INITIAL REMEDIAL DESIGN REPORT

ZIDELL WATERFRONT PROPERTY
3121 SW MOODY AVENUE
PORTLAND, OREGON
ECSI NO. 689

Prepared for

ZRZ REALTY COMPANY

July 24, 2009
Project No. 8014.01.17

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MAUL
FOSTER
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The material and data in this report were prepared under the supervision and direction of the undersigned.

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LIST OF ILLUSTRATIONS (CONTINUED)

ACRONYMS AND ABBREVIATIONS

ACM	asbestos-containing material
bgs	below ground surface
BMP	best management practice
City	City of Portland
COCs	chemicals of concern (including chemicals of ecological concern)
COE	U.S. Army Corps of Engineers
Consent Judgment	September 12, 2006, General Judgment on Stipulation and Consent, Case No. 0609-09344
COP	City of Portland Vertical Datum (Elevation 0.0 COP is Elevation -1.375 NGVD)
DEQ	Oregon Department of Environmental Quality
DSL	Oregon Department of State Lands
EVS	Environmental Visualization System
FEMA	Federal Emergency Management Agency
FS	feasibility study
GIS	Geographic Information Systems
ISCMP	Interim Source Control Measures Plan
MFA	Maul Foster & Alongi, Inc.
NGVD	National Geodetic Vertical Datum of 1929
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
OHSU	Oregon Health & Science University
OHW	ordinary high water
OLW	ordinary low water
OMMP	Operations, Maintenance and Monitoring Plan
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RAO	remedial action objective
RBC	risk-based concentration
RCM	reactive core mat
RI	remedial investigation
ROD	Record of Decision
site	tax lots 1 and 42, the area directly under the Ross Island Bridge, the riverbank adjacent to these areas, and the in-water sediment cap area
SMA	sediment management area
SMP	soil management plan
SWCA	SWCA Environmental Consultants

TRM	turf reinforcement mat
Zidell	ZRZ Realty Company, Zidell Marine Corporation, and Tube Forgings of America, Inc.

1 INTRODUCTION

Maul Foster & Alongi, Inc. (MFA) has prepared this Initial Remedial Design Report on behalf of ZRZ Realty Company, Zidell Marine Corporation, and Tube Forgings of America, Inc. (collectively referred to in this report as Zidell) for the Zidell waterfront property located at 3121 SW Moody Avenue in Portland, Oregon. This report is meant to fulfill the requirement by the Oregon Department of Environmental Quality (DEQ) for a written report (50% Basis of Design Report) summarizing the initial remedial action design as specified in the Record of Decision (ROD) (DEQ, 2005) and the September 12, 2006, General Judgment on Stipulation and Consent, Case No. 0609-09344 (Consent Judgment) between the State of Oregon and Zidell.

The report is also intended to support Zidell's application for construction and environmental permits from local, state, and federal agencies. Zidell plans to submit a joint permit application to the U.S. Army Corps of Engineers (COE) and to the Oregon Department of State Lands (DSL) based on the design elements presented in this report. Zidell also plans to use the design elements in this report as the basis for a submittal to the City of Portland (City) for an evaluation of whether the proposed design meets the substantive requirements of City code. Other permits and agency reviews, including those required by the Oregon Department of Transportation (ODOT) for work within their right-of-way, will also be required. Design changes that are developed as part of the permitting and agency review processes will be incorporated into the final design. This report does not consider design details associated with the proposed TriMet bridge project.

This initial remedial design represents the remedial design for the Zidell site at this time, and could undergo changes as the design process proceeds. The initial remedial design report is based on extensive engineering, geotechnical, and chemical analyses, including geotechnical static and seismic stability modeling (GeoDesign, 2009) and chemical isolation layer modeling (MFA, 2009e). The remedial design is based on criteria established in the ROD and required by the Consent Judgment, the most important of which are protection of human health and the environment throughout an extended design life. These criteria are met by the design presented in this initial remedial design report.

The development of this design has been an iterative process by the Zidell design team. Once the basic design criteria were met, the design team identified and tested alternatives that would avoid and minimize adverse environmental impacts, as well as enhance environmental values such as fish and wildlife habitat. A few examples resulting from this process include: a reduction in the amount, size and vertical extent of shoreline armoring; changes in the type (i.e., rounded vs. angular), size, and extent of sediment cap armoring; and the use of soil biotechnical engineering techniques for riverbank cap design.

The design presented in the initial remedial design report includes some elements, such as the vegetated riparian terrace in the northern part of the sediment cap, that might not be part of the final design but that are included in order to evaluate and model "worst case" conditions for certain parameters. One such parameter is the post-project 100-year flood elevation in and near the project reach of the river, a calculation required by the City under the rules of the Federal Emergency Management Agency (FEMA). The riparian terrace has been included for the purpose of modeling the FEMA 100-year flood elevation in order to represent "worst-case" impacts on the flood modeling. The riparian terrace will be included in the final design, if needed to provide on-site mitigation for potential adverse environmental impacts to fish and wildlife habitat by other elements of the project design. This need will be determined during the permitting process.

1.1 Site Description

The Zidell waterfront property encompasses 29.67 acres on the west side of a heavily urbanized and modified reach of the Willamette River in the South Waterfront District of Portland, Oregon (sections 3 and 10, township 1 south, range 1 east of the Willamette Meridian) (see Figure 1-1). The property is located in Multnomah County and consists of tax lots 1 (north of the Ross Island Bridge) and 42 (south of the Ross Island Bridge) (see Figure 1-2). The property owned by Zidell does not include the ODOT right-of-way below the Ross Island Bridge. By terms of State Waterway Lease ML-8551, Zidell leases 2.342 acres of state-owned submerged lands in the Willamette River adjacent to tax lots 1 and 42. For the purpose of this report, the "site" includes tax lots 1 and 42, the area directly under the Ross Island Bridge, the riverbank adjacent to these areas, and the in-water sediment cap area, as shown on Figure 1-2. The total area of the site is approximately 44 acres.

The site is bordered to the east by the Willamette River; to the west by SW Moody Avenue and a commercial office building and lot owned by GHS, LLC.; to the northwest by property owned by Oregon Health & Science University (OHSU); and to the south by properties owned by OHSU, North Macadam Investors, LLC, and River Campus Investors, LLC (see Figure 1-2). The site is located in the South Waterfront District urban renewal area, a formerly industrial and now rapidly urbanizing part of Portland located approximately between river miles 13.5 to 14.2.

Historically, the site was used for industrial activities related to ships (building, dismantling, converting, repairing, salvaging). Activities also included scrap metal operations, wire burning, aluminum smelting, and housing construction. Currently, Zidell Marine Corporation builds, sells, and leases steel barges in the operational area of the site located south of the Ross Island Bridge, which includes an office building as well as the barge-building facilities. Barges are launched into the Willamette River approximately once each year at the sloped ramp in the southeast part of the operational area that is referred to as the slipway. The part of the site located north of the Ross Island Bridge consists predominantly of undeveloped, permeable surfaces and small areas of pavement. Site features are shown on Figure 1-3.

TriMet is currently planning to construct a light rail, pedestrian, and bicycle bridge across the Willamette River as part of its Portland-Milwaukie Light Rail Project. The current plans call for the alignment of the bridge to intersect the northern part of Zidell's site, and for construction to begin in the year 2011.

1.2 Project Purpose and Need

On April 14, 1995, Zidell entered into a Voluntary Agreement with the DEQ to conduct a remedial investigation (RI) and feasibility study (FS) at the site (DEQ No. WMCVC-NWR-94-23; ECSI No. 689). The RI was completed in 2003 (MFA, 2003) and the FS was completed in 2004 (MFA, 2004b). The remedial action was selected by the DEQ in the ROD (DEQ, 2005), in accordance with Oregon Revised Statutes 465.200 through 465.380 and Oregon Administrative Rules Chapter 340, Division 122, Section 0090. The remedy selected by the DEQ, as documented in the ROD, is based on the final RI/FS reports and on DEQ modifications to the remedial action recommended in the FS report. The Consent Judgment requires that Zidell complete the selected remedial actions, and includes a schedule for implementation.

The purpose of the remedial action is to address the presence of metals, petroleum hydrocarbons and associated polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and tributyltin and its degradation products in contaminated soil and sediment at the site. The remedial action objectives (RAOs) identified in the ROD are:

Soil

- Prevent future resident and worker exposure to soil containing constituents exceeding acceptable risk-based concentration (RBC) values.
- Prevent ecological receptors from exposure to soil containing chemicals of potential ecological concern exceeding DEQ screening level values.
- Prevent transport of chemicals of concern (COCs)[1] in soil to the Willamette River through stabilization of shoreline and stormwater runoff controls.
- Remediate soil hot spots to the extent feasible.

Sediment

- Protect humans against exposure to site-related COCs above protective levels.
- Minimize transport of sediment containing COCs above cleanup levels to downstream areas of the river.
- Ensure that sediments contaminated with COCs above protective levels do not become accessible to benthic organisms, or to aquatic and terrestrial organisms through food chain exposure.

[1] Chemicals of ecological concern ~~(CECs)~~ and human health COCs are collectively referred to as COCs in this document.

- Remediate hot spots of contamination in sediment by reducing their concentration, volume, or mobility to the extent feasible and practical.

Surface Water

- Protect ecological habitat and beneficial uses of surface water adjacent to the facility.

In order to meet the RAOs required by the ROD and Consent Judgment for sediment and bank soil, certain design realities had to be recognized. These include the need for a design that provides for a high degree of permanence and durability in a highly modified, dynamic, and, at times, high-energy urban fluvial setting. The Zidell reach of the Willamette River includes widely varying fluvial conditions. For example, the area to be capped includes both scouring and depositional environments. The bathymetry includes steep slopes with exposed in situ gravels and cobbles to relatively flat benches composed of fine-grained depositional sands and silts. The flow in the river varies seasonally and tidally, from stagnant to a reversal of flow at the base of the hydrologic cycle to raging torrents with standing waves during extreme flow events. Further, the design had to account for a dynamic urban river environment and the range of vessel traffic using this reach—from paddle craft to commercial tug and barges. In order to meet design RAOs, these factors were carefully considered by both DEQ and Zidell.

