of the remedial action alternatives against the remedial action selection criteria under Oregon Environmental Cleanup Rules.

• **Section 7: Recommended Remedial Alternative for Soil and Sediment.** This section recommends a single alternative and explains the basis for its selection; and provides information required in the Oregon Administrative Rules.

• **Section 8: Public Notice and Comments.** This section provides a description of the public notice and participation activities performed in accordance with Oregon Administrative Rules.

• **Section 9: Documentation of Significant Change.** This section identifies and describes significant changes to the original recommended remedial action (Staff Report) and reasons for the changes.

• **Section 10: Final Decision of the Director.** This section summarizes the determination that the selected remedial action for the site meets statutory and regulatory requirements, and contains the approving signature of the DEQ Director or designated Division Administrator.

• **Appendix A: Administrative Record.** This appendix contains a listing of the site-specific documents, regulations, and guidance and technical information sources that formed the basis for the Record of Decision.

• **Appendix B: Responsiveness Summary.** This appendix provides a summary of the substantive public comments received during the public comment period and DEQ responses to those comments.
2 Site Background

The Zidell waterfront property consists of 32.17 acres in Section 10, Township 1 South, Range 1 East of the Willamette Meridian (Figure 2-1). The site is located at 3121 SW Moody Avenue in Portland, Multnomah County, Oregon (Figure 2-2). The property is bordered by SW Moody Avenue on the west, by property zoned for commercial use on the north (currently vacant property owned by the Oregon Health Sciences University [OHSU]), and by the former Pacific Metals facility on the south currently under redevelopment. The site is bordered to the east by the Willamette River between river miles 13 and 15. Zidell Marine Corporation and Zidell both operate on the site, which varies from 70 feet to 850 feet wide (east to west), and is 3,300 feet long (north to south).

Historically, the site was used for building, dismantling, converting, repairing, and salvaging ships and barges. It was also used for scrap metal operations, wire burning and aluminum smelting, and housing construction. The south part of the site is currently used for barge construction, and the north part is vacant or used to store salvage materials.

Zidell also owns two lots west of SW Moody Avenue, on either side of Grover Street (Caruthers Addition tax lot 1 of lots 1-4 of block 101 and Caruthers Addition lots 1 and 2 and lots 3 and 4 of block 119) (Figure 2-3). These parcels were not used for Zidell’s operations but were reportedly used for vehicle parking.

2.1 Site Description

2.1.1 Topography and Drainage

The site is generally flat, with elevations ranging from 28 feet to 35 feet relative to the City of Portland (COP) datum (COP benchmark 1514) (Figure 2-4). Elevations in the north part of the site are generally higher than those in the south part (35 feet versus 30 feet). The 100-year floodplain elevation is approximately 30.4 feet along this reach of the Willamette River. The elevation of the top of the bank ranges from approximately 25.5 feet to 30.0 feet.

The topography of the site has been modified over the years by fill placement. Based on a review of aerial photographs taken between 1936 and 1984, the youngest fill was placed between 1963 and 1966 along the bank immediately north and south of the Ross Island Bridge. Initial fill placement at the site likely occurred in the early 1900s when heavy industrial activity began in the area. The fill generally consists of gravel with
brick, asphalt, wood, metal, plastic, asbestos, and glass, and it may extend to 40 feet below ground surface (bgs).

The site has approximately 3,000 lineal feet of frontage on the west bank of the river. Shoreline features include steeply sloped banks covered with construction debris, ballast rock, paving stones, and other material. A dock extends along the shore and out into the water in Area 2. A dock formerly occupied approximately 1,430 lineal feet of the site in Area 2; the dock was built in 1942 and destroyed by fires in 1957 and 1983.

Stormwater outfalls (OFs) are present along the river at the site. Two City of Portland (COP) OFs (OFs 6 and 7) for combined sewer overflows (CSOs) are present along the river at the site. In addition, an Oregon Department of Transportation (ODOT) stormwater outfall (OF 42) is in the north part of the site, near COP OF 7 (Figure 2-2). Two OFs that drain the Zidell waterfront property are also present at the site, including two 18-inch lines (OFs 1 and 2) draining Area 1 (the barge-building yard south of the Ross Island Bridge). Two OFs that drain the Zidell or Westwood Development Corporation properties are also present at the site, including two 10-inch lines north of the Ross Island Bridge.

### 2.1.2 Surface Water Hydrology & Fluvial Setting

The site is located between river miles 13 and 15 of the Willamette River, between the Marquam Bridge and Ross Island. Along this reach, the river flows northwest and is 1,400 to 1,500 feet wide. The main channel is bifurcated by Ross Island along this reach of the river. During periods of low and medium flows, tidal effects are evident to river mile 26.5 (Willamette Falls); reverse flow has been measured as far upstream as Ross Island (river mile 15) during low-flow periods.

Figure 2-4 shows the bathymetry for the Willamette River near the site, based on soundings measured in fall 2000 and winter 2003. Near shore river currents appear to support deposition of fine-grained sediment resulting in the creation of a lateral bar or sill, and the development of shallow water habitat. Sediment is generally being deposited near the former dock area next to the north-central part of the site. At the site, shallow water habitat includes the riverbank from an elevation of 18 feet above the Columbia River datum (CR) to a depth of -20 feet CR in the river.

Deep water habitat is found below -20 feet CR. On the basis of the bathymetry, shallow water habitat extends up to 350 feet from the riverbank in the north part of the site and extends to less than 60 feet from the riverbank in the south part of the site. Deeper water in the nearshore area in the south part of the site is attributed to historical dredging. Zidell personnel have indicated that parts of the river next to the dock were dredged to
maximum depths of -32 feet CR in 1955, -30 ft CR in 1961 (500 feet along the south part of the dock), and -32 ft CR in 1978 (585 feet along the south part of the dock) to accommodate passage and moorage of vessels.

2.1.3 Geology and Hydrogeology
The geology of the Portland area is characterized by a broad structural depression or basin filled with sedimentary rocks and bordered by the Cascade Mountains on the east and the Coast Range on the west. Geologic formations in the basin are also folded and cut by a number of northwest-trending faults. The Portland Hills (Tualatin Mountains) form a northwest-trending anticlinal ridge that is faulted along its eastern flank by the Portland Hills fault. The Willamette River flows along the base of the eastern side of the Portland Hills; the Zidell site is located on the southwest bank of the river. A number of additional faults are located approximately parallel or perpendicular to the Portland Hills Fault and are mapped along or near the Portland Hills, with an inferred fault projected immediately west of the site. Upland areas along the margin of the basin are commonly capped by flows of the Columbia River Basalt Group (CRBG), localized flows of Boring lava, and occasionally by sediments of the Troutdale Formation.

The CRBG underlies the entire basin and is overlain by up to 1,300 feet of sediments, deposited primarily by the Columbia and Willamette rivers. From the ground surface to depth, the sediments are composed of up to 200 feet of younger alluvium and up to 1,100 feet of older alluvium, including the Troutdale and Sandy River Mudstone formations.

The site is underlain by up to 35 feet of fill material consisting of construction debris, scrap metal, and material dredged from the Willamette River, and by 25 feet of overbank deposits (from periodic flooding of the river) consisting of clay and fine-grained sandy silt. A sand unit that apparently underlies the overbank deposits near the site is approximately 75 feet thick.

The younger alluvium is underlain by the Pliocene Troutdale Formation. This formation consists of a thick sequence of gravel and sandstone conglomerate with minor beds of clay and sand. The Pliocene-age Sandy River Mudstone (or fine-grained equivalent) underlies and interfingers with the Troutdale Formation. It is composed of mudstone and claystone with scattered lenses of sandstone and conglomerate. The Miocene-age CRBG underlies the Sandy River Mudstone.

The geologic units have been divided into eight major hydrogeologic units in the Portland Basin (Hartford and McFarland, 1989; Swanson et al., 1993; McFarland and Morgan, 1996). From youngest to oldest, they include: (1) the unconsolidated sedimentary aquifer (USA); (2) the Troutdale gravel aquifer (TGA) in the Troutdale
Formation; (3) confining unit 1 (CU1); (4) the Troutdale sandstone aquifer (TSA) in the Troutdale Formation; (5) confining unit 2 (CU2); (6) the sand and gravel aquifer (SGA); and (7) Columbia River Basalt Group (CRBG) flows and interflow zones. The eighth unit consists of undifferentiated fine-grained sediments (UF) and occurs in areas of the basin where the TSA and SGA are absent or where there is insufficient information to characterize the aquifer units in the fine-grained Sandy River Mudstone.

The following aquifers are interpreted to be present at or near the site: the unconsolidated sediments of the USA (generally underlying fill material from 34 feet to 100 feet bgs), the cemented sand and gravel deposits of the TGA (generally below 100 feet bgs), the UF (generally below 200 feet bgs), and the CRBG aquifer (generally below 200 feet bgs). The clayey silt and sand of the USA near the Willamette and Columbia rivers yield from 5 to 40 gallons per minute (gpm), depending on a well’s location (McFarland and Morgan, 1996). The poorly to moderately cemented conglomerate and sandy conglomerate of the TGA is an important and productive aquifer in the Portland Basin, in which many public-supply, industrial, and domestic wells are completed. Most wells will yield a minimum of 50 gpm (McFarland and Morgan, 1996). Several engineering and industrial wells located near the site are completed in this aquifer. The UF is generally a poor water-bearing formation. The CRBG is also used as an aquifer near the site and is capable of producing more than 1,000 gpm.

Groundwater is present in the fill material at depths ranging from about 5 feet and 30 feet depending on a well’s location and the season. The depth to water varies seasonally, with the greatest fluctuations observed near the Willamette River. Groundwater flows toward and discharges into the Willamette River. The shallow groundwater flow direction, however, may be locally modified by seasonal fluctuations in the river and by permeability differences associated with underground utility piping and different types of fill. Horizontal gradients range from 0.02 ft/ft to 0.05 ft/ft. Estimates of horizontal hydraulic conductivity ($K_h$) range from 0.00075 feet per minute (ft/min) in MW-11 to 0.102 ft/min. Estimates of horizontal groundwater velocity for the shallow fill aquifer range from 0.06 ft/day to 17.28 ft/day.

### 2.1.4 Climate and Meteorology

The climate in Portland is west coast marine, characterized by moderate rainfall. About 80 percent of the rainfall occurs from October to May, 9 percent in June and September, and 3 percent in July and August. The average rainfall in Portland is 36.3 inches, according to records from 1961 to 1990. December is the wettest month, with rainfall averaging 6.1 inches. July is the driest month, averaging 0.63 inches of rainfall.
Wind direction is usually northwesterly in spring and summer and southeasterly in fall and winter. Average wind speed in Portland ranges from 6.5 miles per hour (mph) in early autumn to 10 mph in winter. The annual mean wind speed is 7.9 mph (Oregon Climate Service, 2001). The highest summer temperatures generally occur when hot, dry continental air masses move west through the Columbia River Gorge. Cold continental air moving through the gorge in the winter brings the coolest weather. In general, temperatures in the winter range from 32°F to 52°F. Temperatures in the summer range from 54°F to 80°F.

2.1.5 Current and Reasonably Likely Future Land Use
The 32.17-acre Zidell waterfront property has been a heavy industrial site since the turn of the last century, and adjacent properties have been industrialized since before World War II. The Zidell property and adjacent properties are currently zoned for central commercial use (CXdg). The CX zone is intended to provide for commercial development within Portland’s most urban and intensely developed areas. A broad range of uses is allowed to reflect Portland’s role as a commercial, cultural, and governmental center.

Future development of the site is expected to emphasize commercial, retail, and high-density residential development, similar to other proposed or completed development projects near the site and immediately north of the Marquam Bridge. The site is subject to the Central City and North Macadam design guidelines. Figure 2-5 shows the anticipated future site infrastructure layout. The Willamette River Greenway overlay provides for a greenway setback that extends 100 feet landward from the existing top of the bank.

2.1.6 Current and Reasonably Likely Future Beneficial Water Use
Groundwater. The Zidell property and the region are supplied with potable water by the COP municipal water supply. Groundwater in the general vicinity of the site is not now used or anticipated to be used as a source of drinking water at or near the site. The site and the North Macadam District will be redeveloped in the future and will be supplied with water by the COP municipal water supply.

Shallow groundwater discharges to or is recharged by the Willamette River (depending on the season). Groundwater is currently not used or anticipated to be used for beneficial purposes in the future in the region except as recharge for the Willamette River. Beneficial uses of shallow groundwater include discharge to the Willamette River. Beneficial uses of surface water include aesthetic quality, recreation, transportation,
wetland areas, fishing and hunting, anadromous fish passage, and fish and wildlife habitat. Deeper groundwater from Troutdale and deeper aquifers in the region is currently used and is reasonably anticipated to be used for industrial and engineering purposes in the future. The Zidell waterfront property has not adversely affected these beneficial uses of deep groundwater within the region.

**Surface Water.** The Willamette River is the sole surface water body within the locality of the facility. Beneficial uses of Willamette River water include aesthetic quality, recreation, transportation, wetland areas, fishing and hunting, anadromous fish passage, and fish and wildlife habitat.

Future water supply sources may include the Willamette River upstream of the site. Currently, the cities of Tigard, Wilsonville, Tualatin, and Sherwood are evaluating the use of Willamette River water and the construction of a water treatment plant on the Willamette River. Plant intakes would be at least 24 miles upstream of the site and above Willamette Falls and the quality of surface water would not be affected by COIs detected in soil, groundwater, or sediment at the Zidell site. Other current uses of the Willamette River are unlikely to change in the future.

### 2.2 Site History

In 1926, Coast Steel and Machinery occupied the north part of the site. By 1930, Zidell Machinery and Supply Company and Zidell-Steinberg Company occupied a warehouse and sold steel plates from a small area east of and next to SW Moody Avenue, north of the Ross Island Bridge. From 1920 to 1942, numerous businesses occupied the rest of the present site. In 1942, Commercial Iron Works was constructed. From 1942 to 1947, Commercial Iron Works built and repaired ships during World War II. Ships were built south of the Ross Island Bridge, where a large dock was constructed to support such operations.

In 1947, the Zidell Ship Dismantling Company leased the Commercial Iron Works dock from the Portland War Assets Administration. The Zidell Company dismantled surplus World War II ships on the river beside the docks until cranes could move sections to the shore north of the Ross Island Bridge for final dismantling and storage. Electrical wire was burned to recover copper in an open pit and later in two incinerators north of the Ross Island Bridge. Various Zidell companies, a steel-tube-forging business, and a plumbing supply company occupied the site during the 1950s and 1960s.

In 1965, a fire destroyed five Commercial Iron Works buildings south of the Ross Island Bridge. A Zidell company began building barges in a new metal building constructed on the south part of the site in 1968. In 1973, a second fire destroyed another Commercial
The Iron Works building immediately south of the Ross Island Bridge. The docks caught fire in 1957 and in 1983.

Ship dismantling, wire burning, and secondary aluminum smelting ceased by approximately the mid-1970s. Since that time, most site activity has been in buildings south of the Ross Island Bridge, where Zidell companies maintain offices and Zidell Marine Corporation has barge-building facilities. From about 1983 to 1986, Jones Construction Company leased the site north of the bridge to manufacture prefabricated modular housing.

Most of the current site activity is on Tax Lot 42, where the Zidell companies maintain offices. Zidell Marine Corporation builds and sells or leases steel barges, and Zidell manages the Zidell companies’ real estate holdings. Current manufacturing activities are essentially limited to barge fabrication by Zidell Marine Corporation, in the large building on the south part of Tax Lot 42 (see Figure 2-3).

### 2.3 Regulatory History

On December 13, 1968, the first waste discharge permit was issued to Zidell Explorations, Inc., to control oil discharges to the river during ship dismantling. Oil recovered from ships was transferred to a bottomless oil/water separator, floating on the Willamette River, from which oil was pumped as it accumulated.

In 1969, the DEQ disapproved the continued use of the floating separator and, as part of a July 1, 1970 wastewater discharge permit, required Zidell to construct an on-shore oil/water separator system that controlled ship ballast water, yard runoff, and other oily water. The permit expired on December 31, 1979 and was not renewed because ship dismantling had ceased.

DEQ files for Zidell Explorations, Inc. record oil spills into the Willamette River on July 5, 1972 and September 6, 1973. In addition, on September 24, 1986 the DEQ recorded an oil spill into the Willamette River from a floating crane.

On May 12, 1975, an air contaminant discharge permit (ACDP 26-2071) was issued for secondary smelting. On June 1, 1980, the ACDP expired and was not renewed because smelting had ceased.

In April 1988, Zidell removed four USTs, including one 5,000-gallon heating oil UST, two 1,000-gallon gasoline USTs, and one 10,000-gallon UST, as recorded in the DEQ UST files under the Resource Conservation and Recovery Act (RCRA). Zidell personnel reportedly observed no releases from the USTs when they were removed.
Since September 1989, Zidell Explorations, Inc., has been registered as a RCRA hazardous-waste generator of F001, F005, D001, D003, and D008 hazardous wastes (USEPA generator identification No. ORD 0277165650), which are shipped off-site for treatment and/or disposal.

Zidell was issued a National Pollutant Discharge Elimination System (NPDES) 1200-Z general stormwater discharge permit in June 1999.

2.4 Previous Investigations

2.4.1 Federal Preliminary Assessment
In September 1987, the DEQ completed a federal preliminary assessment (PA) of the site with oversight from the USEPA, and concluded that the site should be investigated further because of past industrial land use (DEQ, 1987).

In 1988, EPA’s Contractor, Ecology and Environment Inc. (E&E) prepared a site investigation report. E&E’s site inspection concluded in July 1988 that although on-site hazardous waste disposal was not confirmed, past on-site land use suggested the potential for past releases of hazardous substances (E&E, 1988). Because of the limited use of surface water and groundwater, E&E concluded that the risk to human health and the environment did not merit further assessment by the USEPA. Further investigation was left to the property owner, under DEQ oversight.

In November 1990, a strategy recommendation was prepared by the DEQ Site Assessment Section. The recommendation was to perform an expanded preliminary assessment (XPA) to collect representative soil and groundwater samples and determine whether remedial action was necessary at the site.

2.4.2 OMNI Environmental Evaluation
The earliest environmental sampling at the site was conducted by OMNI in 1988 (OMNI, 1989). The sampling results indicated the presence of arsenic, lead, chromium, PCBs, PAHs and petroleum hydrocarbons in soil. Volatile organic compounds (VOCs) and metals were detected in groundwater samples.

2.4.3 EMCON Preliminary Assessment & Site Investigation
EMCON performed a PA in 1994 to identify potential threats to human health and the environment (EMCON, 1994). The PA completed by EMCON concluded that potential...
releases of asbestos, metals, oils, PAHs, and solvents may have occurred. Site features or areas of concern (AOCs) included former wire-burning incinerators, transformers, open-pit wire-burning area, gasoline and fuel oil USTs, oil/water separator near the river, steam-cleaning area and crane pit sump, electrical/maintenance/carpentry shop, oil-storage area, and the steam-cleaning area, and non-point source releases generated during historical ship dismantling, salvaging, and processing operations or from materials in the fill. The identification of these features is provided in Table 2-1 and the locations illustrated in Figure 2-6.

From April 1995 to February 1996, EMCON performed an expanded preliminary assessment (XPA) to characterize the distribution of hazardous substances at the site to evaluate possible threats to human health and the environment, and determine what areas of the site required additional assessment. A total of 130 soil samples, 24 groundwater samples, and 18 sediment samples were analyzed primarily for metals, PCBs, PAHs, VOCs, and chlorinated herbicides in selected areas. The presence of asbestos was noted during subsurface exploration. The results from the XPA were incorporated into the RI, and are discussed in Section 3 of this report.
3 Remedial Investigation Summary

A general description of the RI is summarized below. Specific procedures and methods for conducting the investigation activities are presented in the RI Report. The RI was completed by Maul Foster and Alongi, Inc. (MFA) between 1997 and 2004. Plans and reports prepared by MFA on behalf of Zidell are summarized in the Administrative Record Index.

3.1 Remedial Investigation Elements

A number of areas of concern identified in pre-RI investigations were further characterized during the RI. The characterization of site soils included collection of additional samples to determine background concentrations for metals, and determine the horizontal and vertical extent of soil contamination. A total of 32 Geoprobe™ borings were installed and 15 test pits excavated to characterize the horizontal and vertical extent of soil contamination.

The groundwater investigation included installation of seven additional groundwater monitoring wells to improve the coverage of the groundwater monitoring network. The groundwater monitoring wells were located to assess previously identified groundwater contamination and potential groundwater impacts downgradient of areas with elevated concentrations of metals in subsurface soil to assess potential leaching of contaminants from soil to groundwater and migration to the Willamette River. Subsurface soil samples were also collected and analyzed during the installation of new groundwater monitoring wells to further assess the vertical distribution of hazardous substances. Groundwater monitoring was conducted during completion of the RI from wells where COIs were detected above screening criteria (e.g. drinking water maximum contaminant levels [MCLs], ambient water quality criteria [AWQC], or ecological screening level values [SLVs]). Measurements were also collected to assess aquifer properties to evaluate transport and fate of chemicals of interest (COIs) migrating in groundwater.

The Willamette River sediment investigation, which was completed in several phases, included sampling and analysis of 72 bulk sediment and 21 pore water samples collected at and near the Zidell waterfront property to evaluate sediment physical properties, the distribution of COIs in sediment, toxicity and the potential for impact to surface water quality. The COIs included in the analytical testing included PCBs, PAHs, metals, butyltins, and TPH. In addition, 15 bulk sediment samples were tested for toxicity using acute 10-day amphipod (Hyalella azteca) survival test and acute/chronic 10-day midge (Chironomus tentans) survival and growth tests.
COIs that affect all media at the site (soil, groundwater, and river sediment) are as follows: PCBs, metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), PAHs, and petroleum hydrocarbons (primarily in the heavy-oil and diesel ranges). The RI also evaluated VOCs in soil and groundwater, chlorinated herbicides and organophosphorous pesticides near an area on the neighboring Schnitzer property where pesticides were formulated, dioxins and furans in soil in wire burning areas, and butyltins in sediment. Asbestos-like material has been observed in soil near the riverbank. Impacts in the upland area extend from the ground surface to depths up to 34 feet in localized areas. Willamette River sediments are impacted in some areas from the riverbank to 500 feet into the river and to at least 10 feet below the sediment/water interface.

In September 2004, additional investigation was conducted to characterize the contaminant distribution in the riverbank to support development of remedial alternatives for the FS (MFA 2004b). As part of this investigation, surveys were conducted to assess the bank dimensions, evaluate habitat characteristics, and bank stability. A total of 28 transects were surveyed along the bank and soil samples were collected at elevations of approximately 13 feet and 24 feet COP datum and analyzed for metals, PAHs, PCBs, and organotins. Samples of insulation debris were also collected to verify the presence of asbestos.

### 3.2 Nature and Extent of Contamination
The following subsections summarize the nature and extent of contamination in soil, groundwater, sediment, and sediment pore water at the Zidell site.

#### 3.2.1 Soil
The following COIs were detected above the screening values protective of human and ecological receptors (see Section 3.4) in soil: PCBs (primarily Aroclor 1254, Aroclor 1260, and total PCBs); antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc; PAHs; VOCs (benzene); and petroleum hydrocarbons (diesel, gasoline, oil, grease, and other petroleum hydrocarbons). Table 3-1 summarizes the range of concentrations of COIs detected in soil in the site upland areas, and Table 3-2 summarizes COIs detected in surface soils along the bank of the Willamette River.

Soil contamination in Areas 2 and 3 were more widespread than in Area 1, presumably because Area 1 has been paved during much of the operational history of the site and much of the salvaging operations occurred in Areas 2 and 3. For the most part, significant contamination is limited to less than 5 feet below ground surface (bgs), except
in a limited area in Area 2 and near the shoreline where contaminant distribution is more complex as a result of historical fill activities.

**Asbestos Materials.** Asbestos containing material (ACM) has been confirmed in landfilled insulation materials in several locations along the riverbank in the area where ship salvaging activities historically occurred. The landfilled material containing ACM is several feet thick in these areas.

**VOCs & TPH.** A number of chlorinated and fuel related VOCs were detected in soil in the former locations of USTs in Area 1. Detected concentrations were below their respective USEPA Region 9 preliminary remediation goals (PRGs) and hot spot concentrations, except for benzene in one sample. VOCs were generally not detected in soil in Areas 2 and 3. Detected concentrations did not exceed their respective PRGs. Heavy weight petroleum hydrocarbons products were detected in at concentrations ranging from 20 mg/kg to 80,000 mg/kg.

**Metals.** Of the nine metals that were evaluated in the RI, antimony, arsenic, and lead exceeded background concentrations or PRGs with the highest frequency. Lead is widespread at the site and concentrations exceeding background levels in approximately half of the samples tested for lead. The highest lead concentrations were detected in Area 3, with a maximum detected concentration of 58,000 mg/kg. Other metals detected at concentrations significantly above background levels include antimony, cadmium, chromium copper, mercury and zinc.

**Polycyclic Aromatic Hydrocarbons.** Carcinogenic PAHs were detected more frequently in Area 2 than in Areas 1 and 3. Benz(a)anthracene and benzo(a)pyrene were detected above their respective PRGs and hot spot concentrations at only one location in Area 1, the former steam cleaning area next to the maintenance building. Carcinogenic PAHs were detected in approximately one-half the samples collected from Area 1, with most of the detected concentration exceeding PRGs. Only one of eighteen samples collected from Area 3 exceeded PRGs.

**Polychlorinated Biphenyls.** PCB Aroclors detected in Area 1 at levels exceeding PRGs but below hot spot concentrations were limited to the transformer locations. Total PCB Aroclors exceeded hot spot concentrations in Area 2 at nine sampling points, and in Area 3 at six sampling locations.

**Dioxins and Furans.** Soil samples collected near former wire-burning areas were analyzed for dioxins and dibenzofurans. Analytical results for dioxins and furans are reported in terms of a number of chlorinated dibenzo-\(p\)-dioxin and dibenzofuran congeners, which have similar molecular structures but differ in number and position of chlorine atoms on the molecule, which results in varying degrees of congener toxicity. The congener 2,3,7,8-tetrachlorodibenzo-\(p\)-dioxin (TCDD) is the most toxic of the
congeners, and so is commonly used to represent the entire group of dioxins and furans. The less-toxic congeners are usually referred to in terms of “TCDD equivalents” and thus are each assigned a specific toxic equivalency factor (TEF) by which the detected concentrations of each congener are multiplied to obtain TCDD-equivalent concentrations. Transformed concentrations can then be compared to the PRG for TCDD, which is the only congener assigned a USEPA Region 9 PRG. Dibenzofuran congeners were the only compounds detected above the equivalent 2,3,7,8-TCDD PRG.

3.2.2 Groundwater
Groundwater monitoring has been performed since 1995 from 15 monitoring wells completed prior to and as part of the RI. Groundwater monitoring was also conducted using push-probe sampling methodology in discrete areas to assess the nature and extent of petroleum contamination associated with USTs or sumps.

As noted above, shallow groundwater is not currently used for drinking water purposes and is not expected to be used for drinking water in the future. Therefore, the only potential receptors for shallow groundwater are aquatic organisms in the surface water and sediments of the Willamette River. The groundwater monitoring results are therefore compared with AWQC for the protection of ecological receptors in freshwater established by the USEPA and the DEQ’s Level II ecological screening level values (SLVs) for freshwater.

Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, PCB Aroclors 1254 and 1260, ethylbenzene, xylenes, toluene, and carbon disulfide have been detected in at least one location at levels exceeding DEQ’s SLVs or the AWQC. Table 3-3 summarizes the groundwater data for metals, PAHs and PCBs.

VOCs and TPH. A number of VOCs were detected in one or more samples in groundwater samples collected from MW-5, which is located approximately 500 feet from the Willamette River shoreline. Detected concentrations did not exceed the AWQC or DEQ SLVs, except for ethylbenzene (up to 12.6 µg/L) and xylenes (up to 32 µg/L for m,p-xylene and up to 75 µg/L for total xylenes). Occasional detections of VOCs have been reported in other on-site monitoring wells at levels below the AWQC or SLVs.

Detected concentrations of diesel in wells near UST areas have periodically exceeded 1 mg/L. TPH concentrations in downgradient monitoring points located near the shoreline occasionally exceeded 1 mg/L of diesel or heavy oil. As discussed in Section 3.5.3, contaminant transport modeling indicates VOCs and TPH in groundwater are not predicted to reach the Willamette River at significant concentrations.
**Polychlorinated Biphenyls.** Aroclors 1254 and 1260 was the only PCB congener detected in groundwater at the site. All of the detected concentrations exceeded AWQC of 0.014 µg/L, but did not exceed the DEQ SLV for aquatic receptors of 94 µg/L. The concentrations of Aroclors detected in these wells have decreased since 1997 coincident with modified sampling procedures that reduced the suspended solids in samples. The detections of PCBs in groundwater, therefore, are suspected to be associated with PCBs sorbed to fine soil particles and not dissolved in groundwater.

**Total and Dissolved Metals.** Groundwater samples were analyzed for antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Compared with dissolved metal concentrations, total metal concentrations were consistently higher. The elevated total metals concentrations are believed to be attributable to the mobilization of fine grained soil particles caused by the purging and sampling methodology. Turbid groundwater samples typically result metal concentrations that are not indicative of the concentrations actually moving in the aquifer.

Detected concentrations of total and dissolved metals varied during monitoring from 1997 through 1999. In general total concentrations declined during this period after low-flow sampling techniques were implemented. Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc have been detected at concentrations exceeding DEQ fresh water SLV for aquatic receptors from MW-5 and/or MW-9. Groundwater modeling results indicate metals will not reach the Willamette River at levels exceeding ambient water quality criteria (AWQC).