Where possible, the design has been modified to reflect a more natural appearance and to provide greater habitat value. The remedy components are described in detail in Section 3.

1.3 Report Organization

This initial remedial design report includes the following sections:

- Section 2 summarizes existing conditions, with emphasis on those that have been investigated as part of the remedial design process.
- Section 3 provides an overview of the remedial action.
- Section 4 describes the remedial design components completed to date.

The initial remedial design report is based on an iterative and dynamic process between Zidell and the DEQ. A number of individual design documents have been developed by Zidell, discussed extensively and submitted to the DEQ for its review, modified as requested by the DEQ and resubmitted (if necessary) for approval by the DEQ. These documents, which are the basis for the initial design described in this report, have been or will be posted to the DEQ's Web site at http://www.deq.state.or.us/lq/cu/nwr/Zidell/:

- April 13, 2007, Interim Source Control Measures Plan (ISCMP) (MFA, 2007a)
- June 25, 2007, Source Control Supplemental Assessment (MFA, 2007b)

- October 12, 2007, bank line toe erosion and scouring evaluation (MFA, 2007c)
- February 18, 2008, Stormwater Evaluation Report (MFA, 2008b)
- January 28, 2009, asbestos abatement and riverbank erosion control report (MFA, 2009a)
- February 2, 2009, Sediment Cap Boundary Report (MFA, 2009b)
- March 19, 2009, Sediment, Pore Water, and Surface Water Sampling Report (MFA, 2009c)
- Final Report of Geotechnical Engineering Services Riverbank Stability Evaluation and Sediment Cap Design (GeoDesign, 2009)
- Sediment Cap Chemical Isolation Layer Model Report (MFA, 2009e)
- Stormwater Source Control Status Report (MFA, 2009d)

2 EXISTING CONDITIONS

For the purpose of the remedial design, the bank and sediment areas of the site have been divided into four separate reaches: the slipway reach, the south bridge reach, the north bridge reach, and the downstream reach. Each reach requires a different approach to the remedial design because of significant differences in the physical condition of the reach (see Section 3.6). Some of the following descriptions of existing conditions reference the four reaches, which are shown on Figure 2-1.

2.1 Topography and Bathymetry

2.1.1 Topography

The upland portion of the site is generally flat, with elevations ranging from 28 feet to 37 feet City of Portland Vertical Datum (COP) (see Drawing C0.1). 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 ordinary high water (OHW) line is 18 feet COP, as described further in Section 4.2. 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, consistent with fill placement and urban development that has modified the former floodplain of the entire reach of the Willamette River that passes through Portland. As part of the RI (MFA, 2003), aerial photographs taken between 1936 and 1984 were reviewed to determine the fill history of the site. The most recent fill occurred 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-containing material (ACM), and glass. The fill thickens from west to east toward the river, and can extend to 40 feet below ground surface (bgs) on the eastern portion of the uplands.

Like much of the urban river in Portland, the Zidell bank is steeply sloped and consists of construction debris, ballast rock, paving stones, soil, and other material that has acted as armoring against erosion. The bank slopes generally range from 1:1 to 2:1.

2.1.2 Bathymetry

The channel morphology of the Willamette River varies along the Zidell reach in significant ways, all of which have major impacts on the remedial design and considerations affecting cap stability (see Drawing C0.1 and Figure 2-1).

The in-water slope in the slipway and south bridge reaches is about 2:1 within 60 to 80 feet from shore, and then rapidly decreases to less than 25:1 as it approaches the depth of the main channel (see Drawing C0.1 and Figure 2-1). The elevation of the bottom of the main channel is approximately -25 to -35 feet COP in this area.

Immediately north of the Ross Island Bridge, the main channel begins to shift farther to the east (i.e., farther away from the site shore). The in-water slope in the north bridge reach and the southern portion of the downstream reach is approximately 2:1 to 5:1 within 70 feet of the shoreline. In these areas, a small, shallow depositional area, or sediment bench, is located at the base of the slope (see Figure 2-1). The elevations of the bench range from 5 to -10 feet COP. The width of the bench increases to up to 200 feet wide in the downstream reach, with slopes varying from 5:1 to over 25:1. On the eastern side of the bench, the river bottom falls away at a slope between 3:1 and 5:1 to match the bottom of the main channel at a distance of 300 to 400 feet from shore. The elevation of the bottom of the main channel is -35 to -55 feet COP in this area.

In the northern portion of the downstream reach, the in-water slope is generally more than 10:1 and is fairly consistent down to the main river channel bottom, which is at a depth of approximately -35 to -40 feet COP.

2.2 Stormwater

Stormwater from the Zidell site either infiltrates into the ground or discharges to the Willamette River through two private outfalls and one City outfall (Outfall 6) and by direct sheet flow. The stormwater system is shown on Figure 1-3. There are two City stormwater outfalls on or in the vicinity of the Zidell property (Outfalls 6 and 7b). Both of these outfalls discharge in the proposed sediment cap area. Outfall 7b represents a rerouting of stormwater from two outfalls on the property that were abandoned in 2007: City Outfall 07 and ODOT Outfall 42.

2.3 In-Water Structures

For the purposes of this initial remedial design report, in-water structures are considered those structures that are located within the footprint of the sediment cap area. Known in-water structures within the project site include piles, remnants of a former dock located in the downstream reach, City Outfalls 6 and 7b, and a City water line (see Figure 1-3 and Drawing C0.1). The City water line creates a bathymetric "ridge," as shown on Figure 2-2. The Zidell stormwater outfalls are located higher up on the bank (above the sediment cap). No other in-water structures are known to exist within the site and no other in-water structures were identified through single-beam and multibeam sonar bathymetric surveys completed in 2007 (see Figure 2-2). Supports for the Ross Island and Marquam bridges are close to the outer (eastern) boundary of the site (see Figures 1-3 and 2-2).

2.4 Bank Armoring

Areas of the existing bank armoring, consisting of construction debris, ballast rock from ship dismantling activities, paving stones, and other material, are similar aesthetically and functionally to designed and constructed riprap (MFA, 2004a). The appendix provides a set of bank photographs, taken in 2007, that spans the entire site. Because of the nature of the bank fill history, the limits of the top and bottom of the armor are very apparent and abrupt in some locations, while in others the armor density diminishes less dramatically. Section 4.3.1 describes the process that was used for delineation and surveying of the top and bottom of the existing armor, as shown on Figure 2-3. The elevation of the top of existing armor ranges from 10 to 29 feet COP, and the elevation of the bottom of existing armor ranges from approximately 3 to 10 feet COP. In some areas, the bottom of armor was not surveyed because it was below the water surface at the time of the survey. In these areas, the bottom of armor is assumed to be approximately 3 feet COP.

2.5 Soil Chemistry and Toxicity

As described in the ROD, the COCs in soil at the site include metals (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc), PAHs, and PCBs. Table 4-1 of the ROD provides soil cleanup levels and hot spot concentrations. The location of soil exceeding hot spot concentrations is shown on Figure 2-4, which is based on Figure 4-1 of the ROD.

2.6 Sediment Chemistry and Toxicity

As described in the ROD, the COCs in the Willamette River sediment adjacent to the site include metals, PAHs, PCBs, and tributyltin. Sediment chemistry and toxicity data, based on sediment sampling, are described in detail in the Sediment Cap Boundary Report (MFA, 2009b). Concentrations of COCs are generally highest in sediment located near the shore where most of the historical over-water ship dismantling and repair activities took place. Sediment characterization data show that most of the contamination and associated risk to human and ecological receptors is in the sediment located within approximately 50 feet of the shore.

Concentrations of COCs are generally highest in three nearshore areas: near the northern site boundary, the area south of the Ross Island Bridge near stormwater outfalls (Zidell Outfall 2 and City Outfall 6), and near the former ship dismantling dock and the former oil/water separator associated with this dock (see Figure 1-3).

2.7 Sediment Physical Parameters

MFA evaluated grain size distribution as part of the fluvial analysis (MFA, 2008a), based on surface sediment samples collected in 89 locations within and near the site. Grain size results from surface sediment were used to prepare a contour map of the percentage of fine-grained sediment (i.e., the percentage of fine sand and silt, referred to as "percent fines") (see Figure 2-5). In general, the percent fines are highest in the central and northern nearshore areas. Between these two nearshore areas, coarser-grained sediments are evident near the former COP Outfall 7 and the former ODOT Outfall 42, both of which were abandoned in 2007. In the southern portion of the study area scouring has occurred, and in many cases in situ gravel and cobble deposits are exposed.

In the areas over 250 feet from shore, percent fines are low (generally less than 10 percent) in the southern part of the study area, and grain size appears to be highly variable in the central and northern parts of the study area.

The percent fines contours are consistent with field observations, which indicated that sediment was composed of coarser-grained sands and gravels south of the Ross Island Bridge, and finer-grained silts north of the Ross Island Bridge (MFA, 2007d). Figure 2-6 shows the variation in substrate conditions throughout the sediment cap area, as determined by field observations and sieve analyses.

Total organic carbon was measured in 78 sediment samples; concentrations ranged from 0.036 percent to 3.02 percent, with an average of 1.07 percent.

2.8 Fluvial Setting

Before the urban development of Portland, the Willamette River was very dynamic, with a wide floodplain and relatively frequent floodplain turnover (i.e., change in the position of the floodplain). The river through the Portland reach was generally wider and shallower than the current river, with extensive shoals throughout. The fluvial characteristics of the portion of the Willamette River that flows through downtown Portland have been extensively altered, nearly eliminating floodplain turnover in the urban reach. In terms of morphology, the river has been highly channelized, and most of the natural floodplain has been filled as a result of Portland's urban growth along both sides of the river for over a century. Flow in the river is also impacted by 13 COE dams on the Willamette River. Even where floodplain remains, much of the habitat quality of the floodplain has been diminished because of hydraulic controls eliminating or significantly reducing the magnitude and duration of natural flooding.

Along the site, the Willamette River flows northwest and is 1,400 to 1,500 feet wide. The main channel is divided by Ross Island near the southern part of the site. 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 the site and Ross Island during low-flow periods (Caldwell and Doyle, 1995). In contrast, winter floods can create large channelized flows along the reach of the site with discharges up to 420,000 cubic feet per second.[2]

A 2008 fluvial analysis of the site evaluated changes in bathymetry over time, using grain size distribution and model-generated river velocities in order to delineate estimated potential depositional and erosional areas offshore of the Zidell site (MFA, 2008a). Figure 2-7 shows the depositional and erosional areas as determined during the evaluation. Depositional areas appear to be located in the downstream reach within 150 feet from shore. An erosional area was identified spanning the southern bridge reach and extending approximately 100 feet from shore.

2.9 Water-Dependent Site Activities and Expected Vessels

The southern operational area of the site, located south of the Ross Island Bridge, is currently used to build steel barges. Zidell Marine Corporation launches barges into the Willamette River at the slipway launch area in the slipway reach. A crane barge is moored next to the slipway ramp and is used to complete finishing work on recently launched barges. After the barges are launched, tugboats maneuver them into position at a location adjacent to the crane barge.

Various vessels (including canoes and kayaks, jet skies, small to large recreational power boats, cruise tour boats, tugboats, fire boats, and barges) use the river along this reach.

2.10 Biology and Habitat

2.10.1 Documented Fish and Invertebrates

General groups of benthic invertebrates that have been documented from the lower Willamette River, including the Zidell reach (Fishman, 2002; Friesen et al., 2005; GSI, 2009), were summarized by SWCA Environmental Consultants (SWCA, 2009b) and are listed below by type of dominant substrate.

[2] This is the daily mean flow rate from February 9, 1996, the maximum daily mean flow rate on record at the USGS Station 14211720 (Willamette River at Portland Morrison Bridge). http://waterdata.usgs.gov/or/nwis/sw.

	SOFT-BOTTOM (SAND/SILT/CLAY)	GRAVEL/COBBLE SUBSTRATES
LIKELY TO BE MOST ABUNDANT	Worms (oligochaetes, nematodes, and polychaetes)	Ephemeroptera (mayfly) larvae
	Chironomid (midge) larvae and pupae	Tricoptera (caddisfly) larvae
	Diptera (fly) larvae	Mollusks (snails)
	Corophiid amphipods (scuds)	Worms (oligochaetes, nematodes, etc.)
	Bivalves (clams)	Chironomid (midge) larvae
	Hyrdachnidia (water mites)	Corophiid amphipods (scuds)
	Cyclopoid copepods	
LIKELY TO BE PRESENT	Crayfish	Crayfish
	Odonates (dragonfly) larvae	Odonates (dragonfly) larvae
	Ephemeroptera (mayfly) larvae	Cyclopoid copepods
	Tricoptera (caddisfly) larvae	Diptera (fly) larvae
	Ostracods	Ostracods
	Isopods (sowbugs)	Isopods (sowbugs)
	Gammarid amphipods (scuds)	Gammarid amphipods (scuds)
	Mollusks (snails)	Bivalves (clams)
		Hyrdachnidia (water mites)

The fish community at the project site is a combination of native and nonnative species, including those that use the water column and those that live near the bottom (SWCA, 2009b). Fish communities typically are influenced by habitat conditions such as substrate type, depth, velocity, and presence of vegetation or cover. Because a variety of conditions occur in the project area, providing varying habitat value, fish communities may vary accordingly. Fishes that had previously been documented from the lower Willamette River, including the Zidell site (Farr and Ward, 1993; Fishman, 2002; Pribyl et al., 2004; Wydoski and Whitney, 2003; Zaroban et al., 1999), as well as expected habitat use, were summarized by SWCA (2009b) and are listed below.

COMMON NAME	SCIENTIFIC NAME	HABITAT USE	STATUS
Pacific lamprey	*Lampetra tridentata*	Benthic, silt, sand, and gravel substrates	Native
White sturgeon	*Acipenser transmontanus*	Benthic, soft substrates	Native
American shad	*Alosa sapidissima*	Water column, various habitats	Nonnative
Cutthroat trout	*Oncorhynchus clarki*	Water column, various habitats	Native
Coho salmon	*Oncorhynchus kisutch*	Water column, various habitats	Native, threatened
Steelhead trout	*Oncorhynchus mykiss*	Water column, various habitats	Native, threatened
Rainbow trout	*Oncorhynchus mykiss*	Water column, various habitats	Native

COMMON NAME	SCIENTIFIC NAME	HABITAT USE	STATUS
Chinook salmon	*Oncorhynchus tshawytscha*	Water column, various habitats	Native, threatened
Mountain whitefish	*Prosopium williamsoni*	Shallow waters	Native
Chiselmouth	*Acrocheilus alutaceus*	Benthic, cobbles, or larger substrates	Native
Goldfish	*Carassius auratus*	Soft-bottom substrates, prefer littoral zone with vegetation	Nonnative
Common carp	*Cyprinus carpio*	Shallow water, soft-bottom substrates	Nonnative
Peamouth	*Mylocheilus caurinus*	Water column or benthic, soft-bottom substrates	Native
Northern pikeminnow	*Ptychocheilus oregonensis*	Water column or benthic, sand and mud substrates	Native
Longnose dace	*Rhinichthys cataractae*	Among rocks and boulders	Native
Speckled dace	Rhinichthys occulus	Soft-bottom substrates in shallow water	Native
Redside shiner	*Richardonius balteatus*	Shallow (with vegetation) or deep waters	Native
Largescale sucker	*Catostomus macrocheilus*	Benthic, prefer shallow waters	Native
Mountain sucker	*Catostomus platyrhynchus*	Benthic, soft and hard substrates with cover	Native
Yellow bullhead	*Ictalurus natalis*	Hides in aquatic vegetation	Nonnative
Brown bullhead	*Ictalurus nebulosus*	Shallow areas near shorelines	Nonnative
Channel catfish	*Ictalurus punctatus*	Benthic, soft substrates	Nonnative
Banded killifish	*Fundulus diaphanous*	Shallow areas with sand or gravel	Nonnative
Western mosquitofish	*Gambusia affinis*	Shallow vegetated areas	Nonnative
Threespine stickleback	*Gasterosteus aculeatus*	Slow-flow areas	Native
Sand roller	*Percopsis transmontana*	Backwater areas with debris or habitat complexity	Native
Pumpkinseed	*Lepomis gibbosus*	Backwater areas with vegetation	Nonnative
Warmouth	*Lepomis gulosis*	Soft substrates with vegetation	Nonnative
Bluegill	*Lepomis macrochirus*	Shallow areas with cover or structure	Nonnative
Smallmouth bass	*Micropterus dolomieui*	Rocky substrates, water column	Nonnative
Largemouth bass	*Micropterus salmoides*	Shallow areas with cover or structure	Nonnative
White crappie	*Pomixis annularis*	Water column	Nonnative
Black crappie	*Pomoxis nigromaculatus*	Soft substrates with rooted vegetation	Nonnative
Yellow perch	*Perca flavescens*	Shallow and deep waters	Nonnative

COMMON NAME	SCIENTIFIC NAME	HABITAT USE	STATUS
Walleye	*Stizostedion vitreum*	Prefer substrates of gravel or larger	Nonnative
Prickly sculpin	*Cottus asper*	Benthic	Native
Reticulate sculpin	*Cottus perplexus*	Benthic	Native
Starry flounder	*Platichthys stellatus*	Benthic, soft substrates	Native

2.10.2 Plant Survey

Based on the results of a March 2009 vegetation survey completed by SWCA (2009a), vegetation within 100 feet inland of the OHW line is dominated primarily by invasive species, including Himalayan blackberry and butterfly bush. In addition, distinct areas dominated by Japanese knotweed and black locust were observed in the project area. Several native species were scattered throughout the site, with the dominant natives consisting of black cottonwood and Scouler willow. Other native species noted on the site occurred only in small quantities and were not dominant. Figure 2-8 shows the vegetation mapped by SWCA. The vegetation list below includes all tree and shrub species observed on site by SWCA (2009a).

COMMON NAME*	SCIENTIFIC NAME	STATUS
Herbaceous		
Japanese knotweed	*Polygonum cuspidatum*	Invasive*
Vines		
English ivy	*Hedera helix*	Invasive*
Shrubs		
butterfly bush**	*Buddleja davidii*	Invasive*
black hawthorn	*Crataegus douglasii*	Native
beaked hazelnut	*Corylus cornuta*	Native
Scot's broom	*Cytisus scoparius*	Invasive*
Western crabapple	*Pyrus [Malus] fusca*	Native
Himalayan blackberry**	*Rubus discolor*	Invasive*
Scouler willow**	*Salix scouleriana*	Native
Douglas spirea	*Spiraea douglasii*	Native
Trees		
big-leaf maple	*Acer macrophyllum*	Native
paper birch	*Betula papyrifera*	Native
Oregon ash	*Fraxinus latifolia*	Native
black cottonwood**	*Populus trichocarpa [balsamifera]*	Native
pin oak	*Quercus palustris*	Introduced
black locust	*Robinia pseudoacacia*	Introduced

* Listed as a B-List noxious weed by the Oregon Department of Agriculture
** Dominant species

2.10.3 Habitat

As described above, the riverbank at the site generally has a very steep slope composed of large boulders, riprap, concrete blocks, construction debris, ballast material from ships, and wooden piling. The existing riverbank provides minimal riparian habitat (SWCA, 2009b). Vegetation is mostly nonnative and generally is present only above 13 feet COP. The current riparian baseline at the site is characterized by a simple plant community dominated by a few invasive species. Tree density over most of the site is low (canopy covers less than 5 percent of the bank), except in the area of the former dock and the slipway, where the canopy covers up to 50 percent of the bank (MFA, 2004a). Though the scarcity of native vegetation on site may be a reflection of the dense cover of nonnative plants, the level of site disturbance and the low quantity and quality of soil along the bank provide a difficult environment for most native vegetation (SWCA, 2009b). The bank slope and composition of bank substrates are likely the primary determinants of plant community structure.

Based on the bathymetry, shallow water habitat, represented by the area with river bottom elevations of approximately -20 feet and higher, extends up to 350 feet riverward from the riverbank in the north part of the site, and to less than 60 feet from the riverbank in the south part of the site. Deep water habitat is found below -20 feet COP.