**Polycyclic Aromatic Hydrocarbons.** Detected concentrations of PAHs did not exceed their respective AWQC or DEQ SLVs for aquatic receptors, except for benz(a)anthracene and benzo(a)pyrene in samples from MW-5 and MW-8 that were collected in 1995. These detections are likely due to suspended sediments in the water samples as discussed for PCBs.

**Chlorinated Herbicides and Organophosphorous Pesticides.** Groundwater samples from MW-6 and MW-11 were analyzed for chlorinated herbicides and organophosphorous pesticides because the wells are near a former pesticide and herbicide manufacturing company northwest of this part of the site (Unit A of the former Schnitzer property). Pesticides were not detected at or above the MRLs in groundwater samples collected from the wells. Generally herbicides were not detected at or above the MRLs, except for 2,4,5-T, 2,4,5-TP (silvex), 2,4-D, and dicamba in samples collected in 1994 and 1995. Herbicide concentrations were detected at low part per billion (ppb) levels. There are no AWQC or DEQ SLVs available for these compounds.
3.2.3 Sediment
Sediment samples were collected from the Willamette River adjacent to the facility during 4 rounds of sampling. Figure 3-1 shows the facility storm drainage system and associated outfalls and the location of the sediment sampling locations. The following summarizes the nature and extent of COIs in surface and subsurface sediment and pore water and the results of the toxicity testing. Detected concentrations are compared with the DEQ SLVs used in the Level II Screening Ecological Risk Assessment (ERA). Significant levels of contamination are located within 200 feet of the shoreline, although concentrations of metals above background levels were measured up to 500 feet from the shoreline. Background levels were estimated by DEQ based on upstream monitoring in the proximity of Ross Island. The estimated area of significant sediment impacts is discussed in Section 4. Table 3-4 summarizes the results of the sediment testing for COIs for the site.

3.2.3.1 Surface Sediment
Surface sediment is defined as sediment collected from the biologically active zone (depth of 30 centimeters or about 10 inches).

Polychlorinated Biphenyls. PCBs were generally detected only in surface sediment samples. Aroclor 1254 was detected in nine samples at concentrations ranging from 0.12 mg/kg to 5 mg/kg. The detected concentrations exceeded the toxicity SLV of 0.007 mg/kg. Aroclor 1260 was detected in 19 samples at concentrations ranging from 0.0051 mg/kg to 2.6 mg/kg. Fourteen of the detected concentrations exceeded the toxicity SLV of 0.034 mg/kg. Total PCBs were detected in 19 samples at concentrations ranging from 0.0255 mg/kg to 8.45 mg/kg. Sixteen of the detected concentrations exceeded the toxicity SLV of 0.034 mg/kg.

Metals. The distribution of metals contamination is similar to PCBs and other COIs, with metals concentrations exceeding DEQ SLVs in samples located adjacent to the shoreline. Metals concentrations exceeding SLVs include antimony, arsenic, cadmium, chromium, copper, lead, mercury nickel and zinc:

- Antimony was detected at concentrations exceeding the SLV of 3 mg/kg in three sediment samples;
- Arsenic was detected at concentrations exceeding the SLV of 6 mg/kg in seven of 29 surface sediment samples;
- Cadmium was detected at concentrations ranging from 0.12 mg/kg to 6.5 mg/kg, all of which exceed the toxicity SLV of 0.6 mg/kg;
Chromium was detected in all surface sediment samples at concentrations ranging from 11.2 mg/kg to 143 mg/kg. The toxicity SLV for chromium is 37 mg/kg;

Copper was detected in all surface sediment samples at concentrations ranging from 1.6 mg/kg to 1,210 mg/kg. The toxicity SLV of 36 mg/kg was exceeded in samples collected from along the entire shoreline of the site. The highest concentrations were detected near stormwater outfalls and the barge launchway;

Lead was detected at concentrations ranging from 2 mg/kg to 2,290 mg/kg. The toxicity SLV of 35 mg/kg was exceeded in samples collected from along the entire shoreline. The highest concentrations were detected near stormwater outfalls and the barge launchway and under parts of the former dock;

Mercury was detected at concentrations ranging from 0.016 mg/kg to 1.4 mg/kg. The toxicity SLV of 0.2 mg/kg was exceeded in samples collected from samples located along the shoreline, with highest concentrations detected near outfalls immediately north of the Ross Island Bridge;

Nickel was detected in all surface sediment samples at concentrations ranging from 12 mg/kg to 108 mg/kg. The toxicity SLV of 18 mg/kg was exceeded in most of the samples;

Zinc was detected in all surface sediment samples at concentrations ranging from 35 mg/kg to 2,270 mg/kg. The toxicity SLV of 123 mg/kg was exceeded in samples collected from along the shoreline.

Polycyclic Aromatic Hydrocarbons. PAHs were detected in surface sediment samples at most of the sampling locations. The highest concentrations of low-molecular-weight PAHs (LPAHs) in surface sediment were detected near the south part of the former dock and a former oil/water separator at a concentration of 4,330 micrograms per kilogram (µg/kg). Detected concentrations decreased with depth. PAHs included in the calculation of total LPAHs were 2-methyl naphthalene, naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

The highest concentrations of high-molecular-weight PAHs (HPAHs) were also detected near the south part of the former dock and a former oil/water separator at levels up to 22,460 µg/kg. Detected concentrations decreased with depth and with increased distance from the shoreline. Total HPAHs were calculated from fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, dibenzofuran, and benzo(g,h,i)-perylene.
**Petroleum Hydrocarbons.** Hydrocarbon scans generally detected only diesel and heavier petroleum hydrocarbons. Diesel was detected in surface sediment samples collected from upstream of the site at levels up to 74 mg/kg in WRS-22. Diesel was also detected upstream of the site, offshore of the barge launchway, and offshore of COP OF 6.

Lube oil was detected at concentrations ranging from 78 mg/kg to 8,600 mg/kg. Motor oil was detected at concentrations that ranged from 0.17 mg/kg to 890 mg/kg in WRS-46.

**Butyltins.** Tributyl tin (TBT) is the active ingredient in marine anti-foulant paints that may have been present on ships that were salvaged and scrapped at the site. Zidell has reported that they have not used TBT-containing anti-foulant paints on barges. TBT degrades to dibutyltin and monobutyltin by photolysis in surface water and by biological degradation in sediment.

The highest concentrations of dibutyltin and monobutyltin were detected in subsurface sediment samples collected near the south part of the former dock. TBT was detected in surface sediment samples at concentrations ranging from 2 µg/kg to 1,990 µg/kg. TBT concentrations exceeded the toxicity SLV of 3 µg/kg at all locations. Dibutyltin (DBT) was detected in surface sediment samples at concentrations ranging from 2 µg/kg to 368 µg/kg. DBT concentrations exceeded the toxicity SLV of 3 µg/kg in all but four sampling locations. Monobutyltin (MBT) was detected in surface sediment at concentrations ranging from 0.85 µg/kg to 1,140 µg/kg. MBT concentrations exceeded the toxicity SLV of 3 µg/kg at all but four locations sampled.

**Bioassay Toxicity Testing.** Field activity included collecting sediment samples for bioassays (10-day Chironomid and Hyalella tests). The samples submitted for Chironomid tests indicated no statistically significant mortality. Only one sample elicited adverse effects related to Chironomid growth. Three samples elicited statistically significant mortality in Hyalella. A relatively high incidence of mortality (28.8 percent) was seen in one sample collected about 150 feet offshore. A moderate incidence of mortality (17.5 percent) was seen in one sample located downriver and about 500 feet offshore of the north part of the site.

### 3.2.3.2 Subsurface Sediment

Depth-discrete sediment samples were collected at depths ranging from 1 to 10 feet. PCBs were generally detected in deeper sediments near the shoreline but not in samples collected beyond 100 feet from the shoreline. Detected concentrations of Aroclor 1260 decreased with depth, except in WRS-37.
Metals concentrations generally decreased with depth except along the shoreline in the former dock location at 8 sampling locations where significant levels of barium, chromium copper, lead and zinc were detected in subsurface sediments.

PAHs were detected in sediment samples collected from all borings except at two locations. Detected concentrations generally decreased with depth. The highest concentrations of LPAHs (2,500 ug/kg) and HPAHs (3,600 ug/kg) in subsurface sediment were detected at a depth of 7 feet bgs. The toxicity SLVs for the following PAHs were exceeded in one or more locations: 2-Methylnaphthalene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, phenanthrene, and pyrene.

Hydrocarbon scans generally detected only diesel and heavier petroleum hydrocarbons. Diesel was detected in two subsurface sediment samples collected at a depth of 5 feet bgs at concentrations of 98 mg/kg and 160 mg/kg. Motor oil was detected at concentrations that ranged from 42 mg/kg at 10 feet bgs to 900 mg/kg at 5 feet bgs. Detected concentrations of motor oil decreased with depth in several locations, but increased with depth at several others.

TBT concentrations in subsurface sediments ranged from 1 µg/kg to 14,000 µg/kg at 7 feet bgs. TBT concentrations exceeded the toxicity SLV of 3 µg/kg in all but one sample. DBT concentrations ranged from 16 µg/kg to 360 µg/kg, which exceed the toxicity SLV of 3 µg/kg. MBT concentrations ranged from 0.72 µg/kg to 58 µg/kg, with only one sample exceeding the toxicity SLV of 3 µg/kg.

### 3.2.4 Sediment Pore Water

Sediment pore water analyses were performed on samples collected from the biologically active zone at 21 locations and analyzed for butyltins, metals, and ammonia.

TBT and DBT were detected in only one pore water sample at a concentration of 0.6 µg/L, which exceeded the toxicity SLV of 0.063 µg/L. MBT was detected at three locations at concentrations ranging from 0.22 µg/L to 5.3 µg/L and above the SLV of 0.063 µg/L.

Antimony, cadmium, and mercury were not detected in sediment pore water samples. Arsenic was detected at concentrations ranging from 0.0012 mg/L to 0.0042 mg/L, below the toxicity SLV of 0.150 mg/L. Chromium was detected in all samples at concentrations ranging from 0.0014 mg/L to 0.008 mg/L, below the SLV for hexavalent chromium of 0.011 mg/L. Copper concentrations ranged from 0.0011 mg/L to 0.012 mg/L, with one sample exceeding the toxicity SLV of 0.009 mg/L. Lead was detected in two samples...
with one sample exceeding the toxicity SLV of 0.0025 mg/L. Nickel was detected at concentrations ranging from 0.0019 mg/L to 0.0063 mg/L, which are below the toxicity SLV of 0.052 mg/L. Zinc was detected at concentrations ranging from 0.0043 mg/L to 0.026 mg/L and below the toxicity SLV of 0.120 mg/L.

Ammonia was detected at concentrations ranging from 1.4 mg/L to 60 mg/L. The detected concentrations exceeded the toxicity SLV of 0.017 mg/L.

3.3 Contaminant Fate and Transport
This section discusses the processes that control the fate and transport of the COIs detected in soil, groundwater and sediment at the Zidell site. COIs in this evaluation include organic compounds: PCBs, PAHs, and TPH constituents; and metals.

3.3.1 Soil
The COIs in soil are adsorbed to soil particles. Adsorption is expected to be the primary mechanism affecting contaminant fate in the subsurface at the site. Fate and transport mechanisms for COIs adsorbed to soil particles are discussed below.

Polychlorinated Biphenyls. PCBs have low aqueous solubility, relatively low vapor pressure, and extreme resistance to chemical reaction. PCBs tend to adsorb strongly to soils and to resist dissolution. The low solubility of PCB mixtures inhibits the migration of PCBs from soil to groundwater. PCBs have a high vapor pressure and volatilization is not a major factor in the environmental fate and transport of PCBs. PCBs are very stable compounds that resist both oxidation and hydrolysis, undergo very limited photolysis, and are resistant to biodegradation. Because of the persistence and low mobility of PCBs, most PCB contamination is persistent in the environment and tends to be confined to soils close to the point of release, except in circumstances where contaminated soil is transported via erosion cause by significant rainfall events.

Polycyclic Aromatic Hydrocarbons. The breakdown of PAHs in soil is accomplished largely by biodegradation, although biodegradation potential of PAHs decreases as the number of aromatic rings increases. Typically, PAHs with five aromatic rings are relatively resistant to biodegradation. PAHs are similar to PCBs in that they tend to adsorb to soils, particularly soils that are high in organic content, and that volatilization is not typically an important transport process.

Diesel- and Heavy-Oil-Range Petroleum Hydrocarbons. The principal fate of diesel- and heavy oil-range TPH is biodegradation. Petroleum products released into the environment undergo weathering as a result of both volatilization and leaching. Evaporative processes are important in the weathering of petroleum products that contain
a large proportion of volatile components. Given that the fraction of volatile components is low for diesel- and heavy-oil-range TPH, volatilization is not an important transport process for the TPH constituents released at the site.

Leaching introduces the soluble components of petroleum hydrocarbon into the water phase. Aromatics, especially BTEX, tend to be the most water-soluble components. Given that diesel- and heavy oil-range petroleum products tend to have a low aromatic content, leaching tends not to be an important process for those petroleum products. Groundwater monitoring at the site has detected TPH contamination generally less than 1 mg/L, and VOCs including BTEX in the low part per billion ranges. Elevated TPH concentrations may be associated with suspended sediments in the groundwater samples. Groundwater modeling was performed to assess horizontal transport of TPH to the Willamette River. Significant levels of TPH in groundwater were not predicted to reach the Willamette River from inland on-site source areas.

**Metals.** The fate and transport of a metal in soil and groundwater depends significantly on its chemical form and speciation. The presence of inorganic anions (carbonate, phosphate, sulfide) in the pore water of soil influences the soil’s ability to sorb metals chemically. The anions can form relatively insoluble complexes with metal ions and cause metals to desorb or precipitate in their presence, thus reducing their ability to migrate. Soil pH largely influences the mobility of metals in soil. Metal cations are most mobile under acidic conditions, while anions tend to sorb to oxide minerals in that low pH range. Organic matter, particularly humic materials, can cause metals to complex and affect their removal from solution.

Groundwater monitoring at the site identified elevated metals concentrations exceeding AWQC or DEQ SLVs for surface water in unfiltered samples. Groundwater samples that were field filtered to remove suspended solids in the collected samples generally did not show significant levels of metals above SLVs. The groundwater monitoring results support a conceptual fate and transport model for metals in soil that indicates metals are strongly sorbed to soil and not subject to transport via leaching from soil to groundwater, and subsequent migration of groundwater to surface waters.

### 3.3.2 Willamette River Sediment

The primary source of sediment contamination appears to be related to past ship-dismantling activities and fires along the dock. Organotin contamination is most likely associated with paint chips produced by sand blasting. The source of metals is most likely sand-blasting grit, paint chips (chromium, copper, and lead), and other parts of the ships. PCBs may have been contained in cables, gaskets, paint, and elsewhere in older ships, as well as in transformers dismantled at the site. The PAHs and petroleum hydrocarbons may have been generated during ship and tank dismantling as well as
during dock fires. The source of COIs may also be particulates suspended in stormwater discharged to the Willamette River through stormwater outfalls, surface soils eroded from the upland portion or bank of the site, historical groundwater discharges to the Willamette River, and suspended sediment transported from upriver sources.

Many factors influence the transport, fate, and bioavailability of chemicals in sediments and their partitioning into pore water, including the type of chemical (non-polar hydrophobic organic compounds and metals), the chemistry of the environment (oxic versus anoxic, marine versus freshwater), physical conditions (grain size, disturbance, and stability of the sediments), the amount and source of organic carbon in sediments (humic material, coal, soot, oil), the pH and concentration of ammonia in pore water, and the presence of metal sulfides in sediment.

**Organic Compounds.** The fate of PCBs and PAHs in sediment is similar to that in soil. Adsorption to sediment and suspended material is an important fate process. PCB and PAH tendency to adsorb to sediment particles increases with decreasing solubility (which corresponds to the degree of chlorination).

PCBs are highly lipophilic and bioconcentrate in the tissue of aquatic organisms. PAHs tend to concentrate lower in the food chain (i.e. phytoplankton, certain zooplankton, snails etc), and thus species that feed at the lower end of the food chain are at a higher risk of bioaccumulation than species that feed higher on the chain. The human health and ecological risks posed by this process were evaluated in the risk assessment discussed in Section 3.4.

**Metals.** Most metals entering surface water are rapidly adsorbed to particulate matter, which settles out as sediment. The presence of metal sulfides in sediment, as well as the type and amount of organic carbon and the presence of colloids, appears to control the partitioning of metals between sediment and pore water. The extent to which metals bind to marine and freshwater sediments are likely related to acid volatile sulfide (AVS) concentrations within sediment pore water.

**Butyltins.** TBT detected in sediment was apparently released to the environment as paint chips or larger fragments containing marine antifouling paint during historical scrapping and dismantling of ships at the site. TBT is expected to be strongly sorbed to sediment. The tendency for adsorption to humic material and suspended particulates is thought to be much weaker. TBT cations may react with sulfides in sediment to form TBT sulfide.

Once TBT is adsorbed, the decrease in concentration takes place mainly by degradation. The degradation of TBT oxide occurs by the breaking of the carbon-tin bond by means of physicochemical processes (primarily, direct photolysis in surface water) and biological
mechanisms (degradation by microorganisms and metabolism by higher organisms). Sediment data indicates degradation of TBT is occurring in sediment based on the detection of mono- and di-butyl tin compounds.

The lipophilic properties of TBT, its moderately high octanol-water partition coefficient (log $K_{ow} > 3$), and a measured BCF of greater than 6,000 indicate that TBT will strongly bioconcentrate in various aquatic organisms.

3.4 Human Health and Ecological Risk Assessments

This section summarizes the findings of the baseline human health risk assessment (HHRA) and the ecological risk assessment (ERA) that were completed as part of the RI. This section also identifies potential hot spots of contamination based on the results of the HHRA and ERA.

3.4.1 Human Health Risk Assessment

The HHRA evaluated potential impacts to human health associated with site-related constituents detected in on-site soil in the upland part of the site. A reasonable maximum exposure (RME) scenario and a central tendency exposure (CTE) scenario were used to evaluate risk to three types of potential receptors: (1) future residents, (2) excavation workers, and (3) construction workers. An addendum to the HHRA assessed potential human health risks to recreational anglers and tribal fishers to sediment by transfer of contaminants through ingested fish.

COIs were screened to identify contaminants of potential concern (COPCs) for human receptors, as described in DEQ guidance. COPCs are COIs that exceed screening criteria, specifically USEPA Region 9 preliminary remediation goals (PRGs), as described in DEQ guidance. Those COPCs for human receptors that screened in the HHRA and found to occur at risk levels that exceed the DEQ-acceptable potential excess cancer risk (PECR) level of $1 \times 10^{-6}$ for an individual carcinogen, or a HQ of 1.0 for an individual non-carcinogen, are referred to as COCs for human receptors.

The site was divided into four areas of concern for the baseline HHRA. For each of the four soil exposure areas, three soil depth intervals were assessed: 0 to 0.5 feet bgs, 0 to 3 feet bgs, and 0 to 15 feet bgs. Potential future exposure of construction workers to soil considered only the 0-to-15-feet interval in each exposure area. The DEQ-acceptable level for potential excess carcinogenic risk (PECR) related to an individual carcinogen is $1 \times 10^{-6}$; the DEQ-acceptable level for cumulative PECR is $1 \times 10^{-5}$; and the DEQ-acceptable level for non-carcinogenic risk for both an individual chemical hazard
quotient (HQ) and a multiple-chemical cumulative hazard index (HI) is 1.0. In all cases, potential residential exposure produced the highest risk numbers. Table 3-6 summarizes the estimated future risks for the exposure scenarios evaluated in the HHRA.

Potential risk associated with site groundwater was assessed for residents exposed to chemicals that could volatilize from groundwater into indoor and outdoor air, and for excavation workers and construction workers directly contacting groundwater in trenches. Residential exposure to chemicals in indoor and outdoor air was assessed using a fate-and-transport model, in addition to comparing detected concentrations with DEQ risk-based concentrations.

Reasonable maximum exposure (RME) and central tendency exposure (CTE) human health risks were calculated for both carcinogenic and non-carcinogenic risk (referred to in terms of PECR and HI, respectively) based on incidental ingestion of, dermal contact with, and (particulate) inhalation of soil. Results are presented below.

- Potential carcinogenic and non-carcinogenic risk associated with residential RME to multiple chemicals detected in soil significantly exceeds DEQ-established acceptable levels based on risks associated with ingestion of and dermal contact with soil. In the greenway area, the cumulative RME PECR for potential contact of residents with upland soil is $6 \times 10^{-4}$, while the cumulative RME HI is 262. The cumulative CTE PECR and HI are $1 \times 10^{-5}$ and 5, respectively. In the non-greenway area, the cumulative RME PECR for potential contact of residents with upland soil is $2 \times 10^{-3}$, while the cumulative RME HI is 381. The cumulative CTE PECR and HI for the non-greenway area are $1 \times 10^{-5}$ and 2, respectively.

- Potential volatilization of COPCs in soil to indoor and outdoor air would not pose an unacceptable risk to future residents. Low levels of some VOCs were detected in groundwater, but do not pose unacceptable risk to human receptors inhaling indoor or outdoor air.

- Potential risks related to beneficial use of groundwater is not a concern, because deeper aquifers are not impacted and there is no use of shallow groundwater beyond recharge to the river. The area is served by a municipal supply and is reasonably expected to be served by a municipal supply in the foreseeable future.

- Potential risks associated with direct contact of excavation workers and construction workers to groundwater do not exceed DEQ-acceptable levels.

Lead does not have assigned toxicity values, so human health risk cannot be quantified for this chemical. However, exceedances of the site-specific, human health-related lead
cleanup level of 400 mg/kg and hot spot level of 4,000 mg/kg were evaluated. In the Greenway and Non-Greenway areas, the RME and CTE concentrations of lead exceed the cleanup level of 400 mg/kg but not the hot spot level.

For recreational fishers, cumulative RME PECR (1 x 10⁻³) and the highest RME cumulative non-carcinogenic risk (HI = 53) exceed DEQ-acceptable levels in regard to recreational angler exposure to sediment through fish ingestion. Individual carcinogens with RME PECRs that exceed the DEQ-acceptable level of 1 x 10⁻⁶ include Aroclor 1254, Aroclor 1260, arsenic, benzo(a)pyrene, benz(a)anthracene, dibenz(a,h)anthracene, and benzo(b)fluoranthene. Individual non-carcinogens with RME HQs that exceed the DEQ-acceptable level of 1.0 include Aroclor 1254, copper, and cadmium.

The conclusions of the HHRA are that the upland portions of the site pose an unacceptable risk to future residents, and current and future excavation and construction workers. In addition, the existing sediment contamination within 200 feet of the shoreline poses an unacceptable risk to recreational anglers through the fish ingestion pathway. Section 4 of this report describes the remedial action objectives developed for the site in the FS to address these unacceptable risks and associated exposure pathways.

3.4.2 Ecological Risk Assessment
The Ecological Risk Assessment (ERA) involved two assessment levels: scoping (level I) and screening (level II). The level I study identified potentially complete exposure pathways, potential ecological receptors, and the following COIs at the Zidell property: VOCs, semivolatile organic compounds, PCBs, metals, petroleum hydrocarbons, butyltins (in sediment); and dioxins, asbestos, chlorinated pesticides, and organophosphorous herbicides (in soil). Potential terrestrial receptors included plants, birds, small mammals, and soil invertebrates. Potential aquatic receptors included invertebrates, mammals, piscivorous birds and ESA-listed salmonids.

The purpose of the Level II Assessment was to ascertain whether potentially unacceptable ecological risks existed in soil and in Willamette River sediment at the site. The following contaminants of potential ecological concern (CPECs) were identified in shallow soil (0 to 2.5 feet bgs): metals, PAHs, and PCBs. The following CPECs were identified in sediment in the biologically active zone: metals, PAHs, PCBs, and butyltins.

Bioassays (10-day midge [Chironomus tentans] and amphipod [Hyalella azteca] tests were performed on sediment samples to assess potential toxicity to aquatic organisms. The Chironomid samples showed no statistically significant mortality, but the Hyalella samples did elicit significant mortality.
The conclusions of the ERA were that the upland portions of the site posed an unacceptable risk to ecological receptors including terrestrial species, birds, plants and invertebrates. Existing sediment contamination within the Willamette River and along the shoreline of the site poses an unacceptable risk to sediment dwelling organisms and other ecological receptors (e.g. birds and mammals) through food web exposures. Section 4 of this report describes the remedial action objectives developed for the site in the FS to address these unacceptable risks and associated exposure pathways.

### 3.5 Identification of Hot Spots

OAR 340-122-0115(31)(b) defines hot spots in media other than water as hazardous substances that present a risk to human health or the environment exceeding the acceptable risk level and any of the following criteria:

(a) Are present in concentrations exceeding risk-based concentrations corresponding to:

(1) 100 times the acceptable risk level for human exposure to each individual carcinogen

(2) 10 times the acceptable risk level for human exposure to each individual non-carcinogen

(3) 10 times the acceptable risk level for individual ecological receptors or populations of ecological receptors to each individual hazardous substance

(b) Are reasonably likely to migrate to such an extent that [a significant adverse effect on beneficial use(s) of water] or the conditions specified (a) or (c) would be created or

(c) Are not reliably containable, as determined in the feasibility study.

#### 3.5.1 Soil

Hot spots in soil were calculated separately for the greenway and non-greenway areas. In the greenway setback, hot spot concentrations were calculated for both human and ecological receptors. In the non-greenway area, hot spot concentrations were based solely on human health risk levels. Terrestrial ecological receptors are not a concern in the non-greenway area because of the absence of ecologically important habitats. Table
4-1 summarizes the hot spot concentrations for soil. The calculation of hot spot concentrations is discussed below.

**Human Receptors.** Hot spot concentrations for human receptors were calculated in the FS for COCs detected in upland soil based on residential, industrial, recreational and construction worker exposure scenarios. For most COCs, PRGs for soil at residential sites were used as the acceptable risk levels for the hot spot calculations. For COCs that had assigned cleanup levels based on background concentrations (arsenic and chromium), the hot spot concentrations for human receptors also were calculated by using the PRGs as the acceptable risk level, except for zinc. A ceiling value of 100,000 mg/kg was used as the hot spot concentration for zinc.

**Ecological Receptors.** Hot spot concentrations for ecological receptors were calculated by multiplying the ecological cleanup levels by 10. For chromium, a background concentration of 27 mg/kg was used as the site-specific soil cleanup level; multiplying this cleanup level by 10 results in a site-specific hot spot concentration of 270 mg/kg for chromium. Hot spot concentrations for ecological receptors are provided in Table 4-1.

**Hot Spots Based on Likelihood of Migration.** Based on the data collected during the RI, hazardous substances in the soil do not have a high degree of mobility to a degree that it has created a potential hot spot in water. No hot spot areas were identified based on the criteria of not likely to migrate. As discussed in Section 6 of this report, soil contamination can be reliably contained.

### 3.5.2 Sediment

Hot spots in sediment were calculated for both human and ecological receptors. Table 4-2 summarizes the hot spot concentrations. The calculation of hot spot concentrations is discussed below.

**Human Receptors.** Hot spot concentrations for human receptors were calculated for human health through recreational fisherman exposure scenario.

**Ecological Receptors.** Hot spot concentrations for ecological receptors were calculated by multiplying the ecological cleanup levels by 10. Hot spot concentrations for ecological receptors are provided in Table 4-2.

**Hot Spots Based on Likelihood of Migration.** Based on the sediment pore water monitoring data collected during the RI, hazardous substances in sediment do not have a high degree of mobility to a degree that it has created a potential hot spot in water. No hot spot areas were identified based on the criteria of not likely to migrate. As discussed in Section 6 of this report, soil contamination can be reliably contained.
3.5.3 Groundwater
OAR 340-122-0115(31)(a) defines a hot spot in groundwater as a hazardous substance having a significant adverse effect on the beneficial water use. OAR 340-122-0115(5) defines significant adverse effect as current or reasonably likely future exceedance of the following:

(a) Applicable or relevant federal, state or local water quality standards, criteria, or guidance.

(b) In the absence of applicable or relevant water quality standards, criteria, or guidance, the acceptable risk level.

(c) If subsections (a) and (b) of this section do not apply, the concentration of a hazardous substance indicated by available published peer-reviewed scientific information to have a significant adverse effect on a current or reasonably likely future beneficial use of water.

For groundwater in which a significant adverse effect on the beneficial use(s) is identified, the FS must evaluate whether treatment is reasonably likely to restore or protect the beneficial use(s) of water within a reasonable time. If treatment is determined to be able to restore or protect the beneficial use(s) within a reasonable time, the groundwater contamination must be identified as a hot spot.

Calculated risk levels associated with potential human exposure to groundwater (volatilization, direct contact) did not exceed DEQ-established acceptable risk levels.

Beneficial uses of shallow groundwater include discharge to the Willamette River. Beneficial uses of Willamette River water include aesthetic quality, recreation, transportation, wetland areas, fishing and hunting, anadromous fish passage, and fish and wildlife habitat. Total copper and lead concentrations in only one well near the river have intermittently exceeded the AWQC. Petroleum hydrocarbons have also been detected in groundwater in wells along the riverbank.

Transport of selected metals and TPH in groundwater to surface water was modeled using a two-dimensional groundwater flow model. The objective of the modeling was to estimate the concentrations of dissolved TPH and metals entering the river. Dissolved TPH and metals in groundwater were not predicted to reach the river above AWQC or other screening criteria. The modeling results indicate that COIs in groundwater would not adversely impact surface water in the Willamette River. Therefore, there are no hot spots of contamination in groundwater at the site.
4 Remedial Action Objectives and Cleanup Levels

The overall goal of the remedial action for the site is to protect human health and the environment from exposure to COCs and CECs identified in the baseline HHRA and ERA. This section summarizes the site-specific remedial action objectives (RAOs) and cleanup levels for the site that will achieve the overall goal and eliminate or manage the potential risks to human health and the environment. Section 5 provides a description of the remedial alternatives and Section 6 provides an evaluation of the ability of each of the remedial alternatives to satisfy the RAOs.