Small areas of sand beach are found at low water along the shore of the shallow depositional area in the northern project area. Scant emergent vegetation is limited to the small beach area; submergent vegetation has not been observed. The shoreline provides limited fish and wildlife habitat with steep homogenous riprap slopes, typical of heavily urbanized, large floodplain rivers (SWCA, 2009b). There is little to no fine-grained material in the interstitial spaces around the riprap and large fill.

Below the ordinary low water (OLW) line,[3] sand and silt are present in the central and northern portions of the site. Gravels and cobble are present in the southern portion of the site, likely because of erosion resulting from the proximity of the deepest part of the river channel to shore, the steepness of the lower bank, and resulting greater exposure to wave energy and river forces.

The reach of the Willamette River along the site is used by both adult and juvenile salmonids as a migration corridor, and potentially by juvenile Chinook as rearing habitat. Though some gravel is present below the OHW line, substrates are generally not suitable for salmonid spawning (SWCA, 2009b).

[3] The OLW elevation is defined by the COE as the water level established by field observation of seasonally low river levels used to designate a lower boundary of river stage. Because of its inexact nature, OLW is no longer used by the COE for regulatory purposes, and a specific elevation has not been established by the COE (COE, 2004). The initial design plans use 3 feet COP for the OLW elevation.

3 REMEDIAL ACTION

The remedial action design described in this section is based on the RAOs identified in the ROD and the remedial action required by the Consent Judgment. Zidell worked extensively with the DEQ to develop a design that will meet the RAOs and is durable enough to withstand the dynamic and wide range of fluvial forces to which it will be subjected in the future. The RAOs described in the ROD are satisfied by the design because it is permanent and it protects both human and ecological receptors from exposure to contamination. The design provides a protective base on which fish and wildlife habitat, consistent with the current fluvial condition and urban nature of the river, can be established.

The ROD described the remedial actions for soil and sediment separately. The soil remedy, as described in the ROD, was divided into "greenway" and "non-greenway" areas,[4] with the Willamette River bank included in the greenway area. In the development of this remedial design, it has also become important to differentiate between the remedies for the bank and upland areas. The upland areas are defined as those areas above the proposed (i.e., postconstruction) top of bank. This initial remedial design report describes source control and remedial actions for four distinct areas of the site:

- Interior site area, which includes the upland portion of the site that is located outside the ROD greenway area (i.e., the "non-greenway" area described in the ROD).
- Upland ROD greenway area, which includes the area between the greenway boundary line (assumed to be 100 feet from the 2002 City top of bank line) and the postconstruction (i.e., proposed) top of bank.
- Bank area, which includes the area between the proposed top of bank and the sediment area. The bank area is part of the ROD greenway area.
- Sediment area, which generally includes the area riverward of the bottom of the existing armor on the bank.

These remedial action areas are shown on Figure 3-1. The remedial action is also depicted in Drawings C0.0 through C6.2 and L1.0 through L1.6, which comprise the initial remedial design drawings.

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[4]It was necessary to divide the soil remedy into greenway and non-greenway areas because the DEQ required that the soil remedy take into consideration an ecological exposure scenario in the greenway area. The location, configuration, and size of a public Greenway area will ultimately be determined by Zidell's redevelopment plans in coordination with the requirements of the City South Waterfront Greenway Development Code (Title 33, section 510). In the FS, ROD, and Consent Judgment, and for illustrative purposes only, the western greenway boundary was shown to be 100 feet from the 2002 City top of bank line. In this initial remedial design report, the same greenway area depiction continues to be used, again for illustrative purposes, and is designated as the ROD greenway. However, because redevelopment plans for the site have not been finalized, the configuration of the greenway area may change before implementation of the remedy, which will in turn affect the final design of the upland cap and hot spot excavations.

3.1 Project Phases

The project is broken into three phases, consistent with Schedule B of the Consent Judgment. This initial design report has been completed as part of the Phase 1 work and generally covers those aspects of the design that are anticipated to be constructed during Phase 2. A separate design effort will be carried out for the construction of Phase 3. At this time it is not anticipated that a capping design for the interior of the site will be included as part of the Phase 2 design effort, because the property is not expected to be redeveloped within the Phase 2 timeframe.

3.1.1 Phase 1

Phase 1 of the remedy includes the following activities, to be completed within 24 months of entry of the Consent Judgment (on or before September 12, 2008):

- Prepare the remedial design/remedial action work plan. (This was completed in 2007.)
- Prepare a draft source control plan for the upland areas of the site within 45 days of entry of the Consent Judgment, and initiate the final plan within 30 days of DEQ approval. (Source control activities were initiated in 2007 and continue as described in Section 3.2.)
- Initiate coordination of substantive permitting requirements with the City, DSL, and COE within two months of entry of the Consent Judgment. (Communications were initiated in 2006.)
- Undertake good faith effort to complete necessary access agreements for remedy implementation with DSL. (Zidell has initiated discussions with DSL for land acquisition, lease, or easement to facilitate remedy implementation.)
- Initiate supplemental sediment characterization to delineate final sediment cap limits and physical properties related to sediment cap design within two months of the DEQ's approval of the remedial design sediment characterization plan. (This was completed in 2007.)
- Complete the ROD greenway and sediment remedy design plans and specifications within 18 months of entry of the Consent Judgment. (The initial remedial design plans are attached to this report. The specifications will be developed as part of the final design.)
- Undertake good faith effort to complete ROD greenway and sediment remedy permitting within 18 months of entry of the Consent Judgment. (A joint application for the bank and sediment remedy permitting will be completed following DEQ review of this initial remedial design report.)
- Implement relevant deed notifications and restrictions. (The initial form of the easement and equitable servitudes was filed with the Consent Judgment in September 2006.)

The time to complete outstanding Phase 1 milestones has been extended by mutual agreement between the DEQ and Zidell. These extensions are in recognition of the complexity of design issues for this project and the need to proceed carefully through an iterative process of collaborative investigation, modeling, and design.

3.1.2 Phase 2

The second phase of remedy implementation includes the following activities, to be completed within five years of entry of the Consent Judgment (on or before September 12, 2011):

- Removal and off-site disposal of human health hot spot soils and ACM from the ROD greenway area and the interior site area north of the Ross Island Bridge
- For areas north of the Ross Island Bridge, construction of temporary containment cell(s) for management of ecological hot spots from the ROD greenway area, and construction of the ROD greenway area cap within two years of completing permitting and design[5]
- To the extent necessary beyond that completed under Phase 1 source control, stabilization of the ROD greenway south of the Ross Island Bridge to prevent recontamination of the sediment cap
- Selective dredging and/or capping of sediment within the next available Willamette River in-water work window following Phase 1 design and permitting
- Completion of final capping design for the interior site area that incorporates development infrastructure components, to the extent that redevelopment design occurs during Phase 2
- Implementation of final capping design for the interior site area, to be completed during site redevelopment, to the extent that redevelopment occurs during Phase 2
- Implementation of relevant deed notifications and restrictions

3.1.3 Phase 3

The third phase of remedy implementation includes the following activities, to be completed within ten years of entry of the Consent Judgment (on or before September 12, 2016):

[5] The temporary containment cells will be necessary only if the final on-site placement locations are not identified and/or ready (e.g., if development plans are not complete). The design of temporary containment cells has not been included in this report.

- Hot spot removal and ROD greenway remedial actions south of the Ross Island Bridge
- Installation of final upland cap in the interior site area
- Implementation of relevant deed notifications and restrictions

3.2 Source Control

The ROD requires source control measures to protect the Willamette River from potential releases of hazardous substances before implementation of the remedy and during Zidell's continued barge-building operations. Several source control measures were proposed in the 2007 ISCMP (MFA, 2007a) and the 2007 Source Control Supplemental Assessment (MFA, 2007b), and Zidell has implemented these measures. An evaluation of bank toe erosion and scouring was completed in 2007 (MFA, 2007c). Interim bank erosion control measures and removal of ACM from the riverbank were completed in 2008 (MFA, 2009a). Zidell will continue to monitor the bank for erosion and will complete additional erosion control measures as necessary.

Stormwater monitoring under a National Pollutant Discharge Elimination System (NPDES) permit has been an ongoing operational activity at the site. Initial stormwater source control measures were implemented at the site in 2007 (MFA, 2008b). Additional measures were implemented between November 2008 and January 2009 (MFA, 2009d). Zidell will continue to monitor stormwater in accordance with the stormwater sampling plan (MFA, 2009d) to evaluate the adequacy of the stormwater source control measures.

Zidell and the DEQ have acknowledged and discussed the need for DEQ and the City to evaluate, and if necessary, consider and implement, upland source control measures relative to City Outfalls 6 and 7b. Zidell is coordinating and cooperating with the City regarding these source control efforts.

This document does not address source control further.

3.3 Soil Excavation, Screening, Consolidation, and Disposal

The ROD specifies that hot spot soils will be excavated to a depth of 5 feet below final grade in the ROD greenway area of the site and to a depth of 5 feet below current grade in the interior site area.

Hot spot excavation areas are shown on Drawings C3.0 through C3.6. The drawings specify excavation depths of 3 feet or 1 foot from the current ground surface for hot spots in the ROD greenway area. A 3-foot excavation from the existing surface, along with the 2-foot soil cap proposed in the ROD greenway area (see Section 3.5), will provide the required 5 feet of separation between hot spot soil and the final grade. Excavations specified to be 1 foot deep are in areas of the ROD greenway where there are no hot spot soils below 1 foot of the current ground surface. The drawings specify excavation depths of 3 feet or 5 feet from the current ground surface in the interior site area. Excavations in the interior site area specified to be 3 feet deep are in areas where there is no hot spot soil present below 3 feet. The determination of the hot spot excavation boundaries is discussed in Section 4.5.

Additional soil (beyond the hot spot excavation areas) will be excavated from the bank in the southern part of the site (i.e., in the slipway reach and the bridge reaches), as described in Section 3.6, to achieve a stable slope configuration.

The ROD specifies that soil within utility corridors that exceeds RBCs for construction workers will be excavated to a depth of 5 feet below final street grade, as required by the City's soil reuse policy (City, 1999). The location of utility corridors for future redevelopment on the Zidell site is unknown at this time; therefore, no detailed design of utility corridor excavation has been completed beyond what was shown in the FS. The FS utility corridors are not considered representative of likely site development plans.

The ROD allows additional soil to be excavated from the site, as needed for site redevelopment, although the excavation of additional soil is not a required part of the remedial action.

3.3.1 Clearing and Grubbing

Before soil excavation activities, the work area will be cleared and grubbed to remove existing vegetation, which in most areas consists of noxious weeds. An evaluation will be conducted during final design to determine if selected native trees can be protected during construction and retained.

3.3.2 Soil Management

All soil excavated during and after the remedy (including soil excavated during future redevelopment) will be managed as specified in the soil management plan (SMP) that will be developed as part of the final design. Fill material historically placed on the site, especially along the bank, consists of large amounts of oversize, primarily inert material. Soil screening may be used to isolate soil from oversized rocks and concrete debris. At this point in the design, it has not been determined to what extent screening will be utilized. Currently, it is assumed that a 4-inch screen will be used. Oversized rocks and concrete that does not pass through the screen may remain on site. Oversized pieces of metal may be segregated for off-site recycling. If any on-site or off-site recycling options are identified for other inert materials during final design or construction, Zidell will coordinate and seek approval from the DEQ before completing such recycling. Oversize debris unsuitable for fill, such as woodwaste, solid waste, and ACM, will be transported off site for disposal.

Excavated soils to be disposed of off site will be managed appropriately. Bulk ACM encountered during excavation will be transported off site for disposal in accordance with asbestos-disposal regulations. Soil containing COCs (and not containing asbestos) will be disposed of as special waste at a Subtitle D landfill or as a characteristic hazardous waste at a Subtitle C landfill. If necessary, treatment (either on site or off site) of soil slated for off-site disposal may be completed to render it nonhazardous (i.e., remove hazardous waste leaching characteristics). Existing soil data suggest that only a relatively small volume of soil, if any, may potentially have hazardous waste leaching characteristics, and treatment may not be warranted. As part of the final design, areas containing soils potentially containing hazardous levels of COCs will be identified and appropriate testing will be completed before or during soil excavation. The requirement for testing soils for hazardous characteristics will also be described in the SMP.

The ROD specifies that, within the limits described below, excavated soils with contamination exceeding human health hot spot concentrations must be disposed of off site in accordance with applicable state and federal regulations. The ROD sets the off-site disposal volume for human health hot spots at no more than 8,000 cubic yards, using a worst-first approach. The hot spot locations are based on the RI findings and are specified in the ROD (see Figure 2-4). No additional soil testing to evaluate concentrations against hot spot criteria is required as part of the remedial action, unless unexpected conditions or contamination is discovered. Some analysis of screened soil may be required to verify appropriate management procedures. Any additional sampling requirements will be specified in the SMP that will be prepared as part of the final design.

Any human health hot spot soil that must be excavated in excess of 8,000 cubic yards may be managed on site in geotextile-lined containment cells, pending final capping through redevelopment. Ecological hot spots that are excavated will be either disposed of off site or managed in temporary geotextile-lined containment cells until placement of the soil before final capping. The design of containment cells has not been completed as part of the initial design, as it is unknown whether any excavated soil will be managed on site. This decision depends, in part, on the future final grade of the site, which will be dictated by future redevelopment plans.

The ROD also allows for excavated bank soil with contaminant concentrations below human health hot spot levels to be placed in the upland areas of the site, with the condition that all on-site areas in which excavated soil is placed will be surveyed for future reference. It is unknown at this time whether soil excavated from the bank in the southern section of the site will be placed on site or disposed of off site.

3.3.3 Backfill

The limits of the hot spot excavations will be surveyed upon completion. Hot spot excavation areas will then be lined with demarcation fabric before backfill with general fill. The fill will be placed and compacted as required in the project specifications.

3.3.4 Hot Spot Excavation Volume Estimate

The depth (and therefore the volume) of required hot spot excavation in the ROD greenway is dependent on the final grade of the ROD greenway area. The final grade of the bank is proposed in this initial design. However, the final width and elevation of the upland ROD greenway area of the site are unknown and will depend on redevelopment plans. One factor that could significantly affect the final site elevations is the proposed TriMet Light Rail Bridge alignment, which is currently planned to intersect the northern part of Zidell's site. All current bridge configurations include a bridge approach that is at least 10 feet above the existing ground elevation at the assumed greenway boundary. Areas in the final greenway area that will have over 5 feet of clean fill postdevelopment may not require hot spot excavation because the fill will provide the 5 feet of separation between the hot spot and the final grade.

Drawings C3.0 through C3.6 provide the hot spot excavation plan. In the ROD greenway area, the hot spot excavation depths are based on the final bank configuration shown on Drawings C4.0 through C4.5 and assume that the final grade of the upland ROD greenway area will generally be 2 feet above the existing grade. It is estimated that approximately 5,300 cubic yards of soil exceeding human health hot spot concentrations will be excavated (200 cubic yards in the bank area of the ROD greenway, 1,100 cubic yards in the upland part of the ROD greenway, and 4,000 cubic yards in the interior site area).[6] An additional 12,800 cubic yards of soil exceeding ecological hot spot concentrations will be excavated from the ROD greenway area (1,900 cubic yards in the bank and 10,900 cubic yards in the uplands).[7] As mentioned above, it is possible that the excavation plan for hot spots in the ROD greenway upland areas will be modified before completion of the final design. However, it is not anticipated that the hot spot excavation plan and volume estimates for the bank area will change significantly.

3.4 Interior Site Area Soil Cap

An engineered cap will be constructed in the interior site area as part of Phase 3 to prevent contact with impacted soil, minimize exposure to COCs, and prevent erosion of impacted soil to surface water and sediment. A detailed design for the interior site area cap is not addressed in this initial remedial design report (i.e., is not shown on the drawing set) but will be completed during Phase 2 or Phase 3 of the remedial action. The final design of the interior site area cap will depend on redevelopment plans and the requirements for the proposed TriMet bridge, which are not known at this time. The ROD anticipates that some or all of the redevelopment structures and appurtenances will function as the engineered cap. It is anticipated that the

[6] For the purposes of the volume estimates provided here, soil in the greenway that exceeds both human health hot spot concentrations and ecological hot spot concentrations is counted only under the human health hot spot volume.

[7] Ecological exposure scenarios are assumed only in the greenway areas. Accordingly, ecological hot spots are present only in greenway areas. If the location, size, or configuration of the greenway changes, the locations of ecological hot spots will be affected (e.g., if a certain location is eliminated from the greenway in the final redevelopment plans, any ecological hot spots at that location will also be eliminated because the ecological exposure scenario will no longer be relevant).

engineered cap for the interior site area will incorporate buildings, pavement, or other improvements to augment areas of soil cap.

As discussed in Section 3.7.2, the existing asphalt-concrete pavement that covers much of the Zidell Marine Corporation barge-construction operational area and the concrete floor slabs of the existing buildings will be retained for the duration of site operations, or until redevelopment construction activities are implemented (in accordance with ROD criteria for the final site cap).

3.5 Upland ROD Greenway Soil Cap

In the upland ROD greenway area north of the Ross Island Bridge, the engineered cap will be constructed as part of Phase 2, following decommissioning of existing monitoring wells (see Section 3.7.1) and removal of impacted soils, ACM, and debris. The engineered cap will generally consist of a demarcation layer to identify the top of the impacted soil and a 2-foot vegetated clean soil cap, but other equivalent barriers may also be used to accommodate desired greenway features. Clearing and grubbing, as well as some grading of the existing soil, will be necessary before placement of the greenway soil cap. Much of the vegetation that will be cleared consists of noxious weeds.

The final width and elevations of the greenway upland area are currently unknown and will be determined during redevelopment planning. For the purposes of this design, a greenway setback of 100 feet from the top of bank has been assumed, consistent with assumptions used in the FS. It is also assumed that the final grade will be approximately 2 feet above the current grade. Evaluation of the requirements for the TriMet bridge will be incorporated into the final remedial design for the soil cap.

The soil cap for the upland ROD greenway area south of the Ross Island Bridge (i.e., in the current operational area) will not be constructed until Phase 3. The design for the soil cap in this area will be completed during Phase 3 of the remedial action and is not addressed in this initial remedial design report.

3.6 Bank and Sediment Cap

For the purpose of the remedial design, the bank and sediment caps have been divided into four separate reaches, corresponding to four different design approaches: slipway reach, south bridge reach, north bridge reach, and downstream reach (see Figure 3-2 and Table 3-1).

The design of the sediment cap employs four different capping methods: standard sand cap, thin sand cap, armored thin cap, and low-profile cap. Most contaminated sediment within the cap boundary is addressed by a standard sand cap consisting of a minimum 2-foot-thick clean dredge sand layer under a layer of rock armoring. The standard sand cap will chemically and physically isolate contaminants from receptors in the river (MFA, 2009e). Thin cap and armored thin caps are used to provide a clean substrate that separates benthic organisms from low-level concentrations of contaminants. The-low profile cap is used in the slipway area where the thicker standard sand cap cannot be placed because of operational requirements for launching barges on the existing skid rail system. The low-profile cap consists of a reactive core mat (RCM), a geotextile cushion layer, and rock armoring.

Figure 3-3 shows the proposed cap surfaces (sand and different types of rock armor), based on the sediment cap armor design described in Section 4.4.4. Table 3-1 is a design summary for the entire project, organized by reach and elevation ranges within each reach. The table also describes the final surface appearance of each design element, and the existing conditions. The various types of rock armor are described in Table 3-2. Table 3-3 summarizes area and volume quantities for different types of rock armor. The different caps are described in detail in the subsequent sections.