4.1 Remedial Action Objectives

The following site-specific RAOs were developed to describe how protection of human health and the environment would be achieved through the cleanup. The COCs and the media affected, for which the RAOs apply, are included in Tables 4-1 and 4-2.

<table>
<thead>
<tr>
<th>Medium</th>
<th>Remedial Action Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Prevent future residents and worker exposure to soil containing constituents exceeding acceptable risk-based concentration (RBC) values.</td>
</tr>
<tr>
<td></td>
<td>Prevent ecological receptors from exposure to soil containing CPECs exceeding DEQ SLVs.</td>
</tr>
<tr>
<td></td>
<td>Prevent transport of COCs/CECs in soil to the Willamette River through stabilization of shoreline and storm water runoff controls.</td>
</tr>
<tr>
<td></td>
<td>RemEDIATE soil hot spots to the extent feasible.</td>
</tr>
<tr>
<td>Sediments</td>
<td>Protect humans against exposure to site-related COCs above protective levels.</td>
</tr>
<tr>
<td></td>
<td>Minimize transport of sediment containing COCs and CECs above cleanup levels to downstream areas of the river.</td>
</tr>
<tr>
<td></td>
<td>Ensure sediments contaminated with CECs above protective levels do not become accessible to benthic organisms, or aquatic and terrestrial organisms through food chain exposure.</td>
</tr>
<tr>
<td></td>
<td>RemEDIATE hot spots of contamination in sediment by reducing their concentration, volume, or mobility to the extent feasible and practical.</td>
</tr>
<tr>
<td>Surface Water</td>
<td>Protect ecological habitat and beneficial uses of surface water adjacent to the facility.</td>
</tr>
</tbody>
</table>

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4.2 Cleanup Levels and Hot Spot Concentrations

This section summarizes the development of cleanup levels for soil and sediment. Table 4-1 summarizes the cleanup levels and hot spot concentrations for soil, and Table 4-2 summarizes the cleanup levels and hot spot concentrations for sediment.

4.2.1 Soil

**Human Receptors.** EPA Region 9 residential preliminary remediation goals (PRGs) were selected as cleanup levels for soil due to the planned re-development of the property that would include high-density residential use. For arsenic, the background concentration was used as the cleanup level in accordance with the cleanup rules because the PRG is below background. Hot spot concentrations were set at 100 times the cleanup level for carcinogens and 10 times the cleanup level for non-carcinogens, as specified in Oregon Cleanup Rules.

**Ecological Receptors.** The greenway area will be redeveloped and may support native plant and invertebrate communities that may be used by terrestrial birds and mammals. No threatened or endangered species are expected to have significant exposure to site-related chemicals in soil at the site. Consistent with DEQ guidance, chemical-specific cleanup levels for ecological receptors were set at a population level SLVs except for chromium (see Table 4-1). The site-specific cleanup level used for each CPEC is based on the most stringent (lowest) SLV for plants, invertebrates, birds, or mammals. For chromium, the value of five times the most stringent SLV was lower than the background concentration, so the background concentration was used as the cleanup level. Hot spot concentrations for ecological receptors were set at ten times the cleanup level consistent with DEQ guidance.

4.2.2 Sediment

**Human Receptors.** Cleanup levels for sediment were derived based on a recreational fisherman indirect exposure to COCs through fish consumption as a result of bioaccumulation of contaminants present in sediment. COCs that pose an unacceptable risk from the fish consumption pathway are limited to PCBs and PAHs. Hot spot concentrations were set at 100 times the cleanup level for carcinogens and 10 times the cleanup level for non-carcinogens, as specified in Oregon Cleanup Rules.

**Ecological Receptors.** Cleanup levels for sediment were based on the prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines developed by Ingersoll (Ingersoll 2000), and site-specific probable effects quotient (PECQ) of 0.26 using the methodology defined by McDonald (McDonald 2000). DEQ
will use 10 times the PECQ as the hot spot criteria for ecological receptors rather than 10 times the cleanup level for each CPEC in sediment. Table 4-2 also identifies petroleum hydrocarbons as CECs based on bioassay toxicity testing that suggests that there may be an association of toxicity with elevated petroleum hydrocarbons in sediment. No cleanup levels are available for petroleum hydrocarbons, however.

4.2.3 Water
Cleanup levels were not developed for COPCs in groundwater because risk levels associated with potential exposure of human receptors to groundwater did not exceed DEQ-established acceptable risk levels. Oregon Water Quality Criteria under OAR Chapter 340, Division 41 are applicable standards for protection of surface water beneficial uses within the locality of the facility.

4.3 Cleanup and Hot Spot Areas and Volumes
This section summarizes the volume of soil and sediment exceeding the cleanup levels or hot spot concentrations for human health or ecological receptors. Volume estimates were developed separately for the greenway and non-greenway areas.

4.3.1 Soil
For the purposes of the FS, the entire upland property area was assumed to contain one or more COC/CEC at levels exceeding cleanup levels. The estimated volume of soil that exceeded the site-specific cleanup level in the greenway and non-greenway is approximately 682,000 cubic yards. The volume of soil that exceeded the human health hot spot concentrations to a depth of 15 feet below ground surface is 6,600 cubic yards. Table 4-3 summarizes the estimated volume of soil exceeding human health or ecological cleanup levels or hot spot concentrations. Figure 4-1 illustrates the soil that exceeds cleanup levels and hot spot concentrations.

4.3.2 Sediment
Figure 4-2 illustrates the areas of sediment where one or more COCs/CECs exceed the cleanup levels presented in Table 4-2. The volume of sediment exceeding either human health or ecological based cleanup levels is approximately 150,000 cubic yards. The volume of hot spot sediments is approximately 44,000 cubic yards. Table 4-4 summarizes the estimated volume of sediment exceeding human health or ecological cleanup levels or hot spot concentrations.
4.4 Regulatory Requirements

The feasibility study identified several federal, state, and local laws, rules, and requirements that may be applicable to remedial actions at the Zidell site. These are summarized below:

**Oregon Hazardous Waste Management Act (ORS 466).** This act and the implementing administrative regulations (OAR 340-100-0001 et seq.) govern the generation, transportation, treatment, storage, and disposal of hazardous wastes and may have applicability at the Zidell site if remedial actions generate characteristic or listed hazardous wastes. This act incorporates requirements of the federal Resource Conservation and Recovery Act (RCRA) program.

Excavated soils at the site could potentially be classified as RCRA hazardous wastes if they exhibit the characteristic of toxicity as established by the Toxicity Characteristic Leaching Procedure (TCLP) test. Soils exceeding the TCLP criterion for metals would be classified as characteristic hazardous wastes and will be appropriately managed in accordance with all applicable state requirements of OAR 340, Divisions 100 through 120 and federal RCRA requirements of 40 CFR Parts 260, 261, 262, 263, 264, 265, and 268.

**Oregon Solid Waste Management (ORS 459 and OAR 340-093 and 340-095).** This statute and implementing rules govern the management of solid wastes, including the permitting of disposal sites, and are applicable to the off-site management of contaminated soils.

**Oregon Water Quality Standards (ORS 468B and OAR 340-041).** These standards protect aquatic life and public health, and are applicable to the Zidell site for any discharges to the Willamette River from shallow groundwater or overland flow of stormwater.

**Oregon Water Pollution Control (ORS 468B and OAR 340-045).** These laws and the implementing administrative regulations govern discharge of pollutants to surface waters. The act incorporates the state’s delegated program under federal Clean Water Act (CWA), including the NPDES permitting system.

**Oregon Groundwater Quality Protection (ORS 468B and OAR 340-040).** These laws and the implementing administrative regulations constitute Oregon's groundwater protection program. The program incorporates federal Safe Drinking Water Act requirements and maximum contaminant level (MCL) standards. The groundwater protection program policy states that the rules are not to be used as cleanup standards, but they may be used to evaluate non-degradation of existing...
groundwater resources and may be considered for remedial actions that include the use of underground injection control (UIC) systems for stormwater disposal.

**Oregon Air Pollution Control Law (ORS 468A).** This law and its implementing administrative rules (OAR 340-200 through -208) specify permitting procedures, emission limits, and operating and reporting requirements for stationary air pollution sources (e.g., emissions from the air stripper and dust from construction activities). This law incorporates aspects of the federal Clean Air Act, NESHAPS, and new source performance standards. Airborne discharges resulting from future remedial actions may be subject to these requirements.

**Oregon Occupational Safety and Health Code (OAR 347).** These codes, analogous to the federal Occupational Safety and Health Administration codes, contain health and safety requirements that must be met during implementation of any remedial actions. These standards are intended to protect construction and utility workers at the site.

**Fill or Removal Permits for Work in Willamette River.** Section 404 of the CWA prohibits any person from the discharge of dredged or fill material into the waters of the United States (in this case, the Willamette River) without first obtaining a permit from the Corps of Engineers (COE). A similar permit requirement exists under the Oregon fill and removal law, ORS Chapter 196, which is enforced by the Department of State Lands. A permit may be issued by the COE only after the proposed discharge is reviewed and measured against the requirements of the CWA, including the Section 404(B)(1) guidelines implemented by the USEPA (40 CFR § 230). ORS 465.315(3) authorizes the DEQ to exempt remedial actions from the requirement to obtain a State removal fill permit, but does not authorize an exemption from the Federal permit requirement or from underlying substantive requirements of either the CWA or the Oregon fill and removal law applicable to remedial alternatives for sediment at the Zidell site.

**Section 10 Permit for Work in Willamette River.** The COE administers a regulatory program under Section 10 of the Rivers and Harbors Act of 1899 that requires its approval of any work in navigable waters. The Willamette River is a navigable waterway, so Section 10 would most likely apply to any dredging or capping conducted during remedial activities, and a Section 10 permit will be required. Section 10 of the Rivers and Harbors Act may be an action-specific regulatory requirement for the Zidell site.

**Endangered Species Act.** The Endangered Species Act (ESA) of 1973 protects plant and animal species that are listed by the federal government as “endangered” or “threatened” and protects critical habitat necessary for the protection of these species.
In addition to federally listed threatened and endangered species, there are state-listed sensitive species. The Oregon Department of Fish and Wildlife (ODFW) is tasked with protecting threatened and endangered species for the state of Oregon (ORS 655-100-00). The Oregon Natural Heritage Program (ONHP) maintains a database of the locations of threatened and endangered species.

ESA requirements are applicable to the Zidell site if threatened or endangered species are determined to be present or would be affected adversely by site remediation. Two sections of the ESA are of primary importance for site remediation. Section 7 discusses the requirements of consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) (formerly National Marine Fisheries Service) in regard to the presence of listed species in a project area. Section 9 stipulates the prohibitions against the “taking” of a listed species. Taking of a listed species is broadly defined to include “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect,” which also prohibits the significant modification of habitat considered critical to the protection of the listed species.

Generally, an ESA consultation is required for projects that are undertaken, funded or authorized by a federal agency, including the issuance of permits. The results of the ERA for the site should fulfill the substantive requirements of Section 7 of the ESA.

The ONHP search and subsequent discussions with the ODFW (2000) identified the following protected species of anadromous fish, which are or may be present intermittently in waterways in the project area:

- **Coho salmon**—lower Columbia River (*Oncorhynchus kisutch*): Candidate for listing as a federally designated threatened species, state-designated as endangered since July 1999.
- **Steelhead trout**—lower Columbia River (*Oncorhynchus mykiss*): Federally designated threatened species.
- **Chinook salmon**—lower Columbia River (*Oncorhynchus tshawytscha*): Federally designated threatened species.
- **Chum salmon**—lower Columbia River (*Oncorhynchus keta*): Listed threatened species.
In terms of fulfilling the substantive requirements of Section 9 of the ESA, which prohibits the taking of listed species, preventive measures may be needed during the remedial actions at the site. NOAA has identified factors that cause decline in salmonid populations: erosion and sedimentation, contaminants that make their way into streams, dam operations, changes in water temperature, disturbance of material in stream or river channels, ocean and inland fisheries, inadequate water diversion screens, loss of habitat, changes in natural hydrographs, channelization of streams and rivers, and barriers to fish passage (e.g., culverts). Note that the COE obtained a large-scale Section 7 consultation in 2001 for its operation of the Willamette basin reservoir system. This multispecies consultation is intended to address the likely effects on listed species of continued operation of the Willamette River Basin Project, which includes dredging.

**City of Portland.** Plumbing, construction, and building permits may be required for the construction phase of remedial actions. Excavation of more than 50 cubic yards of soil may require a grading and excavation permit from the county. In addition, local zoning ordinance governs the current and future land use of the site and site vicinity, which is an important consideration in the evaluation of current and reasonably likely future land uses and associated environmental protection zones (e.g. greenways adjacent to the Willamette River), and storm water management options.
5 Description of Remedial Action Alternatives

This section summarizes the remedial action alternatives for soil and sediment for the site. The alternatives presented in the FS Report satisfy the requirements for feasibility studies under OAR 340-122-0085. The evaluation of the alternatives against the protectiveness and feasibility criterion specified in OAR 340-122-0090 is described in Section 6.

The descriptions and costs provided in this section summarize the alternatives as formulated in the FS, and do not reflect the modifications included as part of the selected alternatives described in Section 7 of this document.

5.1 Remedial Alternatives for Soil

Seven remedial alternatives were developed for upland soil including no action. The developed alternatives provide a range of removal and containment options for the significant volume of soil contaminated at levels exceeding the human health or ecological based cleanup levels or hot spot concentrations. Each of the soil alternatives, with the exception of the no action alternative includes the following common elements:

Deed Notifications and/or Deed Restrictions: Each of the alternatives includes deed notifications and restrictions to reduce or prevent future exposure of receptors to soil containing residual hazardous substances at concentrations above relevant cleanup levels (CULs). Deed notifications notify potential purchasers of the property of the presence of COCs/CECs in soil. Deed restrictions limit activities or land use at the site and define requirements for future site redevelopment activities. Deed restrictions require that future redevelopment activities at the site comply with a Soil Management Plan.

Soil Management Plan: A Soil Management Plan (SMP) would be developed to guide future excavation activities that could potentially encounter impacted soil. The SMP would outline specific requirements for managing soil on site as part of future redevelopment. Waste disposal requirements and sampling and analysis requirements would also be addressed in the plan.

For the site, in addition to excavation performed as part of remediation, some soil may be excavated from areas such as building footings, underground parking structures, and public right-of-ways (ROWS) for site redevelopment. Soil excavated for redevelopment purposes would be used as backfill on site to the extent feasible, and managed in a way that is protective of human health and the environment. The proper placement of impacted soil will be directly incorporated into redevelopment plans. Also, the plan will...
specify that public streets and utility corridors will contain a minimum of 5 feet of clean fill, as required by the COP’s Soil Reuse Policy (COP, 1999).

The SMP would also specify that if potential ACM is found during excavation, it would be segregated and characterized by a certified asbestos contractor and managed following applicable asbestos and solid waste regulations. The plan would require that areas filled with excavated soil be surveyed and included in deed notifications and deed restrictions.

**Access Restrictions/Fencing:** Access restrictions, such as fencing, would be constructed to restrict public access to the site to prevent contact with soil through completion of site capping. In addition, existing asphalt-concrete pavement that covers much of Operational Area 1 and the concrete floor slabs of the existing buildings will be retained until remedy construction activities are implemented to further reduce the potential for exposure to contaminated soil.

**Engineered Cap:** An engineered cap would be used to prevent contact with impacted soil and thus minimize exposure to COCs/CECs and prevent erosion of impacted soil to surface water and sediment. The engineered cap would consist of a demarcation material to identify the top of the impacted soil, and a 2-foot vegetated clean soil cap. Alternatively, the cap may consist of asphalt concrete or other suitable barriers (e.g., pavers) that will be components of site redevelopment. For that portion of the cap on the river bank below the 10-year flood elevation (or a similar elevation established during design), the demarcation layer would also act as an erosion control layer. A monitoring and maintenance program would be implemented to insure that the integrity of the engineered cap is maintained over time.

Based on the bank evaluation (MFA, 2004), existing bank armoring comprised of concrete, rock, and ballast stone would serve as the cap between an elevation of approximately 3 feet and 13 feet COP datum. Deleterious material (e.g., rebar, wood scrap, wire, rubber etc.) would be removed. Additional armoring may be necessary (e.g., near outfalls) to ensure long-term reliability of the armored cap. The areas for armor improvements will be identified during remedial design.

**Drainage Controls:** A stormwater collection and conveyance system would be designed and constructed as part of the engineered cap to manage stormwater during and after implementation of the final remedy.

**Soil Screening:** Fill material historically placed on the site, especially along the bank, consists of large amounts (75%) of oversize, primarily inert, material (e.g., concrete). Soil screening would be used to isolate the impacted soil from the inert material. The
separated rock and concrete may be stored on site for recycling as aggregate (following crushing) during the site redevelopment. Other oversized material (e.g., wood, solid waste) would be transported off site for disposal.

**Consolidation:** Significant excavation of existing fill material within the future greenway area of the site will be necessary to re-contour the existing bank for placement of a stable soil cap, and additional contaminated soil excavation will be necessary in ROWs. The soil would be temporarily placed in a lined and covered staging area, either before or after screening as described above. Following screening, the reduced volume of excavated soil would be incorporated into the redevelopment design in a manner that ensures protection of human health and the environment.

The site redevelopment may require an overall site elevation increase of approximately 3 to 6 feet. Clean fill will be imported to meet this requirement. Through proper design, impacted soil that requires excavation will be placed below this clean fill, or below other site appurtenances or structures. Parameters for soil placement to ensure long-term protection of human health and the environment will be established in the SMP, and incorporated into redevelopment designs. These include, but are not limited to, requiring that impacted soil be placed outside the public ROWs and utility corridors, within existing impacted areas, and above the water table.

**Excavation and Off-Site Disposal:** Excavation would remove all or some of the soil exceeding the cleanup levels for the site. The soil would be transported to permitted off-site treatment and/or disposal facilities. The excavated soil from this site is not expected to require pre-treatment before disposal. Figure 5-1 illustrates areas where soil contamination exceeding cleanup levels or hot spot concentrations would be excavated for either on-site consolidated containment or off-site disposal.

Assumptions were made in the FS regarding the location, size, and configuration of the Willamette River greenway and non-greenway areas, and public ROWs. The assumptions are based on 2002 redevelopment plans, including the River Parkway Staff Amendment figure prepared by the COP Bureau of Planning, dated October 30, 2002, and considers the 2004 draft Greenway plan, which is not binding on the property owner. Because redevelopment plans for the site have not been finalized, the locations, sizes, and configuration of the greenway and non-greenway areas may change between now and redevelopment. The remedy that is selected for each type of area (greenway, non-greenway, and public ROWs) will be implemented regardless of its location in the final redevelopment plans. Changes in the configuration of each type of area will therefore affect the cost estimates developed for the FS.
5.1.1 Soil Alternative 1: No Action
Under Alternative 1, no additional action would be taken to address the impacted soil present at the site. Alternative 1 assumes that the existing structures are not in place and that no redevelopment will occur. Because no remedial activities would be implemented under Alternative 1, long-term human health and environmental risks for the site would essentially be the same as those identified in the baseline HHRA and Level II ERA. Alternative 1 evaluates whether leaving the site “as-is” meets the RAOs and serves as a baseline against which the other alternatives are compared.

5.1.2 Soil Alternative 2: Engineered Cap
Alternative 2 includes the common elements as described above and would include the following elements:

- Excavation of soil and debris fill during re-grading of the greenway for cap construction for on-site consolidation and capping outside of the greenway;
- Characterization and off-site disposal of ACM encountered during excavations completed for redevelopment;
- Decommissioning of the oily water vault, dry well/stormwater lines, and other historical operational features;
- Decommissioning of monitoring wells installed for the RI;
- Placement of a cap over both the greenway and non-greenway areas of the site.

Alternative 2 relies on engineering and institutional controls to prevent migration and exposure to soil containing COCs/CECs at concentrations exceeding the site-specific CULs. Alternative 2 includes a phased approach to remediation to accommodate future redevelopment of the site. The first phase includes fencing the perimeter of the site to preclude public contact with soil and maintaining existing engineering controls. Existing building foundations or pavement would be used as a temporary barrier against direct contact with soil until site redevelopment occurs. Deed notifications and deed restrictions, including a SMP, would be placed on the property.

The last phase of remediation would be implemented as part of the redevelopment of the site and would include the placement of an engineered cap. The materials used in the engineered cap may vary throughout the site, depending on the differing land uses (e.g., greenway, non-greenway, future public ROWs, buildings, parking lots, open spaces). The material used for the cap will be dictated by redevelopment. The engineered cap may consist of asphalt pavement, a concrete building foundation, clean sand or gravel fill, or any other barrier that precludes direct contact with the soil. Appropriate options for the capping material would be developed in detail during the remedial design, and incorporated into the redevelopment design.
Cap integrity will be ensured through an Operations, Maintenance, and Monitoring Plan (OMMP), which will outline routine cap performance monitoring and schedule and reporting requirements. It will also include contingencies to be taken if the cap fails to meet the performance criteria.

Cap placement above the bank armor requires reducing the bank slope to 3:1 H:V along most of the bank. Alternatively, the RAOs can be achieved by other means that are consistent with the final greenway development plans, so long as they are permitted by the COE and other authorized regulatory agencies. For example, flatter or steeper slopes may be desired. These can be protected from erosion through various means such that the cap is maintained. The estimated volume of fill material to be removed from the future greenway area of the site for consolidation in the non-greenway area is 33,000 cubic yards (assuming a 3:1 H:V final slope). As noted above, this material may be screened, along with the ROW soil, to remove oversize inert materials (e.g., concrete). The oversize material, if clean, could be recycled (crushed for aggregate) for use during redevelopment. If the recycling option is not employed, all excavated materials will be placed in non-ROW areas and capped, as described above. Bank stabilization will also involve erosion control (e.g., silt fence) at the lower edge of the soil cap until the vegetative layer is established.

Standard facility decommissioning techniques will be employed for the oily water vault, dry well/stormwater, and the other historical operational features, concurrent with operational changes or redevelopment. This will involve breaking, cutting, and dismantling of the structures for removal and off-site disposal. Inert material may be left on site for use as fill during redevelopment provided such material is not significantly contaminated with COCs that pose an unacceptable risk to human health or the environment. Monitoring wells will be decommissioned following applicable state law.

The estimated cost for implementation of Alternative 2 is $3.38 million, which includes $213,000 for remedial design, $2.48 million for remedial action construction, $123,000 for long-term monitoring and maintenance, and contingencies of $562,000.

5.1.3 Soil Alternative 3: Engineered Cap with Excavation of Hot Spots in the Greenway—On-Site Management
Alternative 3 contains all the elements described for Alternative 2 and incorporates excavation of an additional 3,800 cubic yards of human health and ecological hot spot soil and debris fill from the greenway area to a depth of 3 feet below final grade. The estimated volume of fill material to be removed from the future greenway area of the site for consolidation in the non-greenway area is 37,000 cubic yards.

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The estimated cost for implementation of Alternative 3 is $3.90 million, which includes $270,000 for remedial design, $2.86 million for remedial action construction, $123,000 for long-term monitoring and maintenance, and $651,000 in contingencies.

5.1.4 Soil Alternative 4: Engineered Cap with Excavation of Hot Spots in the Greenway – Off-Site Management
Alternative 4 is the same as Alternative 3, except the estimated 2,100 cubic yards of soil exceeding residential hot spot concentrations excavated from the greenway areas of the site would be transported off-site for disposal instead of consolidated on-site in the non-greenway area. This soil will be sampled and analyzed post-excavation/post-screening to evaluate off-site disposal options. Screened soil would likely be staged in uniform stockpiles (e.g., 100 cubic yards). Each stockpile will be sampled to verify presumed waste profile characteristics and to confirm that residential hot spot concentrations are exceeded. If concentrations do not exceed the hot spot concentrations, the soil would be managed on site in the temporary cell.

The estimated cost for implementation of Alternative 4 is $4.11 million, which includes $270,000 for remedial design, $3.03 million for remedial action construction, $123,000 for long-term monitoring and maintenance, and $684,000 in contingencies.

5.1.5 Soil Alternative 5: Engineered Cap with Excavation of Hot Spots in Greenway and Non-Greenway—On-Site Management
Alternative 5 is the same as Alternative 3, except an additional 4,400 cubic yards of hot spot soils would be excavated from the non-greenway area for on-site consolidation prior to capping the site. Hot spot soil would be excavated to a depth of 15 feet below final grade.

The estimated cost for implementation of Alternative 5 is $4.05 million, which includes $270,000 for remedial design, $2.98 million for remedial action construction, $123,000 for long-term monitoring and maintenance, and $675,000 in contingencies.

5.1.6 Soil Alternative 6: Engineered Cap with Excavation of Hot Spots in Greenway and Non-Greenway—Off-Site Management
Alternative 6 is the same as Alternative 5, except for off-site disposal of approximately 6,500 cubic yards of soil exceeding human health hot spot concentrations based on residential exposures. In comparison to Alternative 4, Alternative 6 provides an
additional 4,400 cubic yards of hot spot soil in the non-greenway for excavation and off-site disposal.

The estimated cost for implementation of Alternative 6 is $4.44 million, which includes $270,000 for remedial design, $3.31 million for remedial action construction, $123,000 for long-term monitoring and maintenance, and $740,000 in contingencies.

### 5.1.7 Alternative 7: Excavate Soil to Cleanup Levels

Under Alternative 7, all soil with COC/CEC at concentrations exceeding CULs would be excavated and disposed off-site for landfill disposal in accordance with applicable regulations, and excavated areas backfilled with clean fill. The estimated volume of soil for off-site disposal is 330,000 cubic yards. Excavation of soil would follow the procedures described in the design documents, including the SMP, and would be completed either before or as part of redevelopment.

The estimated cost for implementation of Alternative 7 is $30.1 million, which includes $224,000 for remedial design, $24.86 million for remedial action construction, and $5.0 million in contingencies.

### 5.2 Remedial Alternatives for Willamette River Sediments

Five remedial alternatives were developed for Willamette River sediments including no action. The developed alternatives provide a range of removal and containment options for the significant volume of sediment contaminated at levels exceeding the human health or ecological based cleanup levels or hot spot concentrations. Each of the sediment alternatives, with the exception of the no action alternative includes the following common elements:

**Institutional Controls and Monitoring:** Institutional controls would involve use restrictions, marking of boundaries, and monitoring and maintenance programs designed to confirm the long-term effectiveness of the remedial action. The United States Coast Guard Notice to Mariners system will be used to limit the size of ships and activities near the cap area. This system uses radio broadcasts to inform watercraft in the area as well as postings in all marinas. In addition, the perimeter may be marked with buoys and signs to minimize recreational boaters traversing the area.

To ensure cap preservation, legal restrictions would need to be placed to limit in-water development within the sediment management area. Implementing these restrictions would require approval from the Oregon Department of State Lands (DSL) who owns the
river bottom below the OHW elevation. The implementability of this provision is discussed in Section 6 of this report.

An Operations, Maintenance and Monitoring Plan (OMMP) would be developed for routine cap performance monitoring, including the schedule and reporting requirements, an emergency response plan should an environmental upset occur (e.g., vessel grounding or a flood in exceedances of design criteria), and a contingency plan that will identify actions to be taken if the cap fails to meet the performance criteria.

**Engineered Cap:** Remedial alternatives that involve long-term management of contaminated sediment (Alternatives 2 through 4, and Alternative 5 as a possible contingency) include capping sediment to isolate it from aquatic species (i.e. benthic organisms, fish, and wildlife) to minimize or prevent bioaccumulation of contaminants in the food chain, and physical transport downstream. Several cap configurations are possible: conventional sand, armored, and composite.

Conventional capping consists of placing sand or other appropriate material over the top of contaminated sediments. Material selection and cap thickness design are based on consideration of contaminant properties and local hydraulic conditions. Sand-size material or larger is typically preferred as cap material over fine-grained material. The latter are more difficult to place evenly, cause a great deal of turbidity during placement, and are more susceptible to erosion.

With armored caps, a conventional cap is protected from erosive forces through placement of rock. An alternative to conventional armor is the use of interlocking concrete blocks which typically have a lower profile in comparison to conventional armor and may offer some advantages for habitat creation.

Composite capping involves placement of a geotextile or flexible membrane liner directly over the contaminated sediment which is then held down with a conventional capping or armoring material. The geotextile or flexible member liner must be selected for strength, workability and resistance to contaminants of concern.

The western edge of the Sediment Management Area (SMA) is the bottom of the existing armor, which ranges from approximately 3 feet COP in the south SMA to 13 feet COP in the north (including at the barge launch) as well as where the sand beach forms near the bank at the midway point of the SMA.

Based on the bank evaluation (MFA, 2004), bank armor will remain unaltered, except for removal of deleterious material (e.g., rebar, wood scrap, wire, rubber [excludes concrete,
rock, and ballast stone]). Exceptions include areas found during design that need additional armoring to ensure long-term reliability (e.g., near COP outfalls).

5.2.1 Sediment Alternative 1: No Action
Under Alternative 1, no additional action would be taken to address the contaminated sediments. The No Action alternative is the basis for comparison of the other alternatives.

5.2.2 Sediment Alternative 2: Partial Cap
Alternative 2 relies on engineering controls to prevent exposure to and migration of sediments in the SMA where the cap is placed. Under Alternative 2, discrete areas of the SMA would be capped based on engineering considerations. Specifically, those areas within the northern two thirds of the SMA that have existing slopes of 3:1 or less would be capped. Areas internal to the SMA boundaries that have slopes greater than 3:1 would also be capped if the resultant extent of the cap remains within the SMA. Large, excessively steep areas would require excessive cap thickness to reach a stable slope of 3:1 and extend the cap toe beyond the SMA boundary would be excluded under Alternative 2.

Use of these criteria would eliminate capping where the river bank has a slope greater than 3:1 that continues into the river. In these areas, if a cap was constructed, it would require placement of at least 5 to 9 feet of sand to achieve the 3:1 slope, extending up to 40 feet beyond the SMA boundary. Application of this criterion results in a cap that covers approximately 70 percent of the SMA, using a little more than half the volume of cap material needed for Alternative 3 (full cap). Figure 5-2 shows the approximate cap limits for Alternative 2.

Alternative 2 would include the following components:

- Refinement of the SMA boundary through further sediment sampling and analysis, and a preconstruction bathymetric survey.
- Characterization of sediment engineering properties.
- Remove in-water objects and debris.
- Monitoring before, during, and after construction.
- Capping parts of the SMA with a minimum 2-foot-thick engineered sand cap.
- Placement of 1 foot of 2- to 6-inch, rounded, river rock armor on cap to minimize erosion.

Any in-water work to be performed on the Willamette River must be done within the allowable work windows of July 1 through October 31 and December 1 through January...
31. During the work windows, the river elevation and flow varies widely, with high flow conditions common. Access from land will be limited and the use of land-based equipment is infeasible, so virtually all construction work performed would use river-based equipment.

Capping would also require removal of most in-water obstructions. The requirement to remove existing pilings from the dock area will be determined during permitting. A survey would be required to identify the location of the obstructions requiring removal and a plan would need to be prepared with removal procedures.

Cap configuration would depend on the results of the design process. Hydraulic and geotechnical calculations are required, with consideration given to sediment and backfill or armoring material composition in order to determine the most feasible option for some of the steep bathymetry. As part of the cap design process, sediment in the river bank would be analyzed for strength and slope stability. The geotechnical analysis will also include sediment bearing capacity assessment and a seismic evaluation.

The area and thickness of the cap would be determined by considering sediment sample data and physical isolation requirements, edge stability, and chemical diffusion and permeation. Analysis of physical stability will be necessary, with consideration given to slopes, currents, waves, seismicity, and constructability. Navigational and floodway encroachment issues would also be assessed during design.

Floodway encroachment issues will be evaluated as part of design because the cap will be located in the Willamette River floodway. Generally, hydrologic modeling must show that there is no surface water elevation rise in the floodway during a 100-year flood event resulting from the cap installation. Some minor elevation rise may be acceptable if the environmental benefit is substantial. This determination is made by the COE.

The primary physical forces that can affect the cap include high-velocity currents, wind-driven wave action, and vessel-induced waves and propeller wash. Each force is negated through the use of rock armoring over the cap. For this analysis it was assumed that all areas of the cap would be armored with 12 inches of 2 to 6-inch rounded river rock, which is generally considered “fish friendly.”

No known utilities run through the SMA. However, a gas line and water line cross the river north of the SMA near the Marquam Bridge. As part of the design process, all utilities will be precisely located and the owners contacted to coordinate construction work. Given the distance from the SMA, the known utilities are not expected to complicate the installation of the cap.
The estimated cost for implementation of Alternative 2 is $1.51 million, which includes $270 thousand for remedial design, $813 thousand for remedial action construction, $77 thousand for periodic maintenance and monitoring, and $348 thousand for contingencies.

5.2.3 Sediment Alternative 3: Full Cap
Alternative 3 is the same as Alternative 2, except that the full SMA would be capped, as shown on Figure 5-3.

The estimated cost for implementation of Alternative 3 is $2.03 million, which includes $316 thousand for remedial design, $1.15 million for remedial action construction, $92 thousand for periodic maintenance and monitoring, and $467 thousand for contingencies.

5.2.4 Sediment Alternative 4: Hot Spot Dredging with Capping
Under Alternative 4, hot spots in the SMA would be dredged. For the FS, the lateral extent of the hot spots was delineated by establishing the midpoint between sampling locations where hot spot concentrations were exceeded and locations where they were not exceeded. Figure 5-4 shows the estimated extent of hot spots. As with Alternative 5, the assumed depth requiring dredging is 13 feet below the current river bottom. This assumption would be confirmed through further sediment characterization during design.

For long-term stability, over-excavation will be required to reach a 3:1 final hot spot area side slope. Capping of the remaining SMA would be implemented as described in Alternative 2. Alternative 4 would include all of the components listed in Alternatives 2 and 5, adjusted for the revised dredging and cap limits as described above. Under Alternative 4, estimated volumes and areas are as follows:

- Approximately 3,200 linear feet of temporary sheet piling would be installed to a depth of 25 feet below current grade (128,000 square feet) around hot spot areas to control sediment re-suspension and to maintain river bank stability.

- Approximately 44,000 cubic yards of sediment would be dredged, dewatered and transported to a solid waste landfill for disposal.

- Approximately 46,000 cubic yards of sand or sediment backfill would be placed to restore bank stability, minimize erosion potential and safeguard against potential contaminant exposure.

- A 2-foot-thick engineered sand cap would be placed covering non-hot spot areas that exceed the CULs in the SMA (23,500 cubic yards).
One foot of 2- to 6-inch rounded river rock armor would be placed on the cap to minimize erosion (13,000 cubic yards).

Design for Alternative 4 design would be very similar to Alternatives 2 and 5 because similar calculations and modeling would be performed to determine the exact boundaries of dredging and specific configuration of the cap.

The estimated cost for implementation of Alternative 4 is $9.79 million, which includes $415 thousand for remedial design, $7.05 million for remedial action construction, $60 thousand for periodic maintenance and monitoring, and $2.25 thousand for contingencies.

5.2.5 Sediment Alternative 5: Dredging
Alternative 5 would involve removal of all contaminated sediments in the SMA. Alternative 5 would include the components described for Alternative 2 and the following additional components:

- Installation of approximately 5,600 linear feet of vinyl sheet piling to a depth of 25 feet below current grade (224,000 square feet) around entire dredging area to control sediment re-suspension and to maintain river bank stability during dredging.
- Performance of clamshell or hydraulic dredging from a barge to remove sediment exceeding CULs throughout the SMA. The FS assumed dredging to a depth of 13 feet below the current sediment surface resulting in approximately 151,500 cubic yards of sediment removed. Removal of other obstructions, such as pilings in the north part of the SMA.
- Placing backfill of 102,000 cubic yards of sand or sediment (from off-site sources).
- Dewatering of dredge spoils on-site (upland).
- Performing three-stage treatment for water generated from sediment dewatering and for a portion of surface water within sheet pile containment (settling, filtration, and carbon treatment), followed by discharge to the Willamette River.
- Transporting dewatered sediment to RCRA Subtitle D landfill.
- Implementing institutional controls to ensure backfill and bank integrity (e.g., deed restrictions).
- Performing long-term inspections, maintenance, and reporting.

In areas close to the shore, dredging would undermine the bank without the use of sheet piling. Steel sheet piling would need to be installed and the dredging completed using water-based equipment. Sheet pile will likely be necessary around the remainder of the SMA to limit suspended solid transport downstream. An entrance for working vessels...
would be maintained using sediment curtains. Water within the dredging zone may require three-stage treatment for suspended sediment and dissolved constituents. Monitoring would be required, with dredging methods adjusted based on turbidity measurements and compliance levels.

All dredging would take place in the SMA—there would be no over-excavation into areas outside of the SMA. After dredging, backfill would be placed to stabilize slopes nearest the shoreline prior to removal of sheet piling. Some natural slope-stabilizing movement along the north, south, and east periphery of the SMA is likely to occur during removal of sheet piling in these areas.

Material removed through dredging would be transported via barge to an upland portion of the site for dewatering, where water would be treated and solids transported to a RCRA Subtitle D landfill. If dewatered sediment contains excess water (i.e., it fails the “paint filter test”), fly ash or wood byproducts would likely be added to further reduce the moisture content and avoid disposal surcharge fees. This would result in a greater volume of material requiring disposal.

Upon completion of the dredging and backfill, an OMMP would be implemented to assure that area integrity is maintained, that contaminants have been effectively removed, and that any lower-level contamination beneath the dredging area is contained. Maintenance would be conducted as necessary following reporting or inspections. With careful design, major maintenance would not be expected. However, if needed, it is likely to be related to erosion or a maritime related incident, or enhancement of fish and benthic habitat.

The estimated cost for implementation of Alternative 5 is $20.15 million, which includes $403 thousand for remedial design, $15.04 million for remedial action construction, $60 thousand for periodic maintenance and monitoring, and $4.65 million for contingencies.
6 Evaluation of Remedial Action Alternatives

This section presents the evaluation of the remedial action alternatives with respect to the remedy selection criteria in OAR 340-122-0090. Section 6.1 provides an overview of the evaluation criteria in the cleanup rules. Section 6.2 provides DEQ’s evaluation of the remedial alternatives against the remedy selection criteria, which varies in certain respects with the evaluation presented in the FS Report. The results of the evaluation provide the basis for the selected remedial action alternatives for soil and sediment described in Section 7.

6.1 Overview of Evaluation Criteria
The evaluation of remedial action alternatives involves three main criteria:

- The protectiveness of the alternative, based upon the standards set forth in OAR 340-122-0040;
- The feasibility of the alternative, based upon a balancing of the remedy selection factors set forth in OAR 340-122-0090(3) and (4); and
- The extent to which the remedial action alternative remediates hot spots of contamination.

The protectiveness of the alternatives is evaluated relative to the site-specific RAOs and cleanup goals described in Section 4. The feasibility of a remedial action alternative is based on evaluation of the following factors:

6.1.1 Protectiveness
Any removal or remedial action shall address a release or threat of release of hazardous substances in a manner that assures protection of present and future public health, safety, and welfare, and the environment. In the event of a release of a hazardous substance, remedial actions shall be implemented to achieve:

- Acceptable risk levels defined in OAR 340-122-0115, as demonstrated by a residual risk assessment; or
- Numeric soil cleanup levels specified in OAR 340-122-0045, if applicable; or
- Numeric cleanup standards developed as part of an approved generic remedy identified or developed by the Department under OAR 340-122-0047, if applicable; or
For areas where hazardous substances occur naturally, the background level of
the hazardous substances, if higher than those levels specified in subsections
(2)(a) through (2)(c) of this rule.

In the event of a release of hazardous substances to groundwater or surface water
constituting a hot spot of contamination, treatment shall be required in accordance with
OAR 340-122-0085(5) and (7), and OAR 340-122-0090.

A removal or remedial action shall prevent or minimize future releases and migration of
hazardous substances in the environment. A removal or remedial action and related
activities shall not result in greater environmental degradation than that existing when the
removal or remedial action commenced, unless short-term degradation is approved by the
Director under OAR 340-122-0050(4).

A removal or remedial action shall provide long-term care or management, as necessary
and appropriate, including but not limited to monitoring, operation, maintenance, and
periodic review.

### 6.1.2 Effectiveness

- The magnitude of risk from untreated waste or treatment residuals remaining at
  the facility absent any risk reduction achieved through onsite management of
  exposure pathways;
- The adequacy of any engineering and institutional controls necessary to manage
  the risk from treatment residuals and untreated hazardous substances remaining at
  the facility;
- With respect to hotspots of contamination in water, the extent to which the
  remedial action restores or protects existing and reasonably likely future
  beneficial uses of water;
- The adequacy of treatment technologies in meeting treatment objectives;
- The time until the remedial action objectives would be achieved; and
- Any other information relevant to effectiveness.

### 6.1.3 Long-Term Reliability

- The reliability of treatment technologies in meeting treatment objectives;
- The reliability of engineering and institutional controls necessary to manage the
  risk from treatment residuals and untreated hazardous substances, taking into
consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure;

- The nature, degree, and certainties or uncertainties of any necessary long-term management (e.g., operation, maintenance, and monitoring); and

- Any other information relevant to long-term reliability.

6.1.4 Implementability

- The practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays;

- The ability to monitor the effectiveness of the remedy;

- Consistency with federal, state and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies;

- The availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-site treatment, storage, and disposal capacity and services, and availability of prospective technologies; and

- Any other information relevant to implementability.

6.1.5 Implementation Risk

- The potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;

- The potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;

- The potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;

- The time until the remedial action is complete; and

- Any other information relevant to implementation risk.
6.1.6 *Reasonableness of Cost*

The cost of the remedial action including:

- Capital costs, including both direct and indirect costs;
- The net present worth of the annual operation and maintenance costs, including costs for any periodic review requirements;
- The degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management;
- With respect to hotspots of contamination in water, the degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water;
- The degree of sensitivity and uncertainty of the costs and
- Any other information relevant to cost-reasonableness.

6.2 *Evaluation of Soil Alternatives*

6.2.1 *Protectiveness*

Alternatives 2 through 7 were found to be protective. Alternative 7 would be the most protective because all soil above human health and ecological CULs would be removed. Under Alternatives 2 through 6, an engineered cap would be placed over soil containing COC/CEC concentrations that exceed relevant cleanup levels. With an engineered cap in place, no complete exposure pathways to COCs/CECs in soil beneath the cap would exist for potential receptors. Implementation of SMP for re-development, institutional controls in the form of deed notifications and deed restrictions, and a cap monitoring and maintenance program to detect and repair any breaches would provide necessary assurances that the cap would be maintained to prevent future exposures.

Alternatives 3 through 6 are considered more protective than Alternative 2 because soil that contains COC/CEC concentrations exceeding human health and ecological hot spot concentrations in the Greenway within the expected potential exposure zone (3 feet below final grade) would be excavated from the Greenway zone. Alternatives 4 and 6 are considered slightly more protective than Alternatives 3 and 5 because the hot spots would be transported off-site for disposal.
Alternative 1 is not protective because it does not address current unacceptable risks to human health and the environment.

6.2.2 Effectiveness
The evaluation of effectiveness in this section is based on the remedial action alternative’s ability to achieve the desired level of protection, and the magnitude of untreated wastes remaining at the site that would be managed by engineering and institutional controls. Since Alternatives 2 through 6 have common engineering and institutional controls, this criterion was considered neutral in the comparative evaluation of effectiveness between these alternatives.

Alternative 7 was ranked as the most effective alternative because soil above human health and ecological CULs would be removed from the site for off-site disposal, effectively eliminating long-term risk. Alternative 7, however, would take longer to achieve than Alternatives 2 through 6 due to the extensive soil removal that would be conducted.

Alternative 6 was ranked second in effectiveness because it would remove shallow human health hot spots from the site for off-site disposal. Alternative 4 was rated slightly lower than Alternative 6 because hot spot soils between a depth of 3 feet and 15 feet would remain in place in the non-greenway portion of the site. Alternatives 3 and 5 were ranked lower than Alternative 4 because hot spot soils from the greenway area would remain on-site resulting in no substantive reduction in toxicity, mobility or volume. Alternative 2 ranked lower than Alternatives 3 and 5 due to the presence of hot spot soils remaining in the greenway at relatively shallow depth below the soil cap, which increases the potential for significant exposure to COCs in the future.

Alternative 1 is the least effective alternative because no actions are taken to reduce the volume, toxicity, or mobility of the contaminants and does not include engineering or institutional controls to manage the unacceptable risk.

6.2.3 Long-Term Reliability
In general, long-term reliability provides an assessment of the remedial action alternative’s ability to maintain the required level of protection over the long term after it is implemented.

Alternative 7 was given the highest rating because all soil above human health and ecological CULs would be removed, with no residual materials requiring long-term management.
Alternative 6 was rated second in long-term reliability because both Greenway and Non-Greenway soil exceeding human health hot spot concentrations would be managed in an off-site disposal facility, which reduces the uncertainty of potential failure of engineering and institutional controls that could result in a significant risk to human health or the environment.

Alternative 4 was rated third due to some increased uncertainty in long-term reliability of on-site management of hot spot soils in non-greenway areas of the site. Alternatives 3 and 5 were ranked slightly lower than Alternative 4 due to the increased uncertainty involved in management of hot spot soils on-site rather than at an off-site engineered landfill.

Alternative 2 was ranked lower than Alternatives 3 and 5 due to the increased uncertainty in long-term management of hot spot soils within the unpaved greenway portion of the site. Alternative 1 is not reliable because it does not include treatment, engineering or institutional controls, and does not adequately address unacceptable risks posed by the site.

### 6.2.4 Implementability

The assessment of implementability is intended to determine whether, or with how much difficulty, the remedial action alternative can be implemented, the availability of various remediation elements or equipment, consistency or authorization from federal, state or local governmental bodies, and whether the alternative’s continued effectiveness can be assessed and verified.

Alternative 2 was rated highest for implementability. Construction of the engineered cap would present few practical, technical, or legal difficulties, and because the effectiveness of the cap is easily monitored. Deed notifications and restrictions and the SMP would require legal assistance, but would not be difficult to implement since the soil remedies do not involve any off-site properties. Minimal time would be required to obtain authorization for placing the cap. The local approvals required by the COP to implement Alternative 2 would be the same as those required for any other development project and would include a grading plan, land use review, and Greenway review. A Greenway Goal exception is not expected to be applicable to the site because activities in the Greenway will not preclude river-dependent uses. In addition, construction of the cap could be completed using readily available services, materials, and equipment. Because excavation and fill along the river bank above the armor would occur at elevations below the ordinary high water line of the Willamette River (approximately 18 feet COP), a COE permit would be required.
Alternatives 4 and 6 were given the second highest rating for implementability. These alternatives would require transporting impacted soil over public roadways, and disposal in permitted facilities, but do not pose significant implementation issues based on the availability of qualified and licensed service providers, and disposal facilities.

Alternatives 3 and 5 were given the next highest rating for implementability. Implementation problems that might be posed by this approach are the potential design requirements that might be required by DEQ to relocate hot spot materials from the greenway area to the non-greenway areas of the site (i.e. liners comparable to solid waste landfill requirements). The necessary services, materials, equipment, and specialist required to implement the alternative are readily available.

Alternative 7 would require excavation of the large volume of soil requiring transport over public roadways as compared to all other alternatives, and the associated transport and disposal issues identified above.

DEQ does not consider Alternative 1 as implementable because it would pose an unacceptable risk to human health and the environment.

### 6.2.5 Implementation Risk

The evaluation of implementation risk criterion addresses the effects of each alternative during the construction and implementation phase (i.e., up to the point that RAOs are met). Under this criterion, alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action.

Alternative 2 has a low implementation risk, which is primarily associated with potential worker exposure to impacted soil and standard construction safety hazards. As shown in Table 3-6, the estimated risk to site workers exceeds regulatory thresholds by a factor of 4 to 10 for carcinogenic and non-carcinogenic effects, respectively. Potential impacts to the community are associated primarily with fugitive dust emissions associated with excavation. Environmental impacts are primarily associated with potential short-term releases of soil during bank excavation. All of the potential issues are readily manageable through proper design, planning, and implementation. Standard procedures used in the construction and environmental remediation industries can be employed to minimize implementation risk.

Alternatives 3 and 5 have a slightly greater implementation risk as compared to Alternative 2 due to the increased volume of soil managed. As with Alternative 2, these issues are well understood and readily manageable through proper design, planning, and
implementation, and the use of standard construction and environmental remediation industry procedures.

Alternatives 4 and 6 have a greater degree of implementation risk than Alternatives 3 and 5, which are associated with transporting impacted soil over public roadways for disposal in permitted facilities. These are considered minor factors that are readily managed using qualified and licensed service providers.

Alternative 7 was given a lower rating than Alternatives 4 and 6 due to large volume of soil requiring transport over public roadways. Although manageable, implementation risk is expected to be a function of vehicle-miles traveled, which is significantly greater for this scenario as compared to all others.

Alternative 1 has the greatest implementation risk because RAOs would not be achieved resulting in significant risk to onsite workers or future residents at levels higher than construction workers.

6.2.6 Preference to Remediate Hot Spots
This section lists whether or not each alternative treats hot spots and the extent of the treatment, which is a preference under Oregon’s environmental cleanup law.

Alternative 7 remediates all soil exceeding human health and ecological hot spot concentrations through off-site disposal at a licensed disposal facility. Therefore, it meets the Oregon environmental cleanup law’s preference to remediate hot spots.

Alternative 6 substantially meets the Oregon environmental cleanup law’s preference to remediate hot spots through off-site disposal of approximately 6,500 cubic yards of hot spot soil. Alternative 4 provides a lesser degree of remediation of hot spots than Alternative 6, with an incremental volume of 5,700 cubic yards of hot spot material remaining on-site.

Alternatives 3 and 5 do not remediate hot spot soil through treatment or off-site disposal, but does provide containment outside of the Greenway area. Placement of hot spot soils in an engineered containment cell would substantially satisfy this requirement, however.

Alternative 2 provides containment only and does not actively remediate hot spots within the meaning of the Oregon environmental cleanup law. Likewise, Alternative 1 does not meet the Oregon environmental cleanup law’s preference to remediate hot spots.

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6.2.7 Cost Reasonableness

The cost of each remedial action alternative was estimated using standard engineering procedures. The estimated cost includes all elements of the remedial action alternative, including the cost of mobilization, treatment, disposal, site restoration, monitoring, and operation and maintenance (O&M). The estimated cost of a reduced property value was not considered in the evaluation (e.g., estimated losses in property value due to reliance on engineering or institutional controls). Per standard FS protocols, the estimated costs should be within the range of +50 percent to -30 percent of actual costs if the alternative were implemented. The cost estimates for each alternative were noted in Section 5.2. The total cost for each alternative is summarized in Table 6-1.

The evaluation of reasonableness of cost is typically completed in two parts. The first part is an estimate of cost for each alternative and a comparison of costs between alternatives. The second part involves evaluating the degree to which the costs are proportional to the benefits. The second part is a qualitative evaluation. In general, those alternatives that are considered protective (effective and reliable); can be readily implemented with minimal impacts to the community, workers, and the environment; and have a lower cost will be regarded as having a greater level of cost reasonableness. In assessing cost reasonableness of those alternatives that meet the threshold requirement of protectiveness, the relative ability of each alternative to address the four other evaluation criteria (as reflected in the ratings described above) were reviewed together with the relative costs. That is, a relative benefit-to-cost analysis was completed.

For the Greenway, the volume of soil exceeding hot spot concentrations associated with the recreational use scenario is included in the volume exceeding ecological hot spot concentrations. In addition residential hot spot soil would be removed during bank stabilization. Therefore, the volume of soil exceeding ecological and residential hot spot concentrations was used, and is estimated to be 1350 cubic yards. This was compared to the volume corresponding to residential CULs, which is estimated to be 132,000 cubic yards. The analysis shows a significant increase in soil volume (and cost) which is disproportionate with contaminant concentration reductions associated with off-site treatment and/or disposal of soil above cleanup levels but below hot spot concentrations. A similar conclusion was reached for the Non-Greenway. For this area of the site, the estimated volumes of soil above residential hot spot concentrations and residential CULs were 330,000 cubic yards.

Alternative 6 had the highest non-economic factor rating in the FS. The cost differential for Alternative 6 as compared to Alternatives 3 through 5 was not considered excessive. The non-economic rating of Alternative 5 is incrementally higher than that of Alternative 4, and the cost differential as compared to Alternative 6 was lower than the Alternative 4 differential. Combining these benefit and cost factors resulted in a rating slightly lower than Alternative 6 and slightly grater than that assigned to Alternative 4, which was rated
third in the FS. The benefit and cost factors rating for Alternative 3 were above that assigned to Alternative 2, but below those for Alternatives 4 through 6.

Alternative 7 had a low non-economic factor rating, and an estimated cost greatly in excess of all other alternatives, and therefore received a cost reasonableness rating well below the ratings for Alternatives 2 through 6. Alternative 1 does not meet the threshold criterion of protectiveness, and therefore received the lowest cost reasonableness rating.

6.3 Evaluation of Sediment Alternatives

6.3.1 Protectiveness
Ambient levels of PCB Aroclors 1254 and 1260, estimated to be in the range of 10 to 20 ppb by DEQ, are expected to exceed the cleanup level of 2 ppb for each Aroclor. None of the remedial alternatives for sediment would restore the site to human health cleanup levels for PCBs and PAHs due to ambient levels exceeding the cleanup levels.

Alternative 5 was rated the highest in protectiveness, as all sediments exceeding the cleanup levels in Table 4-2 for ecological receptors would be removed, and the excavation areas backfilled with clean sand. Alternative 4 was rated second in protectiveness because hot spot sediments would be removed and residual sediment contamination exceeding cleanup levels would be capped with up to 10 feet of clean sand.

Alternative 3 was found to be protective. Under this alternative, sediment in the SMA would be capped. With an engineered cap in place, no complete exposure pathways to chemicals in sediment beneath the cap would exist for potential receptors. Therefore, no unacceptable levels of risk would exist for human or ecological receptors within the capped SMA. Institutional controls in the form of deed notifications and deed restrictions should be reliable in managing COCs/CECs remaining in sediment at the site, because removal of cap material would not be allowed, and periodic monitoring would be conducted to identify any unanticipated breaches in the cap due to physical transport during major flooding events. The residual risk to ecological receptors from residual contamination outside of the SMA would not exceed the regulatory threshold criteria. The residual risk to human receptors would exceed the regulatory threshold criteria for carcinogenic risk to PCBs due to ambient concentrations within the river.

Alternative 2 is less protective than Alternative 3 as a portion of the SMA would not be capped resulting in unacceptable risk for a portion of the site. Also, residual contamination within the SMA that is not capped could migrate during high flow periods within the Willamette, which could result in re-contaminating the capped portion of the SMA and adjacent areas.
Alternative 1 would leave contaminated sediment that poses and unacceptable risk in place without treatment or controls, and therefore is not be protective of human health or the environment.

6.3.2 Effectiveness
Alternative 5 was rated highest in effectiveness by reducing risk through the removal of impacted sediment from the in-water environment and placing it in a permitted landfill. Alternative 4 was rated lower than Alternative 5 because residual contamination below hot spot levels and cleanup levels would remain. Alternative 3 was rated lower than Alternative 4 because sediment hot spots would not be removed. The hot spots should be effectively managed through capping, however. Alternative 2 is only partially effective because some SMA areas, including hot spots, remain unaddressed. Additionally, recontamination of the capped area is a potential concern. Alternative 1 is not effective at decreasing the risk on site because no actions are taken to control impacted sediment or reduce the volume, toxicity, or mobility of the contaminants. In addition, no engineering or institutional controls are used to manage the risk.

6.3.3 Long-Term Reliability
Alternative 5 is rated as most reliable in the long term, since the sediment is removed and placed in a permitted landfill. Because the sediment is no longer in the in-water environment, this alternative was rated higher than Alternatives 3 and 4. Long-term reliability of Alternative 4 is slightly greater than full containment (Alternative 3), since hot spot sediments are no longer located in the SMA, and therefore cannot be released to the in-water environment. However, because the cap is a reliable long-term remedy, the increase in reliability was not considered significant.

Capping is reliable if properly designed to prevent failure during high-flow conditions in the river. Alternative 3 is considered reliable in the long term provided monitoring and maintenance of the cap is implemented in the long-term to ensure reliability. Alternative 2 is reliable for a portion of the SMA but not in the remaining uncapped areas. Alternative 1 is not reliable in the long term because it does not manage risk from impacted sediments.

6.3.4 Implementability
Cap construction activities under Alternatives 2 through 4 are implementable, as they would be based on proven materials management and placement technologies. Materials and equipment are standard, and are readily available in the Northwest. These alternatives would require an agreement with DSL that facilitates long-term access to and
use of state lands, and require compliance with permitting requirements specified by the COE, DSL, DEQ, and other requirements identified by NOAA related to protection of habitat for T&E fish species. Completing the access/use and permitting requirements will increase the complexity of implementation of these alternatives. DSL has provided comments to DEQ on other sediment remedies involving capping that opposed the placement of a cap and expressed a preference for removal of contaminated sediments from State lands. DSL is also evaluating land sales, easements, and leases to facilitate use of state lands where the selected remedy involves leaving contamination in place, such as with capping. Negotiations related to access and use may delay implementation of any alternative that involves capping of contaminated sediments in place. Because this implementation issue is common to each alternative (including Alternative 5 where complete removal may be infeasible because of technical reasons), the implementability comparison of alternatives focused on the constructability of the remedial components.

Alternative 3 was rated highest in implementability by DEQ. Alternative 4 was rated lower than Alternative 3, due to the increased complexity associated with large volume hot spot dredging, dewatering, transport, and disposal. The permitting and environmental protection measures required for the dredging component of the alternative are significant. The sediment and impacted water volumes to be managed are smaller than for full SMA dredging (Alternative 5).

Alternative 5 is not easily implementable. Standard and specialized equipment, materials, and technologies would need to be applied. The large volumes of sediment to be dredged, dewatered, transported, and disposed of, as well as the large volume of water requiring treatment and discharge make this alternative challenging. Permitting complexity and the necessary environmental protections also add to the difficulty in implementing this option.

DEQ rated Alternative 2 lower in implementability because it does not adequately address risks throughout the site, and could be deemed unacceptable by DSL, who owns submerged portions of the river. As noted in the evaluation of soil alternatives, DEQ does not consider Alternative 1 as implementable because it would pose an unacceptable risk to human health and the environment. DEQ therefore, considers both sediment Alternatives 1 and 2 as not implementable.

**6.3.5 Implementation Risk**

Alternative 3 has minimal implementation risk. Standard construction safety practices could be employed per state and federal regulations. The risk of negative impacts to the environment during implementation is low due to the fact that impacted sediments are not removed from the site and no water treatment is required. The time required for
completion is relatively short. For these reasons, Alternative 3 was rated best for implementation risk.

The implementation risk of Alternative 4 is comparable but lower than full SMA dredging (Alternative 5), because the volumes involved are significantly smaller, the implementation risk is correspondingly reduced.