3.6.1 Slipway Reach

The slipway reach of the cap extends from station -2+04[8,9] (the southern cap boundary) to station 3+00 (see Figure 3-2 and the appendix). The cap design for this reach must accommodate continued barge construction and barge launching at the slipway ramp. Barges are launched approximately once each year. The existing ground surface of the slipway ramp consists of large steel plates covering soil. The steel plates allow the barge to be positioned onto the ramp, using wheeled dollies, prior to launch. Two rails that carry large rail trucks used to maneuver barges into place for launching extend down the ramp to an elevation of approximately 10 feet COP. In addition, a series of three rails and/or beams function as "launching rails" for the barges as they run from the top of the slipway ramp into the Willamette River (see Drawing C2.1). The northern two launching rails extend to an elevation of approximately 0 foot COP, and the southern launching rail extends to an elevation of approximately -5 feet COP. The launching rails are supported by bents that run north to south. Based on Zidell Marine Corporation as-built drawings, three piles support the bents at each point where the bents cross the launching rails.

The slipway reach design consists of the following components, which are described further in the sections below and are summarized in Table 3-1:

- Concrete cap over slipway surface
- Bank excavation
- Repair of existing bank armor
- Armor replacement cap on lower bank

[8] Note that station 0+00 is located at the southern Zidell property boundary.
[9] The stationing used in this document differs from what is used in GeoDesign's bank stability report (GeoDesign, 2009). Areas should be related by references to the specific reach and not by the station value given when referencing between reports.

- Soil cap on upper bank
- Dredging and in-water structure removal as necessary for sediment cap placement
- Low-profile cap over sediment
- Standard sand cap over sediment
- Armored thin cap over sediment

3.6.1.1 Concrete Cap over Slipway Surface

A new concrete working surface will be placed on the floor of the ramp down to an elevation of approximately 5 feet COP (see Drawing C2.1). The working surface of the ramp must be able to support the weight of the barge during positioning of the barge prior to launch when the barge is supported on dollies. The surface must be sufficiently flat so that the wheels of the dollies can travel smoothly. The concrete slab design will likely consist of 8 to 12 inches of reinforced concrete, of sufficient strength to support the weight of the barges during launching. The concrete will be supported by base rock to be placed between the existing rail bents, and on the bents themselves. Before construction of the concrete slab, the existing steel plates will be removed from the ground surface and soil will be excavated/dredged between the bents to allow adequate depth for the base rock and slab so that the top of the slab will be below the existing rails and skid ramp. It is estimated that a maximum of 800 cubic yards of material will be excavated/dredged above elevation 5 feet COP. The soil will either be placed in the interior site area or transported off site for disposal, as described in Section 3.3. Soil management will be further described in the SMP that will be prepared as part of the final design.

The slab design and detailed grading plan for this area will be completed as part of the final design. The DEQ has requested that porous pavement or intercepting features such as swales be evaluated as measures to reduce runoff from the concrete ramp.

3.6.1.2 Bank Excavation

The bank of the Willamette River in the slipway reach will be regraded between elevation 3 and 12 feet COP to a 2:1 slope, transitioning to a 3:1 slope above elevation 12 feet COP, to achieve a stable slope (GeoDesign, 2009). Soil and debris will be excavated as described in Section 3.3 and either placed in the interior site area or transported off site for disposal. Ecological hot spots,[10] as previously identified in the ROD, will be overexcavated to a depth of 5 feet below the final grade; see Section 3.3 for a discussion of excavation and disposal. The south-internal side of the slipway ramp in the slipway reach was constructed with a 2:1 slope in 1993. It will be regraded (cut) above the existing top of armor line (varies from 12 to 15 feet

[10] There are no human health hot spots in the slipway reach.

COP) to accommodate the 2-foot soil cap. Soil and debris fill will be excavated as described in Section 3.3 and either placed in the uplands area or transported off site for proper disposal.

An 18-inch private stormwater outfall is located in the lower bank area just north of the slipway ramp. The design of any modifications required for this outfall will be completed as part of the final design.

3.6.1.3 Repair of Existing Bank Armor

The existing bank armor on both internal sides of the slipway ramp and along the Willamette River south of the slipway ramp will be repaired as needed as part of the remedy and will serve as the final bank cap, as shown on Drawing C2.1. The individual locations for armor repair will be at the direction of the geotechnical engineer. The elevation of the proposed top of the armor repair area ranges from 12 to 15 feet COP in this area. The elevation of the bottom of the existing armor is assumed to be elevation 3. The existing bank armor in this area consists primarily of riprap.

Deleterious material (e.g., rebar, wood scrap, wire, rubber) will be removed from the surface of the bank, but in general, the bank will not be overexcavated to remove these materials, unless this is required to complete the selected remedy and to provide stability. If large pieces of unanticipated debris are encountered, Zidell will consult with the DEQ on the planned management before taking action. Two ship hulls are located near the mouth of the slipway; it is tentatively planned to remove, clean, and provide these to the City for its use. The removal procedure for the hulls will be developed for the final design.

The condition of the bank armor will be assessed during construction, once all vegetation and surface deleterious material have been removed from the bank. Areas where the existing armor is discontinuous or is of questionable structural integrity will be individually flagged by the geotechnical engineer. At each repair area, a skilled contractor will hand-excavate soil to accommodate new filter material (i.e. filter gravel and/or filter fabric) and then hand-size and place Type C rock armor to cover the area and tie into the existing armor.

The section of the internal northern slipway ramp bank located under the barge building has been undercut, but the structure is supported by piles. Additional Type C rock armoring will be hand-placed over filter material on this slope under the building and extending to the mouth of the slipway in order to prevent further undermining of the building. It should be noted that the purpose of the rock armoring is to provide the soil cap and to prevent erosion; it is not to support the building.

3.6.1.4 Armor Replacement Cap on Lower Bank

The portion of the bank between elevation 3 and 12 feet COP will be armored with a 3-foot-thick layer of Type E rock armor with a filter layer consisting of filter gravel and/or filter fabric. Between elevation 12 and 15 feet COP, the bank cut will be armored with 2 feet of Type D rock armor on a layer of filter gravel and/or filter fabric (see Drawing C2.1).

Planting of the armor above elevation 12 is being considered as a potential habitat improvement measure that may be added to the design before the submittal of the permit application package.

3.6.1.5 Soil Cap on Upper Bank

The cap over the bank soil located between the proposed top of armor and the proposed top of bank will incorporate soil bioengineering techniques of using plantings to provide stability and erosion control. To construct the cap, a 2-foot soil cap underlain by a demarcation layer (e.g., brightly colored permeable geogrid or other geotextile) and overlain by a turf reinforcement mat (TRM) will be keyed into the excavated slope, as recommended by the geotechnical engineer. The demarcation layer will be placed on the excavated slope before the lifts of cap soil are placed. The TRM will provide erosion control until the vegetative layer is established. The TRM contains plastic components that provide more certainty of slope stability during vegetation establishment than fully biodegradable erosion control matting. A variety of planting techniques will be used to achieve the desired results of erosion control and soil stability provided by plant roots and aboveground plant mass.

3.6.1.6 Dredging and In-Water Structure Removal

The ROD describes sediment removal and dredging in the slipway area to the extent necessary to install the sediment cap and accommodate barge launching. Soil and/or sediment removal within the slipway down to approximately 0 foot COP (i.e., to the end of the rails) will be needed as described in Section 3.6.1.1.

Based on the initial design components and a detailed 2005 topographic survey of the slipway area (Chase Jones, 2005), it appears that dredging below approximately 5 feet COP may not be necessary; however, bathymetric contours may change before construction of the remedy, and excavation may be necessary to accommodate the low-profile cap. It is anticipated that any sediment that has accumulated in the slipway will be cleared to the top of the existing bents that support the rails. Based on the size of the rail area, it is estimated that a maximum of 200 cubic yards of dredging will be necessary below elevation 5.

The need for dredging at the mouth of the slipway will be evaluated further as part of the final design, including a survey of the separation between the top of existing sediment and the top of the skid ramps just prior to construction of the remedy. To the extent that dredging is necessary, it is likely that the dredged sediment will be dewatered on site before off-site disposal or placed in the interior site area. On-site management of dredged sediment, as described in Section 3.3, is allowed by the ROD and the Consent Judgment.

In-water obstructions include the skid ramps, bents, and their supporting structures. These structures are critical components for continued barge construction and must remain in place. In addition, it is possible that there are eight piles located at the end of the slipway ramp from elevation -8 to -13 feet COP, which are not supporting any structures (see Drawing C0.1). These piles are shown on historical drawings, but their presence has not been verified through surveys. If the piles are still present, they will be removed by cutting them flush with the underlying sediment surface before cap placement.

3.6.1.7 Low-Profile Cap over Sediment

The low-profile cap will be used in the slipway reach where the thicker standard sand cap cannot be placed because of operational requirements for launching barges on the existing skid rail system. The low-profile cap will be placed in the slipway reach from an elevation of approximately 5 feet COP[11] (i.e., at the bottom of the concrete ramp) to an elevation of -22 feet COP. The final design will include details of how the low-profile cap will tie into the concrete slab cap to form a contiguous surface.

The slipway low-profile cap will consist of an RCM, a geotextile cushion layer, and rock armoring. The RCM will serve as the chemical isolation layer of the cap, absorbing contaminants to the extent that they are migrating out of the sediment through groundwater movement. The RCM will contain a blend of two sorptive media: activated carbon (75 percent by volume) for the sorption of organic contaminants, and the mineral apatite (25 percent by volume) for metals sorption. The total media thickness will be a minimum of 1 centimeter. It is anticipated that the RCM will be provided by CETCO, Inc. or an approved equivalent manufacturer. The cushion geotextile layer will consist of 16-ounce, non-woven geotextile with a minimum puncture strength of 250 pounds. The RCM and geotextile will also prevent erosion of underlying contaminated sediments.

Two different types of rock armoring will be used for the low-profile cap. A 12-inch-thick layer of Type C rock armor will be placed in the flat portions of the slipway ramp rail embayment area (see Drawing C2.1). Three feet of Type E rock armor will be placed in the sloped areas. The Type C rock armor will require inspection following each barge launch to verify that there is sufficient material present to protect the RCM.

The RCM and the cushion geotextile will be attached to each other in an upland work area and placed using divers to verify proper overlap of 4 to 8 inches and to verify proper installation such that there are no tears or gouges in the RCM. The

[11] The elevation of the upper end of the low-profile cap will be determined during the final design. At the south side of the slipway, the elevation is dependent on the elevation of the bottom of the existing armor.

RCM will be trimmed to fit around any in-water structures. The divers will temporarily anchor the RCM and geotextile, using helical ground screws or duckbill anchors. The anchoring design will be prepared before the completion of the final design of the remedy. The rock armor will then be placed in a 1- to 3-foot layer. The rock armor and cushion geotextile will serve to protect the RCM from puncture and to prevent the cap from sliding off the slipway ramp or in-water slopes during barge launches.

The rock armor is a necessary part of the design, intended to enhance slope stability over the long term and to prevent catastrophic release of contaminated soils caused by a slope failure. The geotechnical stability modeling demonstrates that a minimum 3-foot-thick layer of rock armor at a maximum slope of 2:1 is required to stabilize the in-water bank slope for the long term (GeoDesign, 2009).

3.6.1.8 Standard Sand Cap over Sediment

A standard sand cap composed of a 2-foot sand layer, 6-inch gravel filter layer, and a 2-foot Type C rock armor layer will be placed below -22 feet COP to the riverward extent of the cap boundary; see Drawings C2.1, C2.2, and C4.0. The rock armor is necessary to protect the cap from tugboat propeller wash during barge launching (GeoDesign, 2009). Additional gravel material will be placed over the Type C rock armor in order to fill the void spaces and minimize the potential for scour of the underlying sand cap.

A 60-foot rock armor extension and transition will be placed on the upstream end of the sand cap to protect the southern edge of the cap from scour. This extension is anticipated to be necessary because of the high water velocities that may occur during flood stages of the river. The extension will reduce the potential for excessive boundary layer turbulence that could occur at the leading edge of the cap, which could be exacerbated by the sudden 4-foot change in surface elevation when compared to a gradual buildup of material.

3.6.1.9 Armored Thin Cap over Sediment

An armored thin cap consisting of a minimum 10-inch-thick layer of sand, a 6-inch layer of filter gravel, and a 2-foot layer of Type C rock armor (GeoDesign, 2009) will be placed east of the standard sand cap offshore of the mouth of the slipway (see Drawings C2.1, C2.2, and C4.0). The armored thin cap provides a physical barrier to low-level concentrations of contaminants in sediment. Armoring is required, since the cap will be located in an area subject to erosive forces of the river and, potentially, by barge launching.

3.6.2 South Bridge Reach

The south bridge reach of the cap extends from station 3+00 to station 7+50 (see Figure 3-2, Drawing C2.0, and the appendix) and is characterized by steeper in-water slopes near shore and a relatively steep bank slope above the OLW.

The south bridge reach design consists of the following components, which are described further in the sections below, shown in profile 4 on Drawing C2.3, and summarized in Table 3-1:

- Bank excavation
- Armor replacement cap on lower bank
- Soil cap on upper bank
- In-water structure removal as necessary for sediment cap placement
- Standard sand cap over sediment

3.6.2.1 Bank Excavation

The part of the bank located above elevation 3 feet COP will be cut to achieve a stable slope of 2:1 and to allow for placement of new rock armor. This is necessary to achieve acceptable geotechnical factors of safety, and to provide a protective cap where the existing condition is not sufficient. The toe of the cut will extend down to elevation 0 foot COP, as shown on Detail 4 of Drawing C2.3. Drawings C3.0 and C3.1 show the slope configuration. Soil and debris will be excavated as described in Section 3.3 and either placed in the uplands area or transported off site for disposal. Ecological hot spots,[12] as previously identified in the ROD, within 5 feet of the final grade will be excavated; Section 3.3 describes excavation and disposal.

City Outfall 6 and a private 6-inch stormwater outfall are located within the existing bank of the south bridge reach (see Drawing C2.0). City Outfall 6 is a brick outfall that was built in 1892 to serve a large upland area west of the Zidell site; however, since completion of the City West Side Interceptor, the outfall drains a much smaller area of and east of SW Moody Avenue. Zidell is working with the City to determine the future of this outfall. The present design shows the depression east of the outfall terminus being filled based on an assumption that the outfall will be abandoned; however, this could change during final design. The design of any modifications required for the private outfall will be completed as part of the final design.

3.6.2.2 Armor Replacement Cap on Lower Bank

Approximately 3 feet of Type E rock armoring will be placed on the lower bank from the toe of the cut slope (elevation 0 foot COP) to an elevation of 15 feet COP.

[12] There are no human health hot spots in the south bridge reach.

The rock armor will be placed on a filter layer consisting of filter gravel and/or filter fabric to prevent erosion of underlying bank soils.

Planting of the armor above approximately elevation 12 is being considered as a potential habitat improvement measure that may be added to the design before the submittal of the permit application package.

3.6.2.3 Soil Cap on Upper Bank

A soil cap will be placed on the upper bank between elevation 15 and the proposed top of bank. The cap will incorporate soil bioengineering techniques of using plantings to provide stability and erosion control. To construct the cap, a 2-foot soil cap underlain by a demarcation layer (e.g., brightly colored geogrid or other geotextile) and overlain by TRM will be keyed into the slope as recommended by the geotechnical engineer. The demarcation layer will be placed on the excavated slope before the lifts of cap soil are placed. The bank will be revegetated as described in Section 4.5. The TRM will provide erosion control until the vegetative layer is established. The TRM contains plastic components that provide more long-term certainty of slope stability during plant establishment than fully biodegradable erosion control matting. A variety of planting techniques will be used to achieve the desired results of erosion control and soil stability provided by plant roots and aboveground plant mass.

3.6.2.4 In-Water Structure Removal

Before capping, in-water obstructions will be removed as necessary for cap installation. The 2007 bathymetric analysis does not show significant obstructions in this area.

3.6.2.5 Standard Sand Cap over Sediment

A standard sand cap will be placed in the water at a 5:1 slope over the existing sediment and will overlap the toe of the rock armor slope (starting at elevation 5 COP); see Drawings C4.0 and C4.1. Erosion resistance will be provided for the sand cap by a 16-inch-thick section of Type B rock armor with a mean grain size of at least 4 inches (GeoDesign, 2009).

The side slope of the river channel is very steep in the south bridge reach and will require additional fill to construct a stable slope of 5:1, which is the maximum slope that can be achieved using in-water placement (GeoDesign, 2009). The standard sand cap will vary in thickness between 2 and 18 feet as a result of the 5:1 slope.

3.6.3 North Bridge Reach

The north bridge reach of the cap extends from station 7+50 to station 11+50 (see Figure 3-2, Drawing C2.0, and the appendix) and is characterized by steeper in-water slopes near shore and a relatively steep bank slope above the OLW line.

The north bridge reach design consists of the following components, which are described further in the sections below, shown on Drawing C2.4, and summarized in Table 3-1:

- Repair of existing bank armor on lower bank
- Bank excavation and soil cap on upper bank
- In-water structure removal as necessary for sediment cap placement
- Sand cap over sediment

3.6.3.1 Repair of Existing Bank Armor on Lower Bank

The existing bank armor within the north bridge reach will be repaired as part of the remedy and will serve as the final bank cap below an elevation of 15 feet COP. The individual locations for armor repair will be at the direction of the geotechnical engineer. In areas where existing bank armoring exists above elevation 15 feet COP, the armor will be removed. The existing bank armor consists of concrete, rock, brick, and ballast stone. Deleterious material (e.g., rebar, wood scrap, wire, rubber) will be removed from the surface of the bank, but in general, the bank will not be overexcavated to remove these materials unless required to complete the selected remedy and to provide stability. Additional Type C or Type D rock armoring will be hand-sized to fit openings, and will be installed in the bank areas where the existing armor is discontinuous or of questionable structural integrity (GeoDesign, 2009). If large pieces of unanticipated debris are encountered, Zidell will consult with the DEQ on the planned management before taking action.

The condition of the bank armor will be assessed by the geotechnical engineer during construction once all vegetation has been removed from the bank. Areas where the existing armor is discontinuous or is of questionable structural integrity will be individually flagged. At each repair area, a skilled contractor will hand-excavate soil and debris to accommodate new filter material and then hand-size Type C or Type D rock armor to cover the area and tie into the existing armor. Additional information on the armor improvement will be developed as part of the final design.

3.6.3.2 Bank Excavation and Soil Cap on Upper Bank

The part of the bank located between elevation 15 and the top of bank will be regraded to achieve a stable slope of 2:1 (GeoDesign, 2009). The elevation of the current top of armor line ranges from 13 to 28 feet COP in the north bridge reach, so a large amount of armoring will be removed in order to stabilize the bank. Soil and debris fill will be excavated as described in Section 3.3 and either placed in the upland area or transported off site for disposal. Before placement of the bank cap, hot spots, as previously identified in the ROD, will be excavated as described in Section 3.3.

The soil cap on the upper bank will incorporate soil bioengineering techniques of using plantings to provide stability and erosion control. To construct the cap, a 2-foot soil cap underlain by a demarcation layer (e.g., brightly colored geogrid or other geotextile) and overlain by TRM will be keyed into the slope as recommended by the geotechnical engineer. The demarcation layer will be placed on the excavated slope before the lifts of cap soil are placed. The bank will be revegetated as described in Section 4.6. The TRM will provide erosion control until the vegetative layer is established. The TRM contains plastic components that provide more long-term certainty of slope stability during vegetation establishment than fully biodegradable erosion control matting. A variety of planting techniques will be used to achieve desired results of erosion control and soil stability provided by plant roots and aboveground plant mass.

3.6.3.3 In-Water Structure Removal

Before capping, in-water obstructions will be removed as necessary for cap installation. The 2007 bathymetric analysis does not show significant obstructions in this area.

3.6.3.4 Standard Sand Cap over Sediment

A standard sand cap will be placed in the water at a 5:1 slope over the existing sediment and will overlap the rock armor slope (starting at elevation 5 COP); see Drawings C4.1 and C4.2. Erosion resistance will be provided for the sand cap in the north bridge reach by a 16-inch-thick section of Type B rock armor (GeoDesign, 2009).

The side slope of the river channel is very steep in the north bridge reach and will require additional fill to construct a stable slope of 5:1, which is assumed to be the maximum slope that can be achieved using in-water placement (GeoDesign, 2009). The standard sand cap will vary in thickness between 2 and 18 feet as a result of the 5:1 slope.