Alternative 5 has considerable implementation risk, resulting primarily from the potential for system upsets and impacted material releases during dredging, transport to the dewatering facility, dewatering, off-site transport, and disposal. System failures during sheet pile installation and removal, and failure of the temporary water treatment system also increase the implementation risk.

While the implementation risk for Alternative 2 is comparable to Alternative 3, it was rated lower than Alternatives 3 through 5 because RAOs would not be satisfied for much of the SMA. Alternative 1 has the greatest implementation risk because RAOs would not be achieved resulting in significant risk to ecological receptors and recreational fishermen that consume fish caught in the area.

### 6.3.6 Preference to Remediate Hot Spots

Alternatives 4 and 5 remediate all sediment exceeding human health and ecological hot spot concentrations through dredging. Therefore, these alternatives meet the Oregon environmental cleanup law’s preference of remediation. Alternative 3 does not actively remediate hot spots through treatment or off-site disposal, but provides containment of most of the sediments with COC/CPEC above cleanup levels. Alternative 2 provides containment for only a portion of the hot spot sediments. Alternative 1 does not treat hot spots.

### 6.3.7 Cost Reasonableness

Details and primary assumptions used in development of the cost estimates are provided in Appendix E of the FS. The cost estimates for each alternative were noted in Sections 5.3. The total cost for each alternative is summarized in Table 6-2.

When comparing the expected performance of Alternatives 2 and 3, Alternative 3 higher than Alternative 2 because the increased cost is warranted to fully achieve the RAOs. The costs for both Alternatives 4 and 5 involving sediment removal are much higher than Alternative 3, which are significantly disproportionate to the decrease in residual risk potentially achievable through removal. Although Alternative 4 meets the preference for hot spot remediation, the costs outweigh the benefits realized.
Alternative 1 does not meet the threshold criterion of protectiveness, and therefore received the lowest cost reasonableness rating.

6.4 Evaluation Summary

Based on the evaluation of soil and sediment alternatives presented in the FS Report, Zidell selected Alternative 6 for soil and Alternative 3 for sediment. DEQ generally concurs with the alternatives selected by Zidell, as modified by DEQ. Section 7 provides a description of the DEQ recommended alternatives that include modifications of the alternatives as described in the FS, a description of other laws that are applicable or relevant to the recommended alternatives, and an evaluation of residual risks.
7 Selected Remedial Alternatives for Soil and Sediment

DEQ has selected Soil Alternative 6 and Sediment Alternative 3, modified as discussed below, as the selected remedial action alternatives for the site. The estimated cost for implementation of Soil Alternative 6 is $4.4 million. The estimated cost for implementation of Sediment Alternative 3 is $3.0 to $4.0 million, which includes an incremental increase of approximately $2.0 million for the DEQ modifications that include the larger SMA cap area and selective dredging in the barge launch way. The total cost of the soil and sediment remedial alternatives is $7.4 to 8.4 million. Figures 7-1 and 7-2 show the integrated upland and in-water remedial alternatives in plan and cross-sectional view, respectively.

7.1 Selected Alternative for Soil

Alternative 6 is the selected soil remedial action alternative, as modified and described below. This remedial action provides a cost-effective, protective approach to remediating impacted soil while allowing for continued barge building operations and subsequent high-density residential, commercial, and recreational redevelopment of the site. Protectiveness is achieved by: 1) excavation and off-site disposal of human health hot spot soils and other hazardous materials from the site; (2) excavation and on-site consolidation of ecological-based hot spot soils on the non-greenway portion of the site; 3) engineering controls involving capping the site to reduce potential exposure to residual contamination; and 4) placement of institutional controls to ensure long-term effectiveness of engineering controls.

Alternative 6 includes the following modifications from the alternative described in the FS:

- Source control measures to protect the Willamette River from further releases of hazardous substances prior to implementation of the soil remedy and continued barge building operations by Zidell;

- On-site or off-site treatment of soil as necessary to remove hazardous waste leaching characteristics prior to off-site landfill disposal of soil exceeding hot spot concentrations based on future residential use of the property;

- Final consolidation of soil removed from the greenway area to the non-greenway area in geo-textile lined cell(s) prior to final capping; and
Excavation of hot spot soils to a depth of 5 feet below final grade in both the greenway and non-greenway areas of the site (instead of 3 feet in the greenway and 15 feet in the non-greenway areas as proposed in the FS).

While not a required element of the selected remedy, installation of stormwater treatment ponds within the greenway for pre-treatment of stormwater from re-developed portions of the site prior to discharge to the Willamette River is compatible with the selected remedy.

7.1.1 Excavation, Screening, Consolidation and Disposal of Soil
Placement of a stable cap within the greenway that addresses hot spot soils within the existing bank will require re-grading the bank slope along the bank. Re-grading of the greenway area south of the Ross Island Bridge may be delayed until barge building operations are terminated subject to implementation of effective source control measures to protect the Willamette River.

Re-grading of the greenway area of the site will involve excavation of approximately 40,000 cubic yards of material from the greenway area. Areas containing hot spot materials or bulk asbestos-containing (e.g., insulation etc.) material (ACM) will be over-excavated to a depth of 5 feet below final grade. Hot spot soil in the non-greenway will also be excavated to a depth of 5 feet below current grade for off-site disposal. The FS Report estimated the volume of hot spot soils for off-site disposal at 6,500 cubic yards. In an effort to maintain cost-reasonableness of the selected alternative, DEQ will limit the volume of hot spot soil for off-site disposal to no more than 8,000 cubic yards using a worst-first approach. Any human health hot spot soil above this volume will be managed on-site in geotextile lined containment cell(s) constructed to hold non-hot spot soil from the greenway area.

Fill material historically placed on the site, especially along the bank, consists of large amounts of oversize, primarily inert, material (e.g., concrete). With the exception of ACM, soil screening may be used to isolate the impacted soil from the inert material. The separated rock and concrete may be stored on site for recycling as aggregate (following crushing) during the site redevelopment. Other oversized material (e.g., wood, solid waste) will be transported off site for disposal.

Screened soil that exceeds the hot spot concentrations in Table 4-1 and ACM (e.g., landfilled insulation material or fabric) will be transported off-site for disposal in accordance with applicable state and federal regulations. Soil that exceeds TCLP regulatory thresholds will be disposed as a RCRA hazardous waste. Alternatively, these
soils may be stabilized on-site and disposed at a DEQ-approved Subtitle D solid waste landfill, provided the stabilized soil does not exceed TCLP leaching criteria and meet RCRA land disposal restriction requirements. The on-site stabilization process is subject to applicable substantive state and federal hazardous waste management requirements, including 40 CFR 262, 265, and 268.

The non-hot spot soil for on-site consolidation will be placed in a lined and covered staging area, either before or after screening as described above. Following screening, the reduced volume of excavated soil will be incorporated into the redevelopment design in a manner that ensures protection of human health and the environment.

Contaminated soils in the utility corridors exceeding the RBCs for the construction worker will be excavated to a depth of up to 5 feet below final street grade as required by the COP’s Soil Reuse Policy (COP, 1999), and appropriately managed in the non-greenway areas outside of utility corridors within the area of contamination (AOC) defined as existing soil contamination areas above the cleanup levels specified in Table 4-1.

The site redevelopment may require an overall site elevation increase of approximately 3 to 6 feet that will likely require importing additional clean fill. Alternatively, dredged, dewatered sediment from the site with COCs below human hot-spot concentrations may be used as fill prior to placement of the final site cap. Additional non-hot spot soils may be excavated as needed for site redevelopment (e.g., below ground parking for new buildings etc.), although the excavation of these soils is not a requirement of DEQ’s selected remedial action. Impacted soil that requires excavation will be placed below clean fill or other site appurtenances or structures. Parameters for soil placement to ensure long-term protection of human health and the environment will be established in the soil management plan (SMP), and incorporated into redevelopment designs. These include, but are not limited to, requiring that impacted soil be placed outside the public ROWs and utility corridors and above the water table. For all redevelopment activities that involve potential exposure to soils exceeding RBCs for the construction worker scenario, the health and safety protocols would be implemented.

7.1.2 Capping
An engineered cap will be used to prevent contact with impacted soil and thus minimize exposure to COCs/CECs and prevent erosion of impacted soil to surface water and sediment. A cap will be placed in those areas where residual contaminants remain above the residential RBCs identified in Table 4-1. Within the greenway area, the engineered cap will consist of a demarcation layer such as geotextile material or plastic sheeting to identify the top of the impacted soil, and a 2-foot vegetated clean soil cap. To
accommodate desired greenway features, barriers equivalent to the 2-foot soil cap may be used, as approved by the DEQ during remedial design. Existing bank armoring comprised of concrete, rock, and ballast stone may serve as the cap between an elevation of approximately 3 feet and 13 feet COP datum. Additional armoring will be installed in the bank areas where existing armoring is discontinuous or of questionable structural integrity. The areas for armor improvements will be identified during remedial design.

For the non-greenway area, the engineered cap may incorporate proposed buildings, pavement, or other improvements constructed as part of the site redevelopment. These may be used augment, parts of the soil cap, with DEQ review and approval. The cap will be installed during, and coordinated with, site redevelopment. If no redevelopment occurs for portions of the site within 10 years from the date of the final DEQ Record of Decision, these areas will be capped as described for the greenway area of the site.

A stormwater collection and conveyance system will be designed and constructed as part of the engineered cap to manage stormwater during and after implementation of the final remedy.

7.1.3 Engineering and Institutional Controls
Access restrictions, such as fencing, will be constructed to restrict public access to the site to prevent contact with soil through completion of site capping. For areas of the site leased to third parties that contains contamination above applicable RBCs, a temporary cap will be installed to protect tenants from exposure to contaminated soil. In addition, existing asphalt-concrete pavement that covers much of the Zidell barge construction operational area and the concrete floor slabs of the existing buildings will be retained until remedy construction activities are implemented to further reduce the potential for exposure to contaminated soil.

Institutional controls will include deed restrictions to prevent disturbance of the cap, address notification of site hazards, and ensure proper controls are implemented prior to and during future site activities. Deed restrictions will restrict activities, operations, or uses that damage or interfere with the integrity of the cap, or disturb residual soil contamination. Deed restrictions will also require the long-term maintenance of the cap and other engineering controls, and provide notification of site hazards. Removal or destruction of the cap or disruption of the residual soil contamination will be cause for initiating additional remedial actions to achieve protective levels. The deed restrictions will also require prior notification to DEQ of any significant changes in site redevelopment plans or changes in site ownership or land use, and if such events occurred, may require an evaluation of the need for further remedial action of all contaminated media to achieve appropriate health-based protective levels. The deed

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restrictions will run with the land and will be enforceable to all current and future owners of the site.

An Inspection and Maintenance Plan specifying the long-term inspection and maintenance requirements for the cap and other engineering controls shall be prepared for DEQ review and approval as part of the remedial design phase of work.

A Soil Management Plan (SMP) shall be developed to guide future excavation activities that could potentially encounter impacted soil. The SMP shall outline specific requirements for managing soil on site as part of future redevelopment. Oversight of excavation activities shall be conducted by an environmental professional to identify ACM or unexpected contaminated soil requiring management. Waste disposal requirements and sampling and analysis requirements shall also be addressed in the plan. The SMP will also specify that if potential ACM is found during excavation, it will be segregated and characterized by a certified asbestos contractor and managed following applicable asbestos and solid waste regulations. The plan will require that areas filled with excavated soil be surveyed and included in deed notifications and deed restrictions.

### 7.2 Selected Alternative for Sediment

Alternative 3 is the selected sediment alternative, as modified and described below. Alternative 3 will include engineering controls involving placement of a sediment cap over the impacted sediments within the SMA, and institutional controls to ensure long-term effectiveness of the cap. Alternative 3 includes the following DEQ modifications to the proposed remedial action alternative presented in the FS Report:

- Extending the SMA to include the zone where WRS-12 and WRS-13 were located and extending the SMA an additional 50 to 100 feet from the shoreline;
- Performing periodic monitoring of sediment conditions outside of the final cap area to assess capping reliability and natural restoration of marginally impacted sediments that exceed cleanup levels specified in Table 4-2; and
- Selective dredging of hot spot sediments in the barge launch area as shown on Figure 7-1 and further specified in Section 7.2.1.

#### 7.2.1 Selective Dredging

Remediation of the hot spot sediments is a high priority to ensure timely protection of human health and the environment, and minimize any further transport of contaminated sediments outside of the SMA area and downstream as a result of on-going barge construction activities. Placement of the sediment cap in this SMA, as described for Alternative 3, would obstruct existing barge launching operations, which are expected to
continue for up to 10 years following the issuance of this remedy decision. Selective dredging of the barge launchway sediments will therefore be conducted within the area shown in Figure 7-1 in a manner that would not restrict barge launching operations following cap placement. If barge building operations are discontinued prior to placement of the sediment cap, dredging of the barge launchway will be reconsidered following consultation with the City of Portland and Zidell on possible use of this area for river-related access consistent with the City of Portland greenway plan.

The dredging area is approximately 300 feet in length and extends 60 to 100 feet from the shoreline. Sediment will be selectively dredged and residual contaminated sediment capped in a manner that maintains current elevations or is compatible with on-going barge launching operations. The dredged sediment will either be managed on-site as described for the soil alternative or transported off-site for disposal. Specifications for dredging and capping will be developed during remedial design.

### 7.2.2 Engineered Cap

Alternative 3 will include installation of a cap within the modified SMA to isolate contaminated sediment from aquatic species (i.e. benthic organisms, fish, and wildlife) and to minimize or prevent bioaccumulation of contaminants in the food chain, and physical transport downstream. The sediment cap will tie into the armored bank to provide a continuous cap between upland soil and in water sediments.

In-water work performed on the Willamette River will be done within the allowable work windows specified in applicable permits. Prior to capping, most in-water obstructions will be removed. Some of the existing pilings within the dock area may remain if they provide cap stability and habitat-enhancement, and are approved for retention during the permitting process with DSL and COE/NOAA.

The sediment cap area will be no smaller than the FS-SMA or larger than the DEQ-SMA shown in Figure 7-1. The final cap configuration and design specifications will be finalized during remedial design and permitting based on the additional sediment characterization to refine the cap boundaries and hydraulic and geotechnical analyses. The area and thickness of the cap will be determined by considering sediment sample data and physical isolation requirements, edge stability, chemical diffusion and permeation, and physical stability. Navigational and floodway encroachment issues would also be assessed during design. For the purposes of this decision, the cap was assumed to be comprised of a two foot layer of sand armored with one foot of 2 to 6-inch rounded river rock.
Floodway encroachment will also be evaluated as part of design because the cap will be located in the Willamette River floodway. If a measurable elevation rise is predicted during a 100-year flood event, then a balanced cut to off-set the flood rise may be required.

No known utilities run through the SMA. However, a gas line and water line cross the river north of the SMA near the Marquam Bridge. As part of the design process, all utilities would be precisely located and the owners contacted to coordinate construction work. Given the distance from the SMA, the known utilities are not expected to complicate the installation of the cap.

7.2.3 Institutional Controls and Monitoring

Institutional controls will involve use restrictions, marking of boundaries, and monitoring and maintenance programs designed to confirm the long-term effectiveness of the remedial action. The United States Coast Guard Notice to Mariners system will be used to limit the size of ships and activities near the cap area. This system uses radio broadcasts to inform watercraft in the area as well as postings in all marinas. In addition, the perimeter may be marked with buoys and signs to minimize recreational boaters traversing the area, and subject to other site restrictions imposed by DSL and the Oregon Marine Board.

Legal restrictions limiting in-water development may also be placed on the final capped SMA area. The state of Oregon owns the river bottom where the sediment cap would be placed. Placement of the cap, use restrictions, and other institutional controls will require DSL approval. These potential restrictions will be assessed further during remedial design when cap specifics are determined, with the goal of maximizing cap preservation.

An Operations, Maintenance and Monitoring Plan (OMMP) shall be developed for routine cap performance monitoring, including the schedule and reporting requirements, an emergency response plan should an environmental upset occur (e.g., vessel grounding or a flood in exceedance of design criteria), and a contingency plan that will identify actions to be taken if the cap fails to meet the performance criteria. The OMMP will include annual visual inspection of the cap for integrity for at least three years following placement. Bathometric surveys will be performed on a periodic basis to confirm that no erosion of capping materials has occurred. Sediment testing will also be performed on a five year schedule for at least 10 years to monitor the natural recovery of low-level sediment contamination outside of the cap boundary, and assess potential releases associated with breaches in the sediment cap discovered during physical inspection. The monitoring program for recovery assessment would be discontinued when residual...
contaminant levels outside the cap area meet the cleanup levels specified in Table 4-2 or ambient levels upstream of the site.

7.3 Remedy Implementation Phasing

The soil and sediment remedies will be implemented in a phased approach. Initial activities will include source control measures to protect the Willamette River from additional releases of hazardous substances that will be implemented concurrent with remedial design and remedial action planning and permitting. Supplemental sediment sampling and analyses will be performed during Phase 1 upon DEQ’s approval of the RD/RA work plan. Permitting and design of all remedial action components will be completed within approximately 18 months of DEQ approval of the RD/RA work plan.

Phase 2 of the selected remedy will include selective dredging and placement of the sediment cap. The second phase will also address the greenway north of the Ross Island Bridge to include hot spot and ACM removal, re-grading and placement of the engineered cap and upgrading existing armoring in the bank line, and placement of non hot-spot soils outside of the greenway in an engineered containment cell. Removal and off-site disposal of limited hot spot soil from the non-greenway may also be completed during the second phase. Deed notifications and deed restrictions, including a SMP, will also be implemented during Phase 2.

Greenway remedial actions south of the Ross Island Bridge and the non-greenway remedial measures will be completed during Phase 3, and will be implemented within ten years of remedy implementation. Existing infrastructure such as pavement, building foundations or importing clean fill would be used in the non-greenway areas as a temporary barrier against direct contact with soil until site redevelopment occurs.

7.4 Satisfaction of Protection and Balancing Factors

7.4.1 Protectiveness
OAR 340-122-0040 requires that all remedies be protective of human health and the environment, as demonstrated through a residual risk assessment (RRA). A RRA was included in the FS Report to support the selection or approval of the remedial action alternatives for soil and sediment. The RRA included the following:

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• A quantitative assessment of the potential risk resulting from concentrations of untreated waste or treatment residuals remaining at the facility at the end of any treatment, excavation, and off-site disposal activities, taking into consideration current and reasonably likely future land- and water-use scenarios and the exposure assumptions; and
• A qualitative or quantitative assessment of the adequacy and reliability of any institutional or engineering controls used for managing treatment residuals and untreated hazardous substances remaining at the facility.

The selected remedial action for soil is protective of human health and the environment provided interim source control measures and temporary engineering controls are effectively implemented. The selected remedial action achieves acceptable levels of risk, as defined by OAR-340-122-0115, as demonstrated by a residual risk assessment conducted as part of the FS. The selected remedy for soil achieves protection through a combination of excavation, treatment and/or off-site disposal of contaminated soils, engineering controls, and institutional controls.

The selected remedial action for sediment is protective of the environment including ecological receptors (benthic organisms, mammals, birds and fish). The residual risk assessment for human health was limited to a qualitative evaluation due to detection limits for PCBs in most of the sediment samples exceeding the cleanup level of 2 ug/kg, and the presumed ambient levels being comparable to the “baseline” concentrations (~150 ug/kg) estimated by DEQ for the Portland Harbor Superfund site. PCB levels in the proximity of Ross Island located upstream of the site are estimated by DEQ to be in the range of 10 to 20 ug/kg. PCB concentrations outside of the SMA exceed upstream ambient levels to a limited extent resulting in a residual risk in the range of 10^{-5} for total PCBs via indirect exposure through fish ingestion.

Capping all sediment contamination with PCBs above human health risk-based concentrations is impractical due to ambient levels of PCBs in this stretch of the Willamette River that exceed RBCs. Residual PCB concentrations outside of the capped area are expected to attenuate with time to ambient levels through depositional/erosional processes. Fish advisories have been issued for the lower Willamette River by Oregon Department of Human Services (DHS) related to elevated contaminants including PCBs measured in fish harvested from the river. As part of the 5-year review of remedy protectiveness, DEQ will coordinate with DHS on the continued use of institutional controls in the form of fish advisories for the lower Willamette River. The use of these controls should be effective in reducing fish consumption of resident fish species (e.g. bass, crappie, etc.) by recreational anglers in the general locality of the facility to achieve the acceptable risk level.

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Fish bioaccumulation studies of PCBs and other contaminants in sediment will be evaluated in Portland Harbor to develop more reliable sediment cleanup levels for the fish ingestion exposure pathway. Sediment cleanup levels for fish ingestion will be re-evaluated during the DEQ 5-year remedy review cycles discussed below in Section 7.4.4.

### 7.4.2 Balancing Factors

The recommended remedial actions for soil and sediment are based on a balance of effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost, as described in Sections 6.2 and 6.3. Soil Alternative 6 provided the best balance of these factors. For the sediment remedy, Alternative 3 provided the best balance with respect to these factors. Selective dredging of hot spot sediments in the barge launch way to remediate sediment hot spots and to allow continued barge building operations is feasible and cost-reasonable.

### 7.4.3 Remediation of Hot Spots

The recommended remedial action for soil reme diates hot spots of contamination to the extent feasible. Soil human-health hot spots to a depth of 5 feet below final grade are excavated, treated at an off-site facility, and then appropriately disposed, consistent with ORS 465.315(1)(e) and OAR 340-122-0070 through -0090.

The selected remedial action for sediment includes selective dredging of hot spots that satisfies the preference to remediate hot spots of contamination to the extent practical. Additional hot spot sediment removal was determined to be infeasible due primarily to implementability and to a lesser degree the costs.

### 7.4.4 Periodic Reviews and Contingency Measures

DEQ will conduct periodic reviews of the soil and sediment remedies to ensure that the remedial actions remain protective of present and future public health, safety, and welfare, and the environment. Periodic reviews will be conducted at least every 5 years and will include the evaluation of inspection and maintenance reports for the soil and sediment caps, sediment quality monitoring outside of the capped area, land and beneficial water uses for the site and site vicinity, compliance with institutional controls, and any other relevant information.

Contingency measures may be required in the event that any component of the soil or sediment remedy is compromised such that the remedy no longer meets the protection standard, or that RAOs are not otherwise being satisfied. Contingency measures for
contaminated soil or sediment would prevent exposure to soils exceeding acceptable risk levels and may include one or a combination of the following: (1) excavation, treatment and/or disposal; (2) in-situ treatment, (3) engineering controls; (4) institutional controls.
8 Public Notice and Comment

DEQ’s proposed remedial action for the site was presented in the Staff Report for Recommended Remedial Action, Zidell Waterfront Property, dated January 10, 2005. The Staff Report and supporting documentation of the Administrative Record were made available for public review and comment from February 1, 2005 through March 4, 2005, at DEQ’s Northwest Region Office in Portland.

Pursuant to ORS 465.320 and OAR 340-122-0100, DEQ issued a public notice on February 1, 2005, requesting public comment on the recommended remedial action. The public notice was published in the Secretary of State’s Bulletin and The Oregonian newspaper announcing the availability of the DEQ Staff Report and Administrative Record.

Written comments were received from the Oregon Division of State Lands, Jay Zidell, and Maul Foster and Alongi, Zidell’s environmental consultant. These comments were considered in the preparation of this Record of Decision. Comments are summarized and addressed in Appendix B, Responsiveness Summary.
9 Documentation of Significant Change

DEQ’s proposed remedial action for the site was presented in the *Staff Report for Recommended Remedial Action, Zidell Waterfront Property*, dated January 10, 2005. No significant changes were made to the proposed remedial action for soil and sediment in response to public comments. Minor adjustments to the selected remedy were made related to selective dredging in the barge launch way and the phases and timing for both soil and sediment remedy implementation. These changes are presented in Sections 7.2 and 7.3 of this document.
10 Final Decision of the Director

The selected remedial actions for upland soil and in-water sediment are protective of present and future public health, safety and welfare, and the environment; are based on the balancing of the remedy selection factors, and treat hot spots of contamination to the extent practicable. The selected remedial actions, therefore, satisfy the requirements of ORS 465.315 and OAR 340-122-0040 and 0090. The evaluation of how the selected remedial actions meet the regulatory requirements is provided in Section 7.4.

10.1 DEQ Signature

Dick Pedersen, Administrator
DEQ Northwest Region

Date
ATTACHMENT A
ZIDELL WATERFRONT PROPERTY
ADMINISTRATIVE RECORD INDEX


On February 1, 2005, DEQ issued public notice on its recommended remedial action decision for soil and sediment contamination at the Zidell Waterfront Property Site (ECSI No. 689) in accordance with Oregon Revised Statute ORS 465.320 and Oregon Administrative Rules OAR 340-122-100. Detailed information on the Zidell site including the DEQ Staff Report, and investigation plans and reports included in the Administrative Record for the Staff Report were made available for public review at DEQ’s Northwest Region Office. The formal public comment period ended on Friday, March 4, 2005. Written comments were received from the Oregon Division of State Lands (DSL), Jay Zidell, and Zidell’s contractor, Maul Foster & Alongi (MFA). This Responsiveness Summary documents the written comments in italics followed by DEQ’s responses to the comments.

**DSL COMMENTS**

The Department of State Lands (DSL) has reviewed the Zidell Waterfront Property Feasibility Study prepared December 3, 2004 and the Staff Report prepared by ODEQ January 20, 2005. As the governing body appointed by the State of Oregon to manage its submerged and submersible lands, the State Land Board, through the Department of State Lands has a constitutional responsibility to manage “the lands under it jurisdiction with the object of obtaining the greatest benefit for the people of this state, consistent with the conservation of this resource under sound techniques of land management” pursuant to Article VII, Section 5(2) of the Oregon Constitution. This includes insuring the collective rights of the public to fully use and enjoy this resource for commerce, navigation, fishing, recreation, and other public purposes consistent with applicable federal and state laws.

The Department is fully aware of the importance of remediating contaminated sites along the Willamette River and in the Portland Harbor. We support and appreciate ODEQ’s efforts to work with the responsible parties to identify contamination and prepare plans for remediation. It is beneficial not only to the people of Oregon who use the Willamette but also to the Common School Fund which derives revenue from use and occupation of the submerged and submersible lands of the Willamette River. This said, it is still imperative that DSL’s concerns be addressed and resolved.

The selected alternative for remediation of the contaminated sediments lying in the Willamette River (Alternative 3- Selective Dredging and an Engineered Cap) does not embrace the constitutional responsibility given to this Department. As stated in the ODEQ Staff Report Sections 5.2 and 7.2.3, certain institutional controls would be required to assure the sediment caps integrity and even those would not prevent an accidental grounding of a vessel on the cap, compromising its integrity. Such institutional controls would not only prevent the public from fully enjoying the resource that they own, but would also preclude DSL from deriving revenues for the Common School Fund through leasing and easements on and across the area which have been capped. Considering the potential for development of the upland, once clean up has been completed, that loss of potential revenue from leasing of the submerged and submersible lands adjacent to the upland could be substantial.

Under Section 7.2.3 the Staff Report speaks to an Operations, Maintenance and Monitoring Plan (OMMP) to be developed. Who would be the party responsible for the operation of this plan?
What assurances will DSL have that the plan is being effectively implemented? Will there be a performance bond and if so who would be the beneficiary of that bond?

The OMMP is also to address contingencies for the failure of the cap. Who would be the party responsible for implementing this contingency plan? DSL is concerned that considering the dynamics of the river that ODEQ’s review of the remedial action is scheduled for every 5 years. We believe an annual inspection should be required and DSL should be provided the results of that inspection on an annual basis. How would the OMMP be affected if Zidell sells the upland property for future development? What assurances will DSL have that monitoring and maintenance will continue in the future once the upland changes ownership?

Response: Zidell will be the responsible party for implementation of the OMPP unless an agreement between Zidell and DSL is reached that transfers some or all of the responsibility for implementation of the OMPP. Assurances for implementation of the sediment remedy OMPP will be specified in a consent order or consent judgment between DEQ and Zidell, or alternatively between DEQ, DSL and Zidell. The order or judgment will include financial assurance requirements for implementing the selected remedy including performance of the sediment OMPP. A performance bond is one mechanism of financial assurance that will be considered by DEQ in consultation with DSL. The beneficiary of a bond, if this is the financial assurance mechanism agreed to between DEQ and Zidell, will be the State of Oregon. The order or judgment will also address transfer of ownership of the upland portions of the facility and specify whether or how transfer of property owned by Zidell will address performance of long-term monitoring and maintenance of in-water and bank sediments owned by DSL. While review of the remedial action will occur every 5 years, DEQ intends to require annual cap inspections until the reliability of the cap is established.

Under Section 7.2.2 in the Staff Report there is a discussion concerning the leaving of certain piling in the water for cap stability. Those piling along with the engineered cap will be considered structures occupying state owned submerged and submersible lands. They will require either an easement or lease from DSL. It must be pointed out that in either case the contract between the Department of State Lands and the Party responsible for maintaining the engineered cap will be protective of the State’s ownership, the public’s rights to enjoy the resource, and the Common School Fund, by indemnifying the State of Oregon against any and all failures of the engineered sediment cap. Until these proprietary issues are addressed and resolved DSL cannot approve the placement of an engineered cap on state owned lands.

Response: A final decision concerning leaving certain pilings in the water for cap stability will be made during permitting of the selective dredging and capping of sediments by the U.S. Army Corps of Engineers (COE) and DSL. DEQ understands that Zidell will need to work with DSL to secure use of state land for installation of the sediment cap and access for implementing, monitoring and maintaining all aspects of the remedy. DEQ expects that this will include indemnification for any costs associated with implementation, monitoring and maintenance (as well as any failure) of the remedy, and occur before Zidell commences implementation of the remedy.
ZIDELL AND MFA COMMENTS

General Comments:

1. Sediment Management Area. DEQ has proposed to expand the Sediment Management Area (SMA) to an undefined size. This results in tremendous uncertainty regarding future investigation and cleanup actions that could be required by Zidell. Complete uncertainty about cleanup costs cannot be accommodated in a business context, and would have serious negative ramifications on our ongoing barge construction operations and any future redevelopment.

Available evidence indicates that the Sediment Management Area (SMA), as defined by DEQ in the Staff Report (see Figure 7-1) (DEQ-SMA), is a highly conservative estimate of the Locality of Facility (LOF) for sediment. Zidell is prepared to accept one of two alternatives: first, either default to the technically-based FS-SMA or, second, define the sediment LOF as the DEQ-SMA such that all future actions are within the LOF (i.e., the DEQ-SMA). MFA asserts that the DEQ-SMA is representative of the outermost limit of potential site-related sediment impacts. All future characterization, remediation, and monitoring should be within this area, and engineering controls (e.g., sediment cap) should be applied only to parts of the DEQ-SMA where it is clear that concentrations of site-related chemicals are related to Zidell’s historical operations, above ambient levels relative to Zidell’s historical operations, and may pose a risk to potential human or ecological receptors. For example, the area where polychlorinated biphenyls (PCBs) are clearly elevated above ambient levels due to site-related impacts is a portion of the DEQ-SMA that is similar to the SMA described in the FS (FS-SMA). Final cap boundaries will be established with additional sediment sampling, analyses, and the development of final cleanup levels for sediment within the SMA established for Zidell. If the sediment cap was ever to be expanded to include the entire DEQ-SMA, the alternatives analysis (and residual risk evaluation) completed in the FS would have to be revisited to ensure conformance with FS regulations and guidance, since the DEQ-SMA is more than twice as large as the FS-SMA, and the estimated cost to cap the entire DEQ-SMA increases the cost of the remedy by $1,166,000.

Response: DEQ disagrees with the comment suggesting that the DEQ Staff Report proposed an undefined SMA. The intent of the revised SMA boundary in the Staff Report was to reflect the approximate outer limit where capping would be the technology for mitigating unacceptable risk to human health or the environment. This approach differs from the SMA in the FS Report that DEQ interpreted to be the inner area where capping would be employed, and the final area would be defined based on additional sediment characterization completed during remedial design. From DEQ’s perspective, the approach presented in the DEQ Staff Report provides more certainty from a business standpoint than the approach presented in the FS Report. It should also be noted that the FS did not specify the scope of the monitoring program that would be implemented to assess natural recovery of sediment contamination outside of the proposed FS-SMA boundary.

With respect to the comment suggesting that the DEQ-SMA constitutes the Zidell LOF for sediment, this is not the case. The Zidell FS Report and the technical memoranda

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1 Separate comment letters from Jay Zidell and Maul Foster & Alongi touched on the same themes, and therefore have been integrated by separate general comment topics.
preceding the FS concerning development of the SMA did not definitively define the LOF. The actual LOF for the Zidell sediment contamination is undefined, and cannot be readily defined based on the presence of ambient levels of contaminants (e.g. PCBs) exceeding risk-based concentrations.

Finally, DEQ disagrees with the comment that the feasibility of the DEQ recommended remedy would need to be reevaluated should the area requiring capping extend to the limits of the DEQ-SMA. A larger and more complex sediment capping project was recently constructed at the McCormick & Baxter Superfund site. The successful construction of this cap provides direct evidence that capping the larger DEQ-SMA is feasible from a constructability standpoint.

2. **Ambient Levels for PCBs.** Zidell respectfully disagrees with DEQ’s contention that ambient PCB concentrations in sediment along the industrialized west bank of the Willamette River near the property are similar to concentrations measured in a natural, unindustrialized, backwater area east of Ross Island. The DEQ-SMA includes areas with PCB concentrations above 10 to 12 micrograms/kilogram (µg/kg) where the primary sources of PCBs in sediment are unrelated to the Zidell property.

**Response:** DEQ recognizes that there is considerable uncertainty concerning ambient PCB concentrations in sediment upstream of the Zidell facility. One source of this uncertainty is the elevated detection limits for the PCB analyses on sediment in the earlier phases of the RI. Also, only one sample was collected during the RI upstream of the site (WRS-46) to provide an estimate of upstream ambient levels of contamination. PCBs were not detected in this sample (detection limits for total PCBs at 200 ug/kg, and 0.64 ug/kg). Reliable estimates of ambient levels of PCBs in sediment will need to be developed during remedial design to support any adjustments of the SMA boundary.

3. **Soil Volume for Off-Site Disposal:** In the FS, Zidell established a specific volume (6,500 cubic yards [cy]) of soil exceeding hot spot concentrations that warrants off-site disposal. A rule-governed risk-based approach was used. DEQ’s modified hot spot soil volume (8,000 cy) and excavation depth (5 feet) in the greenway and non-greenway are not “remediation”- or “risk”-based, but are instead “redevelopment”-based. During meetings on October 7, 2004, and November 1, 2004, DEQ agreed to the hot spot excavation depths (3 feet in the greenway and 15 feet in the non-greenway) in the FS report. The depths appear to have been subsequently modified based on conceptual future City of Portland (COP) redevelopment plans (e.g., installation of stormwater swales). Note that the COP does not own, lease, or control the property. Further, the proposed greenway area is still very conceptual and exists only as a potentially applicable City code requirement. The width of the greenway could vary and will be dependent on possible development scenarios that have not been finalized. It is unclear whether the COP will be able to enforce the greenway area requirement in light of Measure 37. MFA recommends that the hot spot soil volumes and excavation depths presented in the FS be retained (i.e., 3 feet excavation depth in the greenway and 15 feet excavation depth in the non-greenway). Note also that impacted soil exposed during redevelopment will be safely managed through the Soil Management Plan (SMP).

**Response:** The FS did not establish a specific volume of hot spot soil for off-site disposal. The volumes presented in the FS were estimates as noted in the title for Appendix E of the FS, which included the results of the modeling used to derive the estimated volumes. DEQ also notes that the FS did not report the level of confidence assigned to the modeling
simulations used to derive the volume estimates. The reliability of the estimates provided in the FS is not known.

The cost estimates presented in the FS included a contingency of 20 percent for the recommended alternative that includes the incremental cost for off-site soil disposal. DEQ’s recommended remedy attempted to provide some certainty to Zidell on how much hot spot soil would be required to be transported off-site. DEQ’s proposed volume limit was based on the FS 6,500 cy estimate plus approximately the 20 percent contingency assumed in the FS cost estimate.

DEQ disagrees with the comment that contends that the modified soil depths for hot spot excavation are not risk-based or rule-governed. Oregon Cleanup Rules do not limit the depth where hot spots would be treated. While DEQ agreed during meetings on October 7, 2004, and November 1, 2004, for Zidell to proceed with development of remedial alternatives in the FS report to the hot spot excavation depths of 3 feet in the greenway and 15 feet in the non-greenway, DEQ did identify in these meetings its preference for removal of hot spots to a depth of five feet for both greenway and non-greenway areas of the site. The residual risk assessment results presented in the FS Report, however, raised concerns with the protectiveness of the remedy based on relatively short-term breaches in the cap. DEQ believes the proposed hot spot removal plan to be more effective because it increases hot spot removal in the portion of the site (near the Willamette River) where it is most susceptible to release by flooding and erosion, while reducing hot spot removal in upland areas away from the river where release/exposure is less likely to occur.

4. **Contingency Dredging.** DEQ has attempted to schedule the sediment remediation of our property in a way that would allow continued operation of our barge construction business; however this unanticipated contingency dredging proposal has costs and a time frame that are untenable. Dredging near the barge launchway to accommodate continued operation is infeasible due to the high estimated cost ($2,750,000). This action would have a significant negative impact on the viability of our barge construction business. It would take an estimated 25 years, or longer, to amortize the cost of this work, which is considerably longer than DEQ’s desired cleanup schedule for the property.

The Staff Report’s two-year time frame for this option is not feasible for the reasons noted above, and would result in the termination of the barge construction operations within that time period. Additionally, our customer base and employee confidence before that date would be severely eroded, quite possibly resulting in us being forced to terminate operations even sooner. It is my intention to remediate this property to protect human health and the environment. Remediation must be considered in the context of an ongoing, economically viable barge construction business. We currently estimate there is at least a ten-year economic building window for construction of barges at this facility. We assume it is not DEQ’s intent to force the shut-down of our operations, and therefore strongly suggest that the dredging contingency be removed in its entirety.

**Response:** For clarification, the contaminated sediments adjacent to the Zidell property are owned by DSL, and Zidell’s use of the SMA area is through a lease with DSL. As noted in DSL’s comments, they believe that full removal of the impacted sediment is necessary, and based on their comments, presumably would not be in favor of significant delays in sediment remedy implementation.
Zidell and MFA comments did not provide any constructive comments that would satisfy the remedial action objectives (RAOs) specified in the staff report in a reasonable time frame. DEQ disagrees with a number of assumptions used in the cost estimate for the contingency prepared by MFA. A more realistic incremental cost for selective dredging is closer to $1.5 million than $2.75 million based on the assumptions used in the DEQ Staff Report concerning dredging area, depth and volume.

With respect to comments related to amortization of the incremental costs for selective dredging, it is unclear why this is an issue for this element of the recommended remedy and is not a consideration for the overall remedial costs for the site. It must be emphasized that selective dredging addresses DEQ’s statutory preference for treatment of hot spots. Even if Zidell believes these costs must be amortized, the incremental costs for selective dredging are significantly lower than the estimate provided by MFA, and apparently within the 10-year operational time frame identified by Zidell.

DEQ’s final remedy decision was modified to provide flexibility during remedial design to develop a cost-effective selective dredging and capping design for the barge launch way that satisfies the preference to treat sediment hot spots.

5. Schedule Flexibility. Zidell is committed to addressing potential human health and environmental impacts associated with past practices on this property. However, these actions must be structured in a way that reflects the importance of ongoing industrial operations on the property, the market realities associated with future redevelopment, and the permitting complexity of the remedial actions. Properly structured prioritization of remedial actions will help address the above issue and allow for cleanup in a sequence of most important to least important. Zidell proposes to implement site-wide interim source control measures to prevent contaminant releases to the sediment remediate the greenway area (and riverbank) north of Ross Island Bridge first. This would result in remediation of approximately 70 percent of the greenway that Zidell owns. It would be followed by greenway remediation south of the bridge, then sediment capping, and then upland remediation.

Specific milestones are not desirable in the Record of Decision (ROD) since several of the most important elements of the remedy (e.g. permitting) are beyond the direct control of DEQ and Zidell. Zidell suggests that, if time frames are specified at all, the ROD should specify the priorities for remedial action (i.e., interim source control measures, greenway remediation, sediment remediation, and finally non-greenway remediation) and establish overall implementation time frames as goals.

Response: As noted in response to specific comments below, DEQ does not agree with the phasing and proposed schedule to implement the remedy. As discussed by DEQ in its comments on the draft FS for upland soils, DEQ will require an integrated upland and in-water cap for the facility. Proceeding with the greenway prior to in-water permitting could be problematic and increase the remedy costs. For example, if permit conditions specified in the COE permit require re-engineering of the bank between elevation 13 and the sediment surface, then further re-grading of the greenway could be necessary. For this reason, the greenway and sediment design and permitting needs to occur concurrently and any additional controls for the bank incorporated into the final greenway design prior to construction. The final remedy incorporates the following priorities that reflect the high priority for remediation of sediment and bank hot spot materials at the facility:
• Implement source control measures for upland/greenway soils concurrent with sediment investigation to finalize the sediment cap boundary and design of greenway and sediment remedy elements;

• Complete greenway and sediment remedy designs and permitting;

• Implement in-water remediation within the next work window for in-water activities on the Willamette River and greenway remediation north of Ross Island Bridge;

• Complete final capping design for non-greenway that incorporate development infrastructure components; and

• Implement final capping design for non-greenway during site redevelopment.

While DEQ has extended the schedule for non-greenway remediation from 5 to 10 years, DEQ expects the hot spot removal and capping of greenway and sediment to be substantially completed within 5 years.

Specific Comments:\(^2\)

1. Section 1.1, soil remedial action, first bullet; page 1-1. The volume of impacted soil warranting removal under DEQ’s rules is 6,500 yards, as provided in the FS.

Response: See response to general comment 3. The FS did not specify a specific volume of soil for off-site disposal.

2. Section 1.1, sediment remedial action, fourth bullet; page 1-2. The selective dredging contingency is infeasible; therefore, the bullet should be deleted.

Response: See response to general comment 4. The selective dredging contingency is not infeasible. DEQ has modified language in the ROD to allow Zidell flexibility in developing a more cost-effective means to address the requirement to treat hot spots of contamination with the secondary objective of allowing continued barge operations at the facility.

3. Section 2.1.2, second paragraph; page 2-2. Figure 2-4 shows the bathymetry for the Willamette River near the site, based on soundings measured in fall 2000 and winter 2003.

Response: Error in Staff Report corrected in final ROD.

4. Section 3.1, third paragraph; page 3-1. Seven sediment samples were tested for toxicity, using amphipod and midge bioassay, in December 2000. In December 2003, toxicity tests were performed on an additional eight sediment samples. As a result, toxicity tests were performed on a total of 15 sediment samples, not seven samples.

Response: Error in Staff Report corrected in final ROD.

5. Section 3.2.3, first paragraph; page 3-5. Estimates of background concentrations based on results collected near the undeveloped, relatively natural east and south sides of Ross

\(^2\) Paragraphs are numbered from the beginning of the section or subsection identified.
Island are unlikely to accurately characterize ambient concentrations nearer to the Zidell property. There are a number of important differences between the Ross Island backwater area and the Zidell property, and background levels of chemicals of interest in sediment are likely to be different between these locations. This area of Ross Island is undeveloped, relatively natural, and relatively undisturbed by industrial and extensive urban use, except for sand and gravel mining near but downstream. Conversely, the history of industrial activity on the west bank of the Willamette River is far more extensive along the same reach of the river, as shown in the attached historical aerial photographs. Due to the long history of industrial and urban activities on the west bank of the river near the property, several chemicals that are unrelated to the Zidell property are likely to be present in sediment at much higher levels than would be found east and south of Ross Island. See Comment #42 for further discussion of this and other related issues.

Response: See response to general comment 2.

6. Section 3.2.3.1, Bioassay Toxicity Testing; page 3-8. The summary of toxicity test results should be updated to include the December 2003 analyses. None of the toxicity test results from the December 2003 sampling event showed significant adverse effects to test organisms. MFA suggests that the discussion of toxicity test results be expanded to more clearly describe spatial patterns. For example, it is not mentioned that the sample causing adverse effects to both chironomids and amphipods was collected several hundred feet upriver of the site and is unlikely to be the result of site-related sediment impacts, or that elevated ammonia concentrations in a sample collected offshore of a municipal outfall (WRS-25), instead of site-related chemicals, likely caused adverse effects. Toxicity test results can be used to infer that large areas of the SMA are not that toxic to benthic organisms.

Response: Most of the summary text included in the Staff Report was from the final RI and FS Report prepared by MFA. Unfortunately, additional data collected between the RI and FS Reports was not fully summarized in the FS or the DEQ Staff Report. Additional information has been incorporated into the ROD, as requested. However, the reports included in the Administrative Record for the site do not provide the basis for the conclusion that the elevated ammonia results found at WRS-25 are the result of discharges from the municipal outfall in the general vicinity of this sampling location. Further testing would be needed to confirm the source of the toxicity in WRS-25. The test results summarized by Northwestern Aquatic Sciences in 2000 showed all water quality observations of overlying water to be within specified ranges with ammonia-N in the overlying water at 0.5 mg/L on days 0 and 10. Ammonia would be expected to be present in areas with high deposition of organic matter, such as wood debris, and would more likely be a problem at a sediment depth >30 cm.

7. Section 4.2.2, Ecological Receptors; page 4-2. In Table 4-2, DEQ appropriately selected reliable probable effect concentrations (PECs) as cleanup levels for most chemicals (MacDonald et al., 2000\(^3\)). The reliable PEC is the concentration of a chemical above which adverse effects are expected to occur more often than not. However, the concepts used by DEQ to select a mean probable effect concentration quotient (PECQ) cleanup level of 0.26 are inconsistent with those used by DEQ to support the chemical-specific ecological cleanup levels based on PECs. The mean PECQ of 0.26 is an estimate of a threshold

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quotient or screening level, not a cleanup level. Screening levels are lower than cleanup levels, and if chemical concentrations are below screening levels, it can be inferred with high confidence that sediment is not toxic to benthic invertebrates. A large proportion of sediment with chemical concentrations above screening levels also will not be toxic to benthic organisms. As discussed in the response to FS comments, the mean PECQ-based cleanup level is estimated to range between 0.7 and 1.2. DEQ also selected several screening levels as cleanup levels for several chemicals for which reliable PECs were not available. In one case, the screening level was based on studies of marine sediment. As discussed in the responses to DEQ’s comments on the FS, more appropriate freshwater sediment cleanup levels are available for these chemicals.

Response: A PEC quotient or PECQ of 0.26 was selected based on the correlation of site-specific toxicity testing and the PECQ. This evaluation was done by Maul Foster and Alongi in 2003 (August 6, 2003 Memo, Establishment of Sediment Management Area). The PECQ takes into consideration the toxicity from a mixture of hazardous substances in sediment at a given location. In order to meet a PEC quotient of 0.26, some of the contaminants need to be below a PEC to meet the PECQ clean up level. This concept is similar to the application of a hazard index for non-carcinogens in human health risk assessments.

PECs were developed to “identify contaminant concentrations above which harmful effects on sediment–dwelling organisms were expected to occur frequently” (MacDonald et al., 1996). A cleanup level where every contaminant concentration used in the quotient calculation is approaching, or above a probable effects concentration (quotients of 0.7 to 1.2), may leave sediment in place with a high probability of eliciting adverse effects. Based on the correlation between observed toxicity at the site and a PECQ, the selection of a cleanup level above 0.26 could result in sediment exposure which is toxic to aquatic invertebrates (hits were observed at PECQs of 0.26 and 0.29).

In addition to use of the PEC quotient, it is also recognized that PECs are not available for all contaminants, and cannot be used as a part of the PECQ methodology. For those contaminants, other threshold numbers are needed to indicate the potential for adverse effects. For this site, this was the case for three chemicals, tributyltin, antimony, and mercury. Methodology and numbers presented by SAIC and Avocet in 2003, are currently being evaluated for appropriateness in Oregon. Until this evaluation is complete, DEQ is currently using NOAA Squirt numbers, or other threshold numbers as cited in the DEQ ecological sediment quality guidelines.

The DEQ recognizes the need to evaluate new information, especially new evaluations developed by NOAA. In a October 31, 2003 memorandum from Maul Foster Alongi to DEQ, TBT criteria developed by NOAA in 2000 was proposed for use at the Zidell site. NOAA (Meador, 2000) developed a sediment number to protect invertebrate prey of 6,000 ug/kg organic carbon. While this study recognizes a number protective of gastropods may need to be lower, DEQ believes this threshold number may be a good site-specific cleanup number protective of the benthic community, especially that portion which juvenile salmonids are exposed. However, it should be noted that this number must be carbon normalized on a sample by sample basis. For example, TOC in sediment at the Zidell site ranged from 0.036 % to 2.7%, with a mean of 0.8% (Table 8, MF&A, October 31, 2003). This would correlate to cleanup numbers ranging from 2.16 ug/kg (0.036 % OC) to 162 ug/kg (2.7% OC) depending on the organic carbon content of the sample. The use of the mean organic carbon number (0.8% OC) to determine a cleanup level (48 ug/kg) would not be protective in portions of the SMA...
where the sediment matrix is primarily comprised of sand and gravel that have low organic carbon content.

DEQ also considered relevant criteria for mercury and antimony. The mercury clean up level of 0.2 mg/kg is appropriate given the range in the literature; the TEL and TEC are 0.174 mg/kg and 0.18 mg/kg respectfully, and the PEL and PEC are 0.486 mg/kg and 1.06 mg/kg, respectfully. MacDonald, 2000 also shows the incidence to toxicity associated with TEC is higher than any other contaminant tested (65.7% - others averaged about 20%). For antimony, the 3 mg/kg cleanup number proposed by DEQ is in our SLV table, which is an Upper Effects Threshold concentration.

8. Section 5. For consistency with the FS, corrections of stated costs and soil volumes are provided in the underline-strikeout version of the Staff Report.

Response: Corrections incorporated. The final ROD includes cost ranges to reflect estimated costs for selective dredging.

9. Section 5, first paragraph; page 5-1. Consider adding the following text immediately following the first paragraph: “The descriptions and costs provided in Section 5 summarize the alternatives as formulated in the FS, and do not reflect proposed modifications as outlined in Section 7 of this Staff Report.”

Response: Proposed text revision incorporated.

10. Section 5.1.2, first bullet; page 5-4. The FS deliberately excluded specific soil volumes in describing Alternative 2 and the other alternatives with respect to soil removed for the purposes of bank stabilization. Volumes were not included because the final greenway design is not known, and therefore the actual volume to be removed may vary somewhat from that which was assumed for FS cost comparison purposes.

Response: Comment noted. DEQ included these volume estimates in the Staff Report to better reflect the relative differences between alternatives and associated estimated costs. DEQ also believes these volumes are relevant in the alternative descriptions because removal of soil to accomplish a stable bank configuration for capping is required, and was not developed with the sole purpose of satisfying City of Portland Greenway Plans for the South Waterfront area.

11. Section 5.1.2, fifth paragraph; page 5-4. The Staff Report states: “Cap placement above the bank armor requires reducing the bank slope to 3:1 H:V along most of the bank.” Please add to this statement the following, or similar, text: “Alternatively, the RAOs can be achieved by other means that are consistent with Zidell’s final greenway development plans, as long as they are permitted by the U.S. Army Corps of Engineers (COE) and other authorized regulatory agencies. For example, flatter or steeper slopes may be desired. These can be protected from erosion through various means such that the cap is maintained.” Also, please add “(assuming a 3:1 H:V final slope),” as shown in the redline/strikeout text.

Response: The final ROD language has been modified to reflect that the 3:1 slope was used for costing purposes in the FS, and that the remedial design will include necessary specifications for installation of a stable cap for the site.
12. Section 5.1.4, first sentence; page 5-5. This alternative involves transporting only greenway hot spot soil off site for disposal.

Response: Comment noted. Final ROD modified accordingly.

13. Section 5.2, Engineered Cap, first paragraph. DEQ does not describe the use of a cap for Alternative 5, even as a contingency. Therefore, this statement is unclear and we suggest deleting it.

Response: Comment noted. Final ROD modified accordingly.

14. Section 5.2.2, eighth paragraph; page 5-10. The Staff Report states: “Generally, hydrologic modeling must show that there is no surface water elevation rise in the floodway during a 100-year flood event resulting from cap installation.” Please add to this statement the following, or similar, text: “Some minor elevation rise may be acceptable if the environmental benefit is substantial. This determination is made by the COE.”

Response: Comment noted. Final ROD modified accordingly.

15. Section 5.2.5, second paragraph; page 5-12. Our research suggests that sheet pile around the entire dredge area is likely to be necessary and required.

Response: Comment noted. Final ROD modified accordingly.

16. Section 6.1.2, third bullet; page 6-2. The Staff Report states: “The extent to which the remedial action restores or protects existing and reasonably likely future beneficial uses of water.” To accurately state OAR 340-122-090(3)(a), the above wording should be preceded by: “With respect to hot spots of contamination in water,”. Consistent with the FS, please include the following after this citation: “(Not applicable to this evaluation).”

Response: Comment noted. Final ROD modified accordingly.

17. Section 6.1.2, sixth bullet; page 6-2. To accurately state OAR 340-122-090(3)(a), the following should be added after the fifth bullet: “Any other information relevant to effectiveness.”

Response: Comment noted. Final ROD modified accordingly.

18. Section 6.1.3, fourth bullet; page 6-3. To accurately state OAR 340-122-090(3)(b), the following should be added after the third bullet: “Any other information relevant to long-term reliability.”

Response: Comment noted. Final ROD modified accordingly.

19. Section 6.1.4, fifth bullet; page 6-3. To accurately state OAR 340-122-090(3)(c), the following should be added after the fourth bullet: “Any other information relevant to implementability.”

Response: Comment noted. Final ROD modified accordingly.
20. Section 6.1.5, fifth bullet; page 6-3. To accurately state OAR 340-122-090(3)(d), the following should be added after the fourth bullet: “Any other information relevant to implementation risk.”

Response: Comment noted. Final ROD modified accordingly.

21. Section 6.1.6, fourth bullet; page 6-4. The Staff Report states: “The degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial users of water.” To accurately state OAR 340-122-090(3)(e), the above wording should be preceded by: “With respect to hot spots of contamination in water.”. Consistent with the FS, please include the following after this citation: “(Not applicable to this evaluation).”

Response: Comment noted. Final ROD modified accordingly.

22. Section 6.1.6, sixth bullet; page 6-4. To accurately state OAR 340-122-090(3)(e), the following should be added after the fifth bullet: “Any other information relevant to cost-reasonableness.”

Response: Comment noted. Final ROD modified accordingly.

23. Section 6.2.1, first paragraph; page 6-4. OAR 340-122-040 requires all remedies to be protective of human health and the environment, as demonstrated by the Residual Risk Assessment. Alternatives are either protective (i.e., attain acceptable risk levels), or they are not. The FS follows this “yes/no” process. DEQ has assigned degrees of protectiveness, which differs from the FS process but which does not impact the decisions made. DEQ’s protectiveness scores seem to be based on remedy effectiveness and/or reliability. It appears that the protectiveness scores simply “double-count” those of other balancing factors.

Response: DEQ disagrees that protectiveness should be rated yes/no and not include an evaluation of relative protectiveness. The degree of protectiveness between alternatives can be qualitatively or quantitatively evaluated based on assigning an equal cap failure frequency for each alternative that includes capping. In this case, DEQ used a qualitative evaluation and did not assign a specific failure rate. DEQ considered the cap to consist of the 2-foot soil cover in the greenway and buildings/paved parking in non-greenways specified for each alternative, and considered failure scenarios involving erosion of bank material from flooding and/or uprooting of mature trees planted in the greenway as a result of a storm event. DEQ believes it is less probable that hot spot soils would be exposed to the cap surface if the residual hot spot soil is present at a greater depth than if they were at a shallower depth. DEQ concludes based on this relative evaluation that the DEQ recommended alternative that includes excavation of hot spots to depth of 5 feet is more protective than the Zidell recommended alternative that would result in residual hot spots at a depth of 3 feet.

24. Section 6.2.2, first paragraph; page 6-5. DEQ determined the effectiveness of Alternatives 2 through 6 to be comparable. The FS effectiveness assessment resulted in differing ratings for these alternatives. However, this change does not have a material impact on the decision process.

Response: Comment noted. DEQ considers the effectiveness rating scores in the FS to be highly subjective because there were no quantitative criteria used in the scoring process.
25. Section 6.2.2, second paragraph; page 6-5. Alternative 7 has only short-term risks, as communicated in the FS. Please clarify that only the long-term risks are eliminated under this option.

Response: Clarification to Section 6.2.2 incorporated as requested.

26. Section 6.2.7, fourth paragraph; page 6-9. Alternative 4 was rated fourth for cost-reasonableness, not third as stated in the Staff Report. However, this variance does not have a material impact on the decision process.

Response: The evaluation in Section 6.2.7 reflects DEQ’s rating, not the rating presented in the FS.

27. Section 6.3.1, first paragraph; page 6-9. Zidell disagrees that ambient levels of PCBs are in the range of 10 to 12 µg/kg (see Specific Comment #42).

Response: See response to general comment 2 and specific comment 42.

28. Section 6.3.1, second paragraph; page 6-9. DEQ assigned degrees of protectiveness to the sediment alternatives. The FS differed in its evaluation approach for this parameter. However, this variance does not have a material impact on the decision process. (See Comment #23.)

Response: The evaluation in Section 6.3.1 reflects DEQ’s rating, not the rating presented in the FS.

29. Section 7, first paragraph; page 7-1. For consistency with the FS, corrections of stated costs are provided in the underline-strikeout version of the Staff Report.

Response: Changes to the cost estimates presented in the first paragraph of page 7-1 have been revised consistent with the redline markup of the staff report and revised cost estimates for selective dredging of the barge launchway.

30. Section 7, first paragraph; page 7-1. As stated in General Comment #3 and Specific Comment #32, we do not agree that a soil volume increase from 6,500 cy to 8,000 cy is warranted. However, if the increase were to be implemented, the total cost would increase by approximately $125,000 from that shown in the Staff Report, plus a contingency of approximately $25,000.

Response: The proposed alternative did not increase the soil volume as discussed in the response to general comment 3.

31. Section 7.1, second paragraph, first bullet; page 7-1. All off-site disposal will be in a manner consistent with applicable laws and regulations. Disposal of the Resource Conservation and Recovery Act (RCRA)-regulated soil without treatment may be an option, and should not be precluded. Please clarify in the ROD that treatment is necessary only to the extent required by waste disposal regulations.

The proposed revised text makes this part of the Staff Report consistent with text on page 5-3 (first paragraph under Excavation and Off-Site Disposal) and page 7-2 (Section 7.1.1, fifth paragraph) of the Staff Report, which are shown below:
• Page 5-3: “The excavated soil from this site is not expected to require pretreatment before disposal.”

• Page 7-2: “Soil that exceeds TCLP regulatory thresholds will be disposed of as a RCRA hazardous waste. Alternatively, these soils may be stabilized on site and disposed of at a municipal landfill....”

**Response:** The ROD language has been modified to address apparent inconsistencies identified in the comment.

32. Section 7.1, second paragraph, second bullet; page 7-1. DEQ’s modified hot spot excavation depth (5 feet) in the greenway and non-greenway is not “remediation”- or “risk”-based, but is “redevelopment”-based. During meetings on October 7, 2004, and November 1, 2004, DEQ agreed to the hot spot excavation depths (3 feet in the greenway and 15 feet in the non-greenway) before finalization of the FS report, and now appears to have modified the depths based on conceptual future COP redevelopment plans (e.g., installation of stormwater swales). Note that the COP does not own, lease, or control the property. Further, the proposed greenway area is still very conceptual and exists only as a potentially applicable City code requirement. The width of the greenway could vary and will be dependent on possible development scenarios that have not been finalized. It is unclear whether the COP will be able to enforce the greenway area requirement in light of Measure 37. MFA recommends that the hot spot excavation depths presented in the FS be retained (i.e., 3 feet excavation depth in the greenway and 15 feet excavation depth in the non-greenway). The SMP will direct soil-handling procedures below these depths.

**Response:** DEQ disagrees with the representation that the increased depth of hot spot soil excavation is not remediation or risk based. DEQ, therefore, has not modified the selected alternative as requested.

33. Section 7.1, second paragraph, third bullet; page 7-1. The type of stormwater features noted here and shown on Figure 7-1 are “redevelopment-based,” not “remediation-based,” and are therefore not required by DEQ rules. Figure 7-2 identifies the swale as a “possible future feature.”

**Response:** DEQ disagrees. DEQ rules provide for consideration of future land and water use. DEQ acknowledges that future use of the non-greenway will require stormwater management for drainage of impervious surfaces. DEQ can under Oregon cleanup rules prohibit disposal of stormwater with UIC systems (i.e., drywells) pursuant to OAR 340-122-0040(4). Conversely, it is appropriate for DEQ to identify what stormwater features are compatible with the selected remedy to protect the long-term integrity of the sediment cap. The inclusion of these features in the selected remedy is intended to provide guidance to the City of Portland on stormwater features that are compatible with the selected remedy for the site. The final remedy does not require the installation of these features.

34. Section 7.1, third paragraph; page 7-2. Text in the attached underline-strikeout version of the Staff Report clarifies the proposed remedial action phasing, and management of the asbestos-containing materials (ACM) (see Attachment A).

**Response:** See response to general comment #5 regarding phasing of remedy implementation. Clarification of ACM for removal has been incorporated into the final ROD.
35. Section 7.1, third paragraph; page 7-2. Hot spot soils are defined by risk, and are reflective of both contaminant levels and distance from the final ground surface. Also, it may be misleading to imply that the soil moved to the non-greenway will be permanently placed in an engineered containment cell. This soil will be safely managed under a cap, with the cap type and configuration defined by redevelopment (e.g. parking lot, paved open space). Taking these two points into consideration, clarification is recommended, as shown in Comment 39.

**Response:** DEQ agrees that hot spots are defined by risk. DEQ uses the most conservative reasonable current or future exposure scenario in defining the acceptable risk level for exposure and associated hot spot levels. Depth to contamination is not a consideration in the definition of hot spot under OAR 340-122-0115(31)(b)(A), but is a consideration in evaluating the feasibility in remediating hot spots of contamination. DEQ’s expects that contaminated soil from the greenway area to be placed in the non-greenway in a manner that could facilitate future selective removal by a subsequent owner of the property, if desired. This can best be accomplished through the use of a geotextile liner beneath the contaminated soil and native soil. This is a provision that DEQ considers appropriate since the FS and remedy do not specify certain locations were consolidation would occur.

36. Section 7.1, fourth paragraph; page 7-2. The Staff Report states: “A demarcation layer, such as a geomembrane, would be placed underneath the cap for the purposes of separating residual contaminants from the clean cap materials.” Geomembranes are typically employed to provide an infiltration barrier, and are substantially more robust (and costly) than standard demarcation materials. Installation procedures are also much more extensive. MFA proposes replacing “geomembrane” with “plastic sheeting” to more accurately reflect the expected demarcation material.

**Response:** The purpose of the liner was not to prevent stormwater infiltration. DEQ modified the ROD to specify “geotextile material or plastic lining to segregate contaminated soil from the clean soil cap.” The liner does not need to be impermeable.

37. Section 7.1.1, first paragraph; page 7-2. Like the non-greenway portion of the site, the final configuration and design of the greenway are not known at this time. MFA requests clarification that the primary elements of the greenway remedy (e.g., stable slope, barrier to prevent direct exposure) represent the remedial action as required by DEQ, and that the specific configuration can be altered from the preliminary conceptual configuration used in the FS. This clarification will provide flexibility in the development of the greenway without jeopardizing DEQ’s intent, and will be consistent with the way in which DEQ described the non-greenway remediation. Also, hot spot excavation depths in the greenway should be 3 feet, not 5 feet. (See Comment #32.)

**Response:** DEQ agrees that the primary elements of the greenway remedy are hot spot removal and capping, which will require re-contouring the slope of the bank for stability of the soil cap. The ROD does not include final slope configurations, and indicates the final configuration will be developed during remedial design.

38. Section 7.1.1, second paragraph; page 7-2. With respect to ACM, please clarify in the ROD that DEQ’s intent is to manage materials such as those previously encountered (e.g., landfilled insulation material or fabric) that are exposed during future excavation or redevelopment separately from the soil being managed. The ACM will be transported off
site to a permitted landfill, as described in the FS. This clarification is consistent with the second bullet of the soil remediation summary provided under Section 5.1.2.

Response: DEQ’s intent is to designate off-site landfill disposal of the landfilled insulation material or fabric containing asbestos and not necessarily bulk soil that may contain trace levels of asbestos fragments. The ROD was clarified to reflect this intent.

39. Section 7.1.1, third paragraph; page 7-2. Please include the following or similar: “Any soil above residential hot spot contaminant levels that is excavated to meet design grades would be managed on site in a temporary engineered containment cell constructed to hold non-hot spot soil from the greenway area until such time as it can be incorporated into the non-greenway redevelopment. This soil, along with all soil in the non-greenway, will be capped (see last paragraph of this section).”

Response: As noted in response to comment 35, DEQ’s intent is to specify management of soil in an engineered cell. While the cell does not need to meet design standards for a solid waste landfill, DEQ is specifying that the soil be placed within a geotextile lined cell to facilitate future removal if desired for new development in the distant future.

40. Section 7.1.2, first paragraph; page 7-4. The final greenway configuration is not known, and flexibility is preferable to avoid unintentionally restricting greenway design.

Response: See response to comment 37.

41. Section 7.1.2, third paragraph; page 7-4. Regarding the five-year time frame for non-greenway redevelopment, please note that the three components of site remediation (greenway, in-water, and non-greenway) are interrelated with respect to permitting, and require phasing. Also, phasing allows for continued barge construction and site redevelopment on a schedule dictated by market forces (see Comment #43). Source control should be the highest short-term priority for this site. Zidell embraces USEPA’s and DEQ’s goal of developing a Source Control Strategy for the Lower Willamette River. To that end, Zidell proposes to implement source control measures to prevent or minimize the migration of hazardous substances to sediment and surface water first, and then perform greenway (including riverbank) remediation, in-water work, and finally non-greenway remediation. Source control measures are expected to improve both upland and in-water conditions. Measures could include interim actions and/or elements of the final remedy, and will be established through future negotiations with DEQ.

Zidell also proposes to separate greenway remedial actions north and south of the Ross Island Bridge. In this way the northern portion of the greenway (approximately 70 to 80 percent) can be addressed on a faster timeline, without adversely impacting ongoing barge construction operations.

For greenway remediation to occur, extensive planning, design, and permitting negotiations will be needed, since a) source control includes work on the bank below ordinary high water (requiring COE and Oregon Division of State Lands [DSL] permitting); b) notwithstanding Measure 37 implications, work within the greenway will likely take into account the COP’s long-term goals for the south waterfront (requiring extensive negotiations with the COP); and c) greenway negotiations with the COP are intrinsically tied to non-greenway development plans and negotiations.
Response: The ROD has been revised to incorporate source control measures for implementation during RD/RA and delayed implementation of greenway remediation south of Ross Island in the barge operations area of the site. However, DEQ expects timely implementation of the remedy as discussed in response to general comment 5.

42. Section 7.2, first paragraph; page 7-5. DEQ has modified the SMA (DEQ-SMA) shown in the FS (FS-SMA). The comment below addresses this and other related issues.

For a variety of reasons, the DEQ estimate of ambient PCB concentrations, based on results collected near the undeveloped, relatively natural east and south sides of Ross Island, is unlikely to accurately characterize ambient concentrations near the Zidell property. Along any given reach of the Willamette River, ambient PCB concentrations are likely to be determined by a number of factors such as the types of neighboring sources, proximity to source areas, and fluvial dynamics that lead to sediment deposition and erosion. Because most ambient sources are likely to be located on uplands and PCBs are likely to enter the river near the shoreline, even the distance from the shoreline is likely to influence ambient PCB concentrations in sediment.

The Ross Island sediment samples used by DEQ to estimate ambient PCB concentrations were collected from a backwater area near the eastern shore of the Willamette River. There are a number of important differences between the Ross Island backwater area and the Zidell property, and ambient PCB levels in sediment are likely to be different between these locations. This area of Ross Island is undeveloped, relatively natural, and relatively undisturbed by industrial and extensive urban use, except for sand and gravel mining. The history of industrial activity on the west bank of the Willamette River is far more extensive along the same reach of the river (see Attachment C). The long history of industrial and urban activities on the west bank of the river is likely to have led to much higher concentrations of PCBs in sediment that are unrelated to the Zidell property than would be found east and south of Ross Island.

Century West Engineering Corporation (CWE) prepared a General Assessment of Existing Environmental/Geotechnical Conditions and Potential Development Costs for the North Macadam District in 2000 (see Attachment D). CWE noted that significant industrial development of the area near the Zidell site began in the 1920s. Industrial operations immediately upstream and downstream of the site included an herbicide and pesticide manufacturer, shipbuilding companies, scrap metal salvage, ship dismantling and automobile shredding and baling operations, a foundry, a trailer manufacturer, a lumber company, a power plant, sand and gravel companies, and concrete and asphalt plants. CWE noted that potential contaminants of interest for a number of these sites formerly upstream of Zidell (Lonestar, Lakeside Industries, Pacific Metals and former shipbuilding operations, and TCI) include metals, petroleum hydrocarbons, petroleum hydrocarbon constituents, and PCBs. Sewer outfalls are also located along and upstream of the site. CWE noted that before 1951, domestic and industrial wastes were discharged to the river and potential contaminants of interest include cyanide, volatile organic compounds, metals, petroleum hydrocarbons, and PCBs. Also, the average residual concentration of PCBs in sediment following implementation of the DEQ-approved remedy for the nearby PGE Station L site was approximately 8,000 µg/kg.

Given the extensive history of industrial activities upstream and downstream of the Zidell property and their general similarities with historical industrial activities in the Portland Harbor, MFA believes that the best data set to derive a background concentration for
PCBs in local sediment is the results of Weston’s 1998 Portland Harbor Sediment Investigation Report. The Portland Harbor study evaluated sediment in a 7-mile reach of the Willamette River with industries similar to those historically near Zidell. The apparent baseline concentration of PCBs in Portland Harbor was an estimate of the concentration that can be expected in sediment that is not obviously impacted by a particular known source. Because the spatial scope of the study was large, the potential sources of ambient PCBs are similar to those near Zidell, the location of the study was relatively close to Zidell (between 2 and 10 miles downstream), and the data set was large, the Portland Harbor apparent baseline value for PCBs is the most appropriate background estimate available.

Using both the results of PCB analyses that were completed with relatively low method reporting limits (MRLs) and concentration gradients, it appears that DEQ expanded the SMA (DEQ-SMA) to include sediment where PCBs could be above 10 µg/kg to 12 µg/kg. Although MFA believes that the expanded DEQ-SMA includes locations where the primary sources of PCBs in sediment are unrelated to the Zidell site, the DEQ-SMA accurately incorporates areas where PCB concentrations are above 10 µg/kg to 12 µg/kg (see Attachment E).

Given that the MRLs for PCB analyses achieved in several sediment investigations near the Zidell property (e.g., Ross Island, Portland Harbor, Zidell RI) were typically above 10 µg/kg, the DEQ-SMA boundary is defined by a concentration that is near the practical quantitation limit for PCBs. The DEQ-SMA appears to be a very conservative estimate of the LOF for sediment because it effectively includes all sediment where there is a chance to detect PCBs using standard analytical methods.

In the FS, Zidell established the FS-SMA and proposed capping the entire area. In the Staff Report, DEQ is suggesting an expanded SMA (DEQ-SMA). For the reasons noted above, MFA believes this to be highly conservative and inappropriate. Alternatively, Zidell and MFA would not object to the SMA expansion if it conclusively establishes the outermost boundary of the LOF. Zidell is prepared to accept one of two alternatives: first, either default to the technically-based FS-SMA or, second, define the sediment LOF as the DEQ-SMA such that all future actions are within the LOF. In the Staff Report, DEQ stated that additional sediment investigation should be conducted to establish the cap boundary, and implied that it will be within the DEQ-SMA. This is consistent with the approach proposed in the FS.

With respect to PCBs, it is recommended that the engineered cap be placed over sediment within the DEQ-SMA where there is unambiguous evidence that PCBs are elevated above local ambient levels due to site-related impacts. This recommendation is made because it may be impossible to distinguish between site-related and ambient PCBs in the outer parts of the DEQ-SMA boundary where concentrations are expected to be near the PCB practical quantitation limit. Given the complexity of defining ambient levels of PCBs that may vary as a function of distance from the shoreline, a sediment sampling program aimed at precisely defining the source of low-level PCBs is not feasible and is unlikely to substantially improve the proposed remedy. Instead, multiple lines of evidence should be used in conjunction with the existing and future PCB data to establish the cap boundary, similar to the means in which the FS-SMA boundary was established. In fact, sufficient

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data are now available to define the greatest sediment impacts requiring remediation, and as noted above, the DEQ-SMA boundary is sufficient to define the outermost limits of the sediment LOF.

Although the proposed sediment management approach described above differs from Alternative 3 of the FS, it is consistent with the protectiveness framework outlined by DEQ in Section 7.3.1 of the Staff Report. Alternative 3 of the FS described capping the entire FS-SMA. Under this proposed revision, it is probable that the engineered cap will include all areas in the FS-SMA, and that monitored natural recovery will be used to manage sediment located between the FS-SMA and DEQ-SMA boundaries where it is unclear if PCB levels are elevated above ambient concentrations.

If the engineered cap is to be placed over the entire DEQ-SMA, the sediment remedial alternatives discussed in the FS must be reevaluated. A reevaluation is necessary because the DEQ-SMA more than doubles the area to be capped. The balancing factors used in remedy selection did not consider capping an area of this size, which would result in a cost increase of approximately $1,166,000 (i.e., cap construction cost increase of approximately 80 percent; see Attachment F). Therefore, the FS conclusions are not valid if the cap covers the entire DEQ-SMA. However, if the DEQ-SMA is the area in which some set of remedies is to be considered based on further sampling and analyses inside the boundary, a reevaluation of alternatives will not be necessary. This is because the extent of the engineered cap will likely be within the range evaluated under sediment Alternative 3, and the balancing factors will be largely unchanged.

As discussed in the FS, available data suggest that sediment outside the FS-SMA is unlikely to be toxic to benthic ecological receptors. The results of numerous sediment toxicity tests indicate that sediment outside the FS-SMA is generally not toxic to test organisms. Also, chemical concentrations outside the FS-SMA are generally below PEC-based cleanup levels, and the mean PECQ is generally below 0.26. To further incorporate PCB concentrations into the cap boundary determination process, MFA recommends that some multiple of the ambient concentration estimate be used as the cap threshold criterion to account for uncertainty in ambient estimates and to better ensure that the cap is placed over site-related contamination. The remainder of the DEQ-SMA would be managed through monitored natural recovery.

In summary, modifying the SMA boundary (i.e., to that defined by the DEQ-SMA) is consistent with FS regulations and guidance only if some level of cost certainty is also maintained. This is accomplished by defining the outermost boundary of the sediment remediation area as the DEQ-SMA, ensuring that all future sampling and analyses, remedial action, and monitoring will be within the DEQ-SMA, and that the final cap area does not expand to the full DEQ-SMA.

MFA expects that future sediment sampling, along with the existing weight-of-evidence approach provided in the FS, will result in the cap boundary being near the FS-SMA limits.

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5 The FS included a hot spot cap alternative and a full SMA cap alternative. The reevaluation would likely involve assessing an alternative in which a portion of the SMA is capped, greater than hot spots but less than the full SMA (similar to what is now being considered). A risk reduction assessment would be a component of this reevaluation.
Response: Comments noted. Unfortunately, Zidell collected only one background sample upstream of the site (WRS-46), located approximately 600 feet upstream of the barge launch area. PCBs were not detected in sediment samples collected from this location (detection limits for total PCBs at 200 ug/kg, and 0.64 ug/kg). The discussion on historical activities upstream of the site documented in a preliminary assessment does not take into consideration findings of subsequent site characterization activities undertaken prior to development, which have not identified significant sources of PCB contamination. While this does not preclude the presence of PCB contamination at selected locations along the shoreline upstream of the site, it does reduce the likelihood of such contamination from stormwater runoff from these parcels.

As discussed in response to general comment 1, the DEQ-SMA represents the outer limits where capping would be required. The final boundary may ultimately be defined to be consistent with the FS-SMA boundary based on further sampling and analyses inside the DEQ-SMA boundary and development of reliable estimates of ambient PCB concentrations to be defined during remedial design.

43. Section 7.2, first paragraph, third bullet, and Section 7.2.1; pages 7-5 and 7-6. The Zidell family and companies have a long-standing involvement with this property, operating businesses in the Portland area for over 80 years. Zidell’s involvement has provided an economic benefit to the local, state and national communities for all this time. The Zidell Companies plan on continuing to do so into the foreseeable future. Zidell is very sensitive to potential impacts to our ongoing barge construction operations at the Moody Avenue property; and is engaged in an economically viable and very competitive business. For the reasons outlined below, Zidell takes exception to the dredging contingency alternative proposed. The comments below also address remedy prioritization and timing.

MFA estimates the cost for the selective dredging option to be approximately $2,750,000 (see Attachment G), not $500,000 as stated by DEQ. Barge manufacturing is a highly competitive market. It is simply not economically viable to spend $2,750,000 to dredge a small area of the SMA for the sole purpose of extending the life of the barge construction operations. For example, the time required to sufficiently amortize the dredging investment would be approximately 25 years or longer. Consequently, the two-year window proposed by DEQ will, in effect, be a directive to close the business within two years. In the interim, customer and worker confidence in the viability of the barge construction operations will be severely damaged by this action, making continued operation even during this two-year window uncertain. MFA does not believe it was DEQ’s intent to close Zidell’s business, and Zidell and MFA firmly contend that the dredging contingency alternative should be removed.

Source control should be the highest short-term priority for this site. Zidell embraces USEPA’s and DEQ’s goal of developing a Source Control Strategy for the Lower Willamette River. To that end, Zidell proposes to implement source control measures to prevent or minimize the migration of hazardous substances to sediment and surface water first, and then perform greenway (including riverbank) remediation, in-water work, and finally non-greenway remediation. Source control measures are expected to improve both upland and in-water conditions. Measures could include interim actions and/or elements of the final remedy, and will be established through future negotiations with DEQ.

Zidell also requests the flexibility to separate greenway remedial actions north and south of the Ross Island Bridge. In this way, the northern part of the greenway (approximately 70 to
80 percent) can be addressed on a faster timeline without adversely impacting ongoing barge construction operations.

For greenway remediation to occur, extensive planning, design, and permitting negotiations will be needed, since a) source control includes work on the bank below ordinary high water (requiring COE and DSL permitting); b) notwithstanding Measure 37 implications, work within the greenway will likely consider COP’s long-term goals for the south waterfront (requiring extensive negotiations with COP); and c) greenway negotiations with COP are intrinsically tied to non-greenway development plans and negotiations.

a. The FS assessed short-term negative environmental impacts associated with dredging. Based in part on this assessment, dredging was found not to be the preferred alternative. The limitations associated with dredging as outlined in the FS apply to DEQ’s proposed contingency alternative, and make it an unattractive alternative.

b. Zidell understands that DEQ desires to structure the ROD in a way that ensures adequate progress in site remediation. Zidell does not oppose this objective, but believes that the ROD should be structured so that it considers the market and permitting realities for this site. Specifically, as noted above, a two-year window for terminating industrial operations at the site is not acceptable to Zidell. Similarly, the five-year window for non-greenway redevelopment is problematic, since redevelopment may not be possible or desirable within this time frame. Progress is better achieved by focusing on more immediate implementation of source control measures and a step-wise and interrelated progression of cleanup, continued industrial use, and redevelopment.

c. Not all factors that affect the timing of remediation are controlled by Zidell. For example, the greenway negotiations with COP, and the riverbank and in-water permit negotiations with COE and DSL, are not controlled by Zidell. Therefore, Zidell respectfully suggests that, if time frames are specified at all, the ROD outline the remedial action priorities (e.g., site-wide, interim source control measures, greenway remediation, in-water remediation [sediment cap and monitoring], then non-greenway remediation), and establish overall time frames as goals. For example:

- Initiate negotiations with COP, DSL, and COE within six months of consent order/decree execution, ongoing good faith effort.

- Finalize permitting and design of all remedial action components within 18 months of completing negotiations.

- Perform supplemental sediment sampling and analyses within one month of DEQ’s approval of a work plan.

- Implement greenway remediation north of the Ross Island Bridge within two years of completing permitting and design.

- Implement greenway remedial actions south of the Ross Island Bridge within ten years of completing permitting and design.
• Implement in-water work within one year of completing all greenway remediation.

• Implement non-greenway remediation during within ten years of permitting and design completion (Note: source control will address non-greenway sources, so potential impacts to the greenway and SMA will not occur).

d. Source control ensures flexibility within an acceptable framework for making progress toward completing remedy implementation. Much of the greenway can be remediated by focusing first on the area north of the Ross Island Bridge, which would allow barge construction operations to continue. The ability to phase remediation should be incorporated into the ROD to optimize project progress.

e. To avoid recontamination, the ROD should state that in-water work will be completed only after COP’s combined sewer outfall (CSO) upgrades are complete.

In summary, sediment capping is the only viable alternative, as shown in the FS, and it cannot be done until a) permitting is complete, b) source control is complete, and c) the COP’s CSO improvements are complete. Therefore, the ROD best serves the citizens of Oregon and the needs of the project by structuring the remedial action time frame consistent with these factors.

Response: See response to general comments 4 and 5. DEQ has incorporated flexibility into the final ROD concerning short-term goals for source control, mid-term goals for remedy implementation within the greenway area and in-water sediments, and development of cost-effective selective dredging for the barge launchway area. Collectively, these modifications provide sufficient flexibility for Zidell to develop source control and selective dredging alternatives that are compatible with an amortization schedule consistent with Zidell’s plans to continue barge operations at the facility for approximately 10 years.

44. Section 7.2.2, first paragraph; page 7-5. The expanded SMA as defined by DEQ in the Staff Report (DEQ-SMA) accurately characterizes areas where PCB concentrations are above 10 µg/kg to 12 µg/kg, but most likely includes large areas where the primary source of PCBs in sediment is unrelated to the Zidell site. In the Staff Report, DEQ states, “Capping all sediment contamination (sic) with PCBs above apparent ambient levels in this stretch of the Willamette River is impractical.” Zidell is prepared to accept one of two alternatives: first, either default to the technically-based FS-SMA or, second, define the sediment LOF as the DEQ-SMA such that all future actions are within the LOF. This is consistent with DEQ’s statement in its letter to Steven Shain, ZRZ Realty Company, dated January 25, 2005, in which it states, “Figure 7-1 of the Staff Report includes a modified SMA boundary...While DEQ recognizes that the final area is subject to additional characterization, DEQ believes it is appropriate to identify a larger area during remedy selection to provide potential stakeholders in our cleanup decision with a range of to (sic) potential areas to be capped based on existing information...” (see Attachment B).

Response: DEQ has specified in the ROD that the DEQ-SMA represents the outer boundary where capping would be employed. The DEQ-SMA, however, does not represent the LOF for sediment, which cannot be reliably be defined due to likely co-mingling of site related contamination and other potential upstream sources that contribute to the ambient levels within the lower Willamette River system.
45. Section 7.2.2, third paragraph; page 7-6. The DEQ-SMA is approximately 17 acres, not 8 to 9 acres, as stated. The FS-SMA is about 8 acres.

Response: The text for the ROD has been modified to reflect the approximate area is 17 acres in size.

46. Section 7.2.2, fourth paragraph; page 7-6. Floodway encroachment will be evaluated as part of the sediment cap design, and will be an issue addressed through the COE permitting process. If a measurable elevation rise is predicted during a 100-year flood event, then a balanced cut to offset the flood rise may be required by the COE.

Response: Comment noted and final ROD reflects this concept.

47. Section 7.2.3, third paragraph; page 7-7. Monitoring outside of the cap should not continue until cleanup levels are met because ambient PCBs are above the risk-based concentrations. Instead, the stated goal should be recovery to ambient PCB levels.

Response: The ROD specifies monitoring until contaminant levels reach ambient levels, or in response to a significant flood event where cap integrity may have been compromised.

48. Section 7.3.1, third paragraph; page 7-8. Ambient PCB levels are expected to be higher along the west bank of the Willamette River as compared to the east side (see Comment 42).

Response: See response to comment 42.

49. Section 7.3.1, third paragraph; page 7-8. At present, there are no data to estimate residual PCB levels outside of the DEQ-SMA, so we are unsure of the basis for DEQ’s statement regarding PCB residual risk in the range of $10^{-5}$.

Response: The residual risk estimate is based on presumed ambient PCB concentrations in the range of 10 to 12 ppb.

50. Section 7.3.1, fourth paragraph; page 7-8. Defining the LOF as the outermost boundaries of the DEQ-SMA and incorporating all future sediment characterization, remediation, and monitoring within this boundary is consistent with DEQ’s determination that capping all sediment with PCBs above 10 µg/kg to 12 µg/kg is impractical.

Response: DEQ meant to state that capping all sediments with concentrations less than 10 to 12 ppb is impractical since these levels are DEQ’s best estimate of ambient levels in this reach of the Willamette River. As discussed above, the LOF for the Zidell facility has not been fully defined and cannot be reliably defined due to the presence of ambient levels of PCBs that exceed the cleanup levels of 2 µg/kg.

51. Section 7.3.1, fifth paragraph; page 7-9. Please add “for the lower Willamette River,” as shown in the redline/strikeout text. Also, defining the LOF as the outermost boundaries of the DEQ-SMA and incorporating all future sediment characterization, remediation, and monitoring within this boundary provides the certainty that is essential for forward progress on the property cleanup. To that end, potential modifications of sediment cleanup levels cannot result in remediation beyond that defined in the Staff Report.
**Response:** Proposed text change to fifth paragraph of Section 7.3.1 incorporated. As discussed above, capping limits to the DEQ-SMA boundary have been incorporated. Future monitoring to assess natural recovery will be focused along the edge of the final cap limits, but potentially could extend beyond the DEQ-SMA boundary if the cap is installed to this boundary.

52. Section 7.3.2, first paragraph, and Section 7.3.3, second paragraph; page 7-9. Partial dredging is impractical, as noted above previously, and should not be considered.

**Response:** DEQ disagrees, as discussed in response to associated comments above.

53. Please remove the MFA logo from any modified figures used in the ROD.

**Response:** Logo removed as requested.
Table 2-1
Areas of Potential Concern
Zidell Waterfront Property
ZRZ Realty Company

<table>
<thead>
<tr>
<th>Operating Area</th>
<th>Potential Feature of Concern</th>
<th>Description</th>
<th>Potential Activities and/or Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-1 Former sludge pond (west of present paint shop)</td>
<td>Potential historical releases. The pond was located on CIW map dated 1943. No documentation regarding the purpose of the pond is available. Sludge sample was collected during XPA (S-81 at 6 feet bgs). COPCs were not detected above screening criteria. Groundwater samples collected from MW-2 located downgradient of the former sludge pond did not contain COPCs above screening criteria. No additional work is proposed for the RI.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2 Hydraulic press near former TFA forge (oily vault water).</td>
<td>The vault is located inside of the barge operations building which is covered and contains a concrete floor. Upon discovery of a release of oil to the vault, approximately 200 gallons of water was pumped from a cracked sump at the base of the vault and oil residues were collected. Additional investigation is proposed.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-3A Former transformer station on CIW map. Transformers were once located outside the northwest corner of the TFA's former building.</td>
<td>Some transformers contained PCBs.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-3B A 12-kilovolt PCB transformer is located near the northeast corner of TFA's former building.</td>
<td>Oil residue coats the transformer near its drain valve and extends onto the underlying concrete slab. Four drain holes in the slab may have allowed oil to migrate to underlying soil.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-3C Transformers south of the paint shop.</td>
<td>Possible releases of transformer fluids that could have contained PCBs.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-4 Sump in the former CIW electrical maintenance building.</td>
<td>Sump may have received water that contained oil residues. EMCON collected and analyzed soil samples (e.g., S-57 and S-59 from 2 feet bgs) near the CIW building during the XPA. Additional work is proposed for the sump in the CIW maintenance building because COPCs (e.g., solvents, oil) may have been discharged to the sump.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-5 Steam cleaning area at a machine shop in former CIW building.</td>
<td>Steam cleaning of equipment at a machine shop in a former CIW building may have deposited metals, oils, and solvents onto soil. Destination for wastewater discharged after 1988 when the oil-water separator system was dismantled is unclear.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-6 UST (gasoline)</td>
<td>Potential historical releases.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-7 UST (fuel oil)</td>
<td>Potential historical releases.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-8 Maintenance shop</td>
<td>Possible releases from former steam cleaning operations and below ground vault. Additional investigation is proposed.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2-1
Areas of Potential Concern
Zidell Waterfront Property
ZRZ Realty Company

<table>
<thead>
<tr>
<th>Operating Area</th>
<th>Potential Feature of Concern</th>
<th>Description</th>
<th>Potential Activities and/or Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2-1</td>
<td>Oil storage in former CIW building north of the Ross Island Bridge.</td>
<td>Oils may have been released at this building. The oil storage area was assessed by OMNI (boring S10 and MW-4) and EMCON during the XPA (S-39 and S-40). No further assessment is proposed for this feature.</td>
</tr>
<tr>
<td></td>
<td>2-2</td>
<td>Sumps in crane pits</td>
<td>Oils may have been released to sumps used to service underside of former track-mounted cranes along the dock area. Crane pits were not assessed by OMNI or by EMCON during the XPA. Additional investigation is proposed.</td>
</tr>
<tr>
<td></td>
<td>2-3A</td>
<td>Incinerator for wire burning</td>
<td>Wire burning may have deposited metals in soil, primarily aluminum and copper. Batteries may also have been burned in the aluminum smelter.</td>
</tr>
<tr>
<td></td>
<td>2-3B</td>
<td>Incinerator for wire burning</td>
<td>Soil may also be affected by oil, and possibly by PCBs if it was mixed with oil that had been used as fuel. DEQ speculates about the release of dioxins and furans. Additional investigation is proposed.</td>
</tr>
<tr>
<td></td>
<td>2-4A</td>
<td>Septic system serving a scale house.</td>
<td>The septic systems were for a restroom located in the scale house and lunch room. No COPCs are believed to have been discharged from these features. No further assessment is proposed.</td>
</tr>
<tr>
<td></td>
<td>2-4B</td>
<td>Septic system serving a lunchroom.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-5</td>
<td>Sewer lines</td>
<td>Sewer lines traverse the site and drain to the Willamette River. The lines could leak and release chemicals from off-site locations.</td>
</tr>
<tr>
<td></td>
<td>2-6</td>
<td>UST (gasoline)</td>
<td>Potential historical releases.</td>
</tr>
<tr>
<td></td>
<td>2-7</td>
<td>UST (gasoline)</td>
<td>Potential historical releases.</td>
</tr>
<tr>
<td></td>
<td>2-8</td>
<td>Former Dock area. Whirley tracks and sumps</td>
<td>Potential historical releases.</td>
</tr>
<tr>
<td>3</td>
<td>3-1</td>
<td>Machine shop and electrical shop.</td>
<td>Activities in Area 3 included scrap metal storage, similar to Area 2.</td>
</tr>
</tbody>
</table>

Note:
CIW = Commercial Iron Works. COPCs = Chemicals of potential concern
TFA = Tube Forgings of America. USTs = Underground storage tanks.

<table>
<thead>
<tr>
<th>Willamette River Sediment</th>
<th>Potential historical releases associated with ship dismantling activities.</th>
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<tbody>
<tr>
<td>Ross Island Bridge</td>
<td>Storm water runoff is discharged below the bridge. Any hazardous substances mixed with road runoff may be discharged onto the site below the bridge. Periodic cleaning, painting, and sand blasting of metal surfaces on the bridge may release paint residues (metals) onto the site.</td>
</tr>
</tbody>
</table>

L:\Projects\8014.01_ZRZ Realty\Remedial Investigation\Reporting\RI Report\T-areas of concern.xlsx\Table 2-1 - Areas of Concern
<table>
<thead>
<tr>
<th>Compound</th>
<th>Number of Samples</th>
<th>Concentration</th>
<th>Location of Maximum Concentration</th>
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</thead>
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</tr>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td><strong>Metals</strong></td>
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<td>186</td>
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<tr>
<td>Cadmium</td>
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<td>568</td>
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<td>48</td>
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<td>0.02</td>
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<tr>
<td>Nickel</td>
<td>48</td>
<td>0.12</td>
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<td>126</td>
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<td>Aroclor 1254</td>
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<td>126</td>
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Notes: ^1 Concentrations reported in micrograms per kilogram (ug/kg)
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<th>Compound</th>
<th>Number of Samples</th>
<th>Concentration</th>
<th>Location of Maximum Concentration</th>
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Notes: ¹ Concentrations reported in micrograms per kilogram (ug/kg)
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<th>Compound</th>
<th>Number of Samples</th>
<th>Concentration Range (ug/L)</th>
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<td></td>
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<td><strong>PCBs</strong></td>
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Notes: ¹ Concentrations reported in micrograms per liter (ug/L)
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<th>Compound</th>
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<th>Concentration$^1$</th>
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<td></td>
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<td>Min.   Max.</td>
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<td><strong>PAHs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>79</td>
<td>0.0055 3,000</td>
<td>153 WRS-16</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>79</td>
<td>0.0055 130</td>
<td>118 WRS-15</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>79</td>
<td>0.012  1,700</td>
<td>131 WRS-15</td>
</tr>
<tr>
<td>Benzo(k)floranthene</td>
<td>79</td>
<td>0.0055 1,500</td>
<td>111 WRS-16</td>
</tr>
<tr>
<td>Chrysene</td>
<td>79</td>
<td>0.0055 3,300</td>
<td>167 WRS-16</td>
</tr>
<tr>
<td>Dibenz(a,h)anthracene</td>
<td>79</td>
<td>0.0044 190</td>
<td>65 WRS-16</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>79</td>
<td>0.0044 630</td>
<td>99 WRS-16</td>
</tr>
<tr>
<td><strong>PCBs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aroclor 1254</td>
<td>79</td>
<td>0.12   5000</td>
<td>167 WRS-9</td>
</tr>
<tr>
<td>Aroclor 1260</td>
<td>79</td>
<td>0.12   2600</td>
<td>138 WRS-10</td>
</tr>
</tbody>
</table>

Notes: $^1$ Concentrations reported in micrograms per kilogram (ug/kg)
<table>
<thead>
<tr>
<th>Compound</th>
<th>Number of Samples</th>
<th>Range</th>
<th>Location of Maximum Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>9</td>
<td>0.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Cadmium</td>
<td>9</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Chromium</td>
<td>9</td>
<td>1.4</td>
<td>8</td>
</tr>
<tr>
<td>Copper</td>
<td>9</td>
<td>0.5</td>
<td>12</td>
</tr>
<tr>
<td>Lead</td>
<td>9</td>
<td>0.25</td>
<td>3.2</td>
</tr>
<tr>
<td>Mercury</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Nickel</td>
<td>9</td>
<td>1.9</td>
<td>6.3</td>
</tr>
<tr>
<td>Tributyltin</td>
<td>19</td>
<td>0.03</td>
<td>0.6</td>
</tr>
<tr>
<td>Zinc</td>
<td>9</td>
<td>2</td>
<td>26</td>
</tr>
</tbody>
</table>

Notes:  
1. Concentrations reported in micrograms per liter (ug/L).  
2. Not applicable – compound not detected in sediment pore water samples.
<table>
<thead>
<tr>
<th>Exposure Scenario</th>
<th>Cumulative Excess Cancer Risk(2)</th>
<th>Adverse Health Effects(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Central Tendency</td>
<td>Reasonable Maximum</td>
</tr>
<tr>
<td><strong>Exposure to Soil</strong>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Resident</td>
<td>1x10^{-5}</td>
<td>5x10^{-5}</td>
</tr>
<tr>
<td>Excavation Worker</td>
<td>5x10^{-8}</td>
<td>4x10^{-6}</td>
</tr>
<tr>
<td>Construction Worker</td>
<td>2x10^{-6}</td>
<td>3x10^{-5}</td>
</tr>
<tr>
<td><strong>Exposure to Groundwater</strong>(3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future Resident</td>
<td>----</td>
<td>6x10^{-7}</td>
</tr>
<tr>
<td>Excavation Worker</td>
<td>9x10^{-9}</td>
<td>7x10^{-7}</td>
</tr>
<tr>
<td>Construction Worker</td>
<td>----</td>
<td>4x10^{-7}</td>
</tr>
<tr>
<td><strong>Off-Site Media</strong>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreational Fisherman</td>
<td>1x10^{-5}</td>
<td>1x10^{-5}</td>
</tr>
</tbody>
</table>

Notes:

(1) Based on incidental ingestion and dermal exposure to soil 0-3 feet for future residents and 0-15 feet for workers; the highest risk estimates from Areas 1, 2, and 3 reported here, see Tables 8-1 through 8-4 in RI Report.

(2) Regulatory threshold for cumulative carcinogenic risk is 1x10^{-5} and a hazard quotient of one (1) for systemic effects.

(3) Based on incidental ingestion and dermal contact exposure to groundwater for workers, and inhalation of vapors intruding into buildings for future residents.

(4) Based on indirect exposure of recreational anglers to bioaccumulative compounds in Willamette River sediments through fish ingestion.
### Table 4-1
Soil Cleanup Levels and Hot Spot Concentrations (mg/kg)
Zidell Waterfront Property

<table>
<thead>
<tr>
<th>COC/CEC</th>
<th>Future Residents&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Construction Workers&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Ecological Receptors&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cleanup Levels</td>
<td>Hot Spot Concentrations&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Cleanup Levels</td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antimony</td>
<td>31</td>
<td>310</td>
<td>124</td>
</tr>
<tr>
<td>Arsenic</td>
<td>7</td>
<td>39</td>
<td>13</td>
</tr>
<tr>
<td>Barium</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Beryllium</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Cadmium</td>
<td>37</td>
<td>370</td>
<td>154</td>
</tr>
<tr>
<td>Chromium</td>
<td>210</td>
<td>21,000</td>
<td>32,000</td>
</tr>
<tr>
<td>Copper</td>
<td>3,100</td>
<td>31,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Lead</td>
<td>400</td>
<td>4,000</td>
<td>800</td>
</tr>
<tr>
<td>Mercury</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Nickel</td>
<td>1,600</td>
<td>16,000</td>
<td>6,200</td>
</tr>
<tr>
<td>Silver</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Zinc</td>
<td>23,000</td>
<td>100,000</td>
<td>93,000</td>
</tr>
<tr>
<td>PAHs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>0.62</td>
<td>62</td>
<td>21</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.062</td>
<td>6.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>0.62</td>
<td>62</td>
<td>21</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>6.2</td>
<td>620</td>
<td>210</td>
</tr>
<tr>
<td>Chrysene</td>
<td>62</td>
<td>6,200</td>
<td>2,100</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>0.062</td>
<td>6.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>0.62</td>
<td>62</td>
<td>21</td>
</tr>
<tr>
<td>PCBs&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aroclor 1242</td>
<td>0.22</td>
<td>22</td>
<td>7.6</td>
</tr>
<tr>
<td>Aroclor 1254</td>
<td>0.22</td>
<td>22</td>
<td>7.6</td>
</tr>
<tr>
<td>Aroclor 1260</td>
<td>0.22</td>
<td>22</td>
<td>7.6</td>
</tr>
</tbody>
</table>

NA – Not applicable because baseline conditions for this chemical result in an acceptable risk, or no cleanup criteria exists.

- With the exception of arsenic, cleanup levels for future residents were set at the USEPA Region 9 residential soil PRG (USEPA, 2004). The cleanup level for arsenic was set at the natural background concentrations based on the state-wide 90th percentile value for Washington (WDOE, 1994).

- Cleanup levels for construction workers were set at the DEQ construction worker RBCs using exposure factors defined in DEQ guidance (DEQ, 2003). The USEPA Region 9 industrial soil PRG was used as the cleanup level for lead (USEPA, 2004).

- Cleanup levels for terrestrial ecological receptors were set at DEQ SLVs protective of populations except for chromium which was set at background (DEQ, 2001).

- Human health hot spot concentrations were set at 100 times the cleanup level for carcinogens, and 10 times the cleanup level for noncarcinogens. Ecological hot spot concentrations were set at 10 times the cleanup level.

- DEQ DRAFT update guidance (May 2003) SLV protective of bioaccumulation to bird and mammalian receptors at the population level. Value is a LOAEL based value calculated using methodology presented in Sutter et al., 2000.

- Arsenic hot spot value set at 100 times the health based cleanup value of 0.39 mg/kg


<table>
<thead>
<tr>
<th>Chemical</th>
<th>Recreational Fisher Cleanup Level</th>
<th>Benthic Biota Cleanup Level</th>
<th>Hot Spot Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroclor 1254</td>
<td>2</td>
<td>NA</td>
<td>200</td>
</tr>
<tr>
<td>Aroclor 1260</td>
<td>2</td>
<td>NA</td>
<td>200</td>
</tr>
<tr>
<td>Benz(a)anthracene</td>
<td>211</td>
<td>NA</td>
<td>21,100</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>21</td>
<td>NA</td>
<td>2,100</td>
</tr>
<tr>
<td>Benzo(b)fluoranthene</td>
<td>211</td>
<td>NA</td>
<td>21,100</td>
</tr>
<tr>
<td>Benzo(k)fluoranthene</td>
<td>2106</td>
<td>NA</td>
<td>210,600</td>
</tr>
<tr>
<td>Chrysene</td>
<td>21062</td>
<td>NA</td>
<td>2,106,200</td>
</tr>
<tr>
<td>Dibenzo(a,h)anthracene</td>
<td>21</td>
<td>NA</td>
<td>2,100</td>
</tr>
<tr>
<td>Indeno(1,2,3-c,d)pyrene</td>
<td>211</td>
<td>NA</td>
<td>21,100</td>
</tr>
<tr>
<td>Antimony</td>
<td>NA</td>
<td>3,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Cadmium</td>
<td>NA</td>
<td>4,980</td>
<td>49,800</td>
</tr>
<tr>
<td>Chromium</td>
<td>NA</td>
<td>111,000</td>
<td>1,110,000</td>
</tr>
<tr>
<td>Copper</td>
<td>NA</td>
<td>149,000</td>
<td>1,490,000</td>
</tr>
<tr>
<td>Lead</td>
<td>NA</td>
<td>128,000</td>
<td>1,280,000</td>
</tr>
<tr>
<td>Mercury</td>
<td>NA</td>
<td>200</td>
<td>2,000</td>
</tr>
<tr>
<td>Nickel</td>
<td>NA</td>
<td>48,600</td>
<td>486,000</td>
</tr>
<tr>
<td>Zinc</td>
<td>NA</td>
<td>459,000</td>
<td>4,590,000</td>
</tr>
<tr>
<td>Total PAHs</td>
<td>NA</td>
<td>22,800</td>
<td>228,000</td>
</tr>
<tr>
<td>Total PCBs</td>
<td>NA</td>
<td>676</td>
<td>6,760</td>
</tr>
<tr>
<td>Tributyltin</td>
<td>NA</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>Petroleum Hydrocarbons</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>PECQ</td>
<td>NA</td>
<td>0.26</td>
<td>2.6</td>
</tr>
</tbody>
</table>

**NOTES:**
NA = Not Applicable.

1. COCs and CECs for sediment (MFA, 2003a; MFA and EMS, 2003a).
2. Recreational fisher risk-based concentration (MFA and EMS, 2003a).
3. Reliable probable effect concentrations (MacDonald et al., 2000) were used as cleanup levels for all chemicals except antimony, mercury, and tributyltin. Mercury cleanup levels set at a threshold effects concentration (TEC) (Smith et al., 1996). Antimony cleanup levels were set at an upper effects threshold (UET, SquiRTs), and tributyltin cleanup levels were set at using a marine apparent effects threshold (AET) as a surrogate (SquiRTs) according to DEQ guidance.
4. Hot spot concentration set at 100 times the recreational fisher cleanup levels based on cancer effects, and 10 times the benthic biota cleanup levels.


### Table 4-3
**Estimated Soil Volumes Exceeding Cleanup Levels and Hot Spot Concentrations**

**ZRZ Realty Company**

**Zidell Waterfront Property**

<table>
<thead>
<tr>
<th></th>
<th>Cleanup Level Volume Summary in Cubic yards</th>
<th>Hot Spot Volume Summary in Cubic yards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greenway</td>
<td>Non-Greenway</td>
</tr>
<tr>
<td>Future Resident</td>
<td>132,000</td>
<td>550,000</td>
</tr>
<tr>
<td>Construction Worker</td>
<td>54,000*</td>
<td>96,800</td>
</tr>
<tr>
<td>Industrial Worker</td>
<td>--</td>
<td>276,000*</td>
</tr>
<tr>
<td>Recreationists</td>
<td>110,000*</td>
<td>--</td>
</tr>
<tr>
<td>Ecological Receptors</td>
<td>120,000</td>
<td>--</td>
</tr>
</tbody>
</table>

**NOTE:**
* based on EVS calculation.
** based on EVS visualization for lead.
-- = not calculated.
Table 4-4
Estimated Sediment Volumes Exceeding Cleanup Levels and Hot Spot Concentrations
ZRZ Realty Company
Zidell Waterfront Property

<table>
<thead>
<tr>
<th>Estimated Volume of Sediment at Cleanup Levels in Cubic Yards</th>
<th>Estimated Volume of Sediment at Hot Spot Levels in Cubic Yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>151,000</td>
<td>44,000</td>
</tr>
</tbody>
</table>
# Table 6-1
Soil Alternatives Cost Summary

**ZRZ Realty Company**

**Zidell Waterfront Property**

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Action</td>
<td>$0</td>
</tr>
<tr>
<td>2</td>
<td>Engineered Cap</td>
<td>$3,374,545</td>
</tr>
<tr>
<td>3</td>
<td>Engineered Cap with Greenway Hot Spot Excavation – On-Site Management</td>
<td>$3,906,474</td>
</tr>
<tr>
<td>4</td>
<td>Engineered Cap with Greenway Hot Spot Excavation – Off-Site Management</td>
<td>$4,105,918</td>
</tr>
<tr>
<td>5</td>
<td>Engineered Cap with Greenway and NonGreenway Hot Spot Excavation – On-Site Management</td>
<td>$4,049,408</td>
</tr>
<tr>
<td>6</td>
<td>Engineered Cap with Greenway and NonGreenway Hot Spot Excavation – Off-Site Management</td>
<td>$4,438,968</td>
</tr>
<tr>
<td>7</td>
<td>Excavate Soil to Cleanup Levels</td>
<td>$30,097,733</td>
</tr>
</tbody>
</table>
Table 6-2
Sediment Alternatives Cost Summary
ZRZ Realty Company
Zidell Waterfront Property

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Action</td>
<td>$0</td>
</tr>
<tr>
<td>2</td>
<td>Partial Cap</td>
<td>$1,507,743</td>
</tr>
<tr>
<td>3</td>
<td>Full Cap</td>
<td>$2,024,519</td>
</tr>
<tr>
<td>4</td>
<td>Hotspot Dredging and Full Cap</td>
<td>$9,781,176</td>
</tr>
<tr>
<td>5</td>
<td>Full Dredging</td>
<td>$20,148,338</td>
</tr>
</tbody>
</table>
Figure 2-1

Base map prepared from DeLorme 3-D TopoQuads (1999). Site Location: 3121 SW Moody Avenue, Portland, Multnomah County, Oregon, Section 10, Township 1 South, Range 1 East of the Willamette Meridian.

LEGEND

SITE LOCATION

SURFACE WATER FLOW DIRECTION IN WILLAMETTE RIVER

Maull Foster Alongi Inc.

Vancouver:
(360) 694-2691

Portland:
(971) 544-2139

DATE 05/04/04
DWN. JLN
APPR.
REVIS. 11/29/04
PROJECT NO.
8014.01.11

Figure 2-1
ZRZ REALTY COMPANY
SW MOODY AVENUE
PORTLAND, OREGON
SITE LOCATION
Figure 2-2
Veterinary Research Center
Operational Area: Swinerton Builders of Oregon
Operational Area 1
Operational Area 2
Operational Area 3
S.W. MOODY AVENUE
UNIT C
UNIT B
UNIT A
WILLAMETTE RIVER
LEGEND:
- APPROXIMATE SITE BOUNDARY
- AREA BOUNDARY
- TOP OF BANK
- SHORELINE (8-29-95)
- EXISTING FENCING
- EXISTING PAVEMENT
- EXISTING STRUCTURE
- FORMER STRUCTURE
- STORM DRAINAGE, CATCH BASINS AND PIPING
- STORM DRAIN MANHOLE
- FORMER USE OR FEATURE
- ODDT O.F. CITY OF PORTLAND COMBINED SEWER OVERFLOW OUTFALL
- ODDT O.F. OREGON DEPARTMENT OF TRANSPORTATION OUTFALL

0 200 400 SCALE IN FEET

NOTE:
BASE MAP FROM DMACON, 1994 (DRAWING 3-1).

Vancouver: (360) 694-2691
Portland: (971) 544-2139

MAUL FOSTER ALONGI INC.

Figure 2-2
Veterinary Research Center
Operational Area: Swinerton Builders of Oregon
Operational Area 1
Operational Area 2
Operational Area 3
S.W. MOODY AVENUE
UNIT C
UNIT B
UNIT A
WILLAMETTE RIVER
LEGEND:
- APPROXIMATE SITE BOUNDARY
- AREA BOUNDARY
- TOP OF BANK
- SHORELINE (8-29-95)
- EXISTING FENCING
- EXISTING PAVEMENT
- EXISTING STRUCTURE
- FORMER STRUCTURE
- STORM DRAINAGE, CATCH BASINS AND PIPING
- STORM DRAIN MANHOLE
- FORMER USE OR FEATURE
- ODDT O.F. CITY OF PORTLAND COMBINED SEWER OVERFLOW OUTFALL
- ODDT O.F. OREGON DEPARTMENT OF TRANSPORTATION OUTFALL

0 200 400 SCALE IN FEET

NOTE:
BASE MAP FROM DMACON, 1994 (DRAWING 3-1).

Vancouver: (360) 694-2691
Portland: (971) 544-2139

MAUL FOSTER ALONGI INC.

Figure 2-2
Veterinary Research Center
Operational Area: Swinerton Builders of Oregon
Operational Area 1
Operational Area 2
Operational Area 3
S.W. MOODY AVENUE
UNIT C
UNIT B
UNIT A
WILLAMETTE RIVER
LEGEND:
- APPROXIMATE SITE BOUNDARY
- AREA BOUNDARY
- TOP OF BANK
- SHORELINE (8-29-95)
- EXISTING FENCING
- EXISTING PAVEMENT
- EXISTING STRUCTURE
- FORMER STRUCTURE
- STORM DRAINAGE, CATCH BASINS AND PIPING
- STORM DRAIN MANHOLE
- FORMER USE OR FEATURE
- ODDT O.F. CITY OF PORTLAND COMBINED SEWER OVERFLOW OUTFALL
- ODDT O.F. OREGON DEPARTMENT OF TRANSPORTATION OUTFALL

0 200 400 SCALE IN FEET

NOTE:
BASE MAP FROM DMACON, 1994 (DRAWING 3-1).

Vancouver: (360) 694-2691
Portland: (971) 544-2139

MAUL FOSTER ALONGI INC.
Figure 2.3
ZRZ REALTY COMPANY
SW MOODY AVENUE
PORTLAND, OREGON

TAX LOTS

NOTE: BASE MAP FROM EMCON, 1994 (DRAWING 2-1).
Figure 2-6

ZRB REALTY COMPANY
SW MOODY AVENUE
PORTLAND, OREGON

AREAS OF POTENTIAL CONCERN

NOTES: BASE MAP FROM EMCON, 1994 (DRAWING 3–1).

SCALE IN FEET

0 200 400

Vancouver: (360) 694-2691
Edmonds: (425) 744-1489
Portland: (971) 544-2139

MAUL FOSTER ALONGI

DATE 06/2003

DWN. 8014-01.04

AREAS OF POTENTIAL CONCERN

EXPLANATION

--- Site Boundary
--- Area Boundary
--- Top of Bank
--- Bottom of Bank
--- Existing Structure
--- Former Structure
--- Storm Drainage Catch Basins and Piping
--- Groundwater Monitoring Well
--- GEM Environmental, Inc.

AREA OF POTENTIAL CONCERN (SEE TABLE 2–1)

POTENTIAL CONTAMINANTS AT PAST AND/OR PRESENT SOURCE LOCATIONS (CHEMICALS POTENTIALLY PRESENT OR DETECTED AT OR ABOVE METHOD REPORTING LIMITS AND/OR PRELIMINARY SCREENING CRITERIA)

T = TOTAL PETROLEUM HYDROCARBONS
PCB = POLYCHLORINATED BIPHENYLS
P = POLYPHOSPHATE
CH = CHLORINATED HYDROCARBONS
P = POLYCYCLIC AROMATIC HYDROCARBONS
V = VISIBLE ORGANIC CONSTITUENTS
Figure 3-1

SOIL, GROUNDWATER, AND SEDIMENT SAMPLE LOCATIONS

11/22/04 AJY
11/29/04
Figure 4-1

ZRZ REALTY COMPANY
SW MOODY AVENUE
PORTLAND, OREGON

AREAS OF SOIL EXCEEDING CLEANUP LEVELS AND HOT SPOT CONCENTRATIONS

Vancouver: (360) 694-2691
Portland: (971) 544-2139

SOUND LEGEND:
- SOIL BORING (EMCON)
- SOIL BORING (OWN ENVIRONMENTAL, INC.)
- SOIL BORING (AGI TECHNOLOGIES)
- SURFACE SEPTIC SAMPLE
  (MAUL FOSTER & ALONGI, INC.)
- GEOPROBE (MAUL FOSTER & ALONGI, INC.)
- TEST PIT (EMCON)
- TEST PIT (OWN ENVIRONMENTAL, INC.)
- TEST PIT (AGI TECHNOLOGIES)
- TEST PIT (MAUL FOSTER & ALONGI, INC.)
- MONITORING WELL
  (OWN ENVIRONMENTAL, INC.)
- MONITORING WELL
  (MAUL FOSTER & ALONGI, INC.)

LEGEND:
- APPROXIMATE SITE BOUNDARY
- FUTURE TOP OF BANK
- ESTIMATED EXTENT OF SOIL IN THE NON-GREENWAY EXCEEDING
  CLEANUP LEVELS PROTECTIVE OF FUTURE RESIDENTS
- ESTIMATED EXTENT OF SOIL IN THE NON-GREENWAY EXCEEDING
  CLEANUP LEVELS PROTECTIVE OF CONSTRUCTION WORKERS
- ESTIMATED EXTENT OF SOIL IN THE NON-GREENWAY EXCEEDING
  HOT SPOT CONCENTRATIONS PROTECTIVE OF FUTURE RESIDENTS
- ESTIMATED EXTENT OF SOIL IN THE GREENWAY EXCEEDING
  CLEANUP LEVELS PROTECTIVE OF FUTURE RESIDENTS
- ESTIMATED EXTENT OF SOIL IN THE GREENWAY EXCEEDING
  HOT SPOT CONCENTRATIONS PROTECTIVE OF ECOLOGICAL RECEPTORS
- ESTIMATED EXTENT OF SOIL IN THE GREENWAY EXCEEDING
  HOT SPOT CONCENTRATIONS PROTECTIVE OF FUTURE RESIDENTS
- FUTURE PUBLIC RIGHT-OF-WAYS AND UTILITY CORRIDORS

NOTES:
1) BASE MAP FROM EMCON, 1994 (DRAWING 3-1)
2) THESE AREAS ALSO EXCEED CONSTRUCTION WORKER
   CLEANUP LEVELS

DATE 11/16/94
DWN. 811
APPR. 11/28/94
REVIS 8014.01.11

PORTLAND, OREGON

MAUL FOSTER ALONGI INC.
Figure 4-2

AREAS OF SEDIMENT EXCEEDING CLEANUP LEVELS AND HOT SPOT CONCENTRATIONS
Sediment Alternative 3

NOTES:
1) Control on ground by Chase, Jones & Associates, Inc.
2) Aerial mapping by Spencer Cross (Flight Date: 06/29/95)
3) Datum: City of Portland Bench Mark No. 1514, ELVD. = 36.18
4) Situated in the N.W. 1/4 Section 15, T 11 S, R 1 E. W.M.
5) Base map from Encon, 1996, (Drawing 3-2)

Vancouver: (360) 694-2691
Portland: (971) 544-2139

Figure 5-3
ZRZ Realty Company
SW Moody Avenue
Portland, Oregon

MAUL FOSTER ALONGI INC.

DATE: 10/26/04
DWN: 06/01
APPR: 10/26/04
REVIS: 11/20/04
PROJECT NO: 8014-01.11

SEDIMENT ALTERNATIVE 3
NOTES:
1) CONTROL ON GROUND BY CHASE, JONES & ASSOC., INC.
2) AERIAL MAPPING BY SPENCER & GROSS (FLIGHT DATE: 06/29/93)
3) Datum: City of Portland Bench Mark No. 1514, Elevation 36.18
4) Situated in the N.W. 1/4 Section 10, T 1 S, R 1 E, W.M.
5) Base Map From E.M.N., 1996, (Drawing 3-2)
6) Surveying by Chase, Jones and Associates, Inc. Hydrographers

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Vancouver: (360) 694-2691
Portland: (971) 544-2139

LEGEND:
- APPROXIMATE SITE BOUNDARY
- SEDIMENT MANAGEMENT AREA
- ROCK ARMORING
- EXTENT OF CAP
- EXTENT OF HOT SPOT DREDGING

Figure 5-4
ZRZ REALTY COMPANY
SW MOODY AVENUE
PORTLAND, OREGON

MAUL FOSTER ALONGI INC.

DATE: 11/01/04
DWN: 11/01/04
APPR: 11/01/04
REV: 11/29/04
PROJECT NO: 8014.01.11

SEDIMENT ALTERNATIVE 4

0 200 400 SCALE IN FEET