3.6.4 Downstream Reach

The downstream reach extends from station 11+50 to station 28+59 (see Figure 3-2, Drawing C2.0, and the appendix). This reach is characterized by a shallow in-water bench and steep bank slopes of up to 1:1. The in-water bench extends approximately 200 feet from shore and has a relatively flat slope. Existing piles and stringers (beams on top of the piles) associated with a previous dock structure are located between stations 13+00 and 25+00.

The downstream reach cap consists of the following components, which are described further in the sections below, shown in profile 6 of Drawing C2.4 and profile 7of Drawing C2.5, and summarized in Table 3-1:

- Removal of existing in-water and bank structures as necessary for sediment cap placement
- Bank and sediment cap
- Thin cap over sediment

3.6.4.1 Removal of Existing In-Water and Bank Structures

Before capping, in-water obstructions will be removed as necessary for cap installation. Bankline structures associated with the historical dock will also be removed or filled over. While piling removal is not an explicit element of the remedial action, the initial design anticipates cutting the piling off at the ground or sediment surface before placement of the cap. Stringers from the historical dock structure that span the tops of the piling will also be removed as part of the remedy. Based on the 2007 topographic survey, approximately 2,160 piles are located in the downstream reach.

3.6.4.2 Bank and Sediment Cap

Within the downstream reach, there will be a continuous cap consisting of clean fill placed from the top of the bank out to the sediment cap boundary. Before placement of the bank cap, hot spots within 5 feet of the final grade will be excavated as described in Section 3.3.

The fill located between the top of the bank and approximately 10 feet COP will consist of a minimum thickness of 2 feet of clean, imported general fill (loam, sand, or topsoil) placed at a 3:1 slope; see Drawing C2.4, profile 6. At approximately 10 feet COP, the fill will transition to a 5:1 slope to the river bottom. Material placed below elevation 5 feet COP will generally consist of clean dredge sand. The minimum thickness of the sand layer within the chemical isolation cap boundary is 2 feet. Except for the thin cap area, the cap in this reach ranges from 2 to 18 feet thick; see Figure 3-4 and Drawings C4.2 through C4.5. Below the OHW line, a 12-inch-thick layer of Type A subrounded to rounded rock armor will be placed to protect the fill from erosion.

In the northern part of the downstream reach, a riparian terrace has been incorporated into the sediment cap grading at approximately 10 feet COP, in anticipation of a possible requirement for habitat mitigation. The riparian terrace will be approximately 1 acre in size. The incorporation of the riparian terrace into the design is possible because of the relatively shallow existing bathymetry, which reduces the amount of fill necessary to build the feature. It is anticipated that the final design of the riparian terrace will differ from the uniform-grade feature shown in Drawings C4.3 through C4.5. The riparian terrace will be armored with a 12-inch-thick layer of 6-inch-minus subrounded to rounded rock to protect against erosion and will be landscaped as described in Section 4.6.

City Outfall 7b is located near the north end of the sediment cap, north of the Zidell property line (see Figure 1-3 and Drawing C4.5). The outfall discharges stormwater from City and ODOT drainage areas; no drainage enters this system from the Zidell property. The water quality of discharges from this outfall is unknown at this time. The outfall invert is at elevation 4.98 feet COP, which is below the final grade, 10 feet, of the proposed sediment cap. The design for this area of the cap incorporates an armored swale to prevent effluent infiltration and to convey outfall discharge to the edge of the sediment cap (see profile 7, Drawing C4.5.)

3.6.4.3 Thin Cap over Sediment

Two areas of thin cap are included within the downstream reach as shown in Drawings C4.3 and C4.4 and in profile 6 on Drawing C2.4. The thin cap consists of a 6- to 10-inch layer of clean dredge sand. The purpose of the thin cap is to provide a clean substrate that separates benthic organisms from low-level concentrations of contaminants. The thin caps are located in areas of relatively low contamination where there is evidence of deposition documented in the fluvial evaluation (MFA, 2008a).

3.6.5 Avoidance and Minimization of Potentially Adverse Impacts to Habitat Quality

Starting with the remedial design envisioned in the ROD, the design team looked for alternatives or modifications to design features in each reach of the project that would avoid or minimize potentially adverse impacts to habitat quality. Specific modifications incorporated in this design include the following:

- Planting within the Type A bank armor above elevation 10 in the downstream reach. (Planting of Type E rock armor above elevation 12 in the slipway and south bridge reaches is also being considered as a potential habitat improvement measure that may be added to the design before the submittal of the permit application package.)

- Lowering the rock bank armor from the published OHW elevation (18 feet COP) to the apparent high-water elevation (15 feet COP; see Section 4.2) in the slipway and bridge reaches. Areas above the apparent high-water elevation rely on erosion control provided by the use of soil bioengineering techniques that incorporate clean soil reinforced with plantings, and in some locations, with TRM.

- Reducing the size of the sediment cap armoring rock required in the south bridge, north bridge, and downstream reaches from Type C rock armor to Type A or Type B rock armor, recognizing that the sand layer thickness greatly exceeds the 2-foot thickness required for contaminant isolation and that some areas of the cap are being placed in depositional environments.

- Reducing the bank slope to 3:1 in the downstream reach and reducing the in-water slope throughout most of the sediment cap area to 5:1 or flatter.

- Incorporating, if needed for mitigation, a riparian bench in the northern downstream reach in a relatively shallow area, which will allow for the creation of a seasonally inundated riparian environment.

3.7 Engineering and Institutional Controls

The remedy includes engineering and institutional controls that are described in the following sections. Minimal design or planning work relating to these controls has been completed as part of the initial design. Additional design information related to engineering and institutional controls will be developed for the final design and remedy implementation.

3.7.1 Structure Decommissioning

The ROD requires that operational features, including an oily water vault, a dry well, and stormwater lines, be decommissioned as part of the remedial action. The oily water vault and stormwater lines are shown on Figure 1-3. The location of the oily water vault is based on historical drawings; this feature has not been field located and may have previously been decommissioned. No dry wells remain on site. A former dry well located in the interior site area north of the Ross Island Bridge was decommissioned during the RI.

Any historical operational features found in the bank and upland ROD greenway cap areas will be decommissioned as part of the Phase 2 construction work. This will involve breaking, cutting, and dismantling of the structures for removal and off-site disposal and/or decommissioning features in place. Inert material such as concrete may be left on site for use as fill during redevelopment. Monitoring wells will be decommissioned as part of Phase 2, following applicable state law by overdrilling and filling with a bentonite grout. The final design will incorporate additional information on decommissioning procedures.

It is believed that most historical and current operational structures are located south of the Ross Island Bridge and/or within the interior site area, and will not be encountered until operational change or redevelopment occurs (i.e., as part of Phase 3 of the remedy). Decommissioning plans for these items will be completed during subsequent design efforts for Phase 3 of the remedy.

3.7.2 Access Restrictions before Final Remedy Completion

The ROD requires access restrictions, such as fencing, to restrict public access to the site until completion of site capping. Zidell has already implemented access restrictions, including:

- Fencing surrounding the upland area of the site, as shown on Drawing C0.1
- Signage warning of hazardous materials, posted along the Zidell property boundary, including facing the river from the top of bank, as freestanding signs and as signs attached to fencing
- Installation of temporary caps in areas of the site that are leased to third parties and that contain contamination above applicable RBCs
- Retaining the existing asphalt-concrete pavement that covers much of the Zidell Marine Corporation barge construction operational area and the concrete floor slabs of the existing buildings

3.7.3 Deed Restrictions

Deed restrictions, in the form of an easement and equitable servitudes, will be implemented as part of the remedy. The initial form of the easement and equitable servitudes was filed in October 2006, and includes the following use restrictions:

- The use of groundwater for consumption or other beneficial use is prohibited.
- Disturbance of the cap without written approval from the DEQ is prohibited.
- Maintenance of the soil cap in accordance with the Post-Construction Cap Inspection and Maintenance Plan and the SMP is required.
- Use of land to grow food crops of any type is prohibited.
- Use of the property without maintenance of controls is prohibited.
- Notification to the DEQ of property ownership transfers is required.
- Notification to the DEQ before initiating rezoning of the property is required.

If necessary, the language of the easement and equitable servitudes agreement will be updated following implementation of the remedy (i.e., in Phase 2). It must be recited in any property deed; this will provide notification of site hazards to any future property owners.

3.7.4 Soil Management Plan

The SMP will be developed to guide future excavation activities that could potentially encounter impacted soil. The SMP will be submitted as part of the final design (i.e., in Phase 1 of the remedy). The SMP will outline specific requirements for managing soil on site as part of remedy construction and 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 will also be addressed in the plan. The SMP will 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.

3.7.5 Soil Cap Inspection and Maintenance Plan

A Soil Cap Inspection and Maintenance Plan specifying the post construction, long-term inspection, and maintenance requirements for the cap and other engineering controls will be prepared for DEQ review and approval during Phase 2 as part of the project completion report prepared following construction.

3.7.6 Sediment Cap Operations, Maintenance, and Monitoring Plan

A Sediment Cap Operations, Maintenance and Monitoring Plan (OMMP) will be developed during Phase 2 as part of the project completion report prepared following construction. It will specify 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. Bathymetric 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 ten years to monitor the natural recovery of low-level sediment contamination outside the cap boundary and to assess potential releases associated with breaches in the sediment cap discovered during physical inspection. The monitoring program for recovery assessment will be discontinued when residual contaminant levels outside the cap area meet the cleanup levels specified in Table 4-2 of the ROD or ambient levels upstream of the site.

3.7.7 Other In-Water Institutional Controls

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, as well as postings in all marinas, to inform watercraft in the area. In addition, the perimeter may be marked with buoys and signs to minimize the likelihood of recreational boaters traversing the area.

The State of Oregon owns the river bottom where the sediment cap would be placed. Zidell has initiated discussions with DSL to facilitate remedy implementation. Use restrictions, including limitations on in-water development, may be placed on the sediment cap area. Potential use restrictions will be assessed further as part of the final design, with the goal of minimizing disturbance of the cap. Placement of the cap, use restrictions, and other in-water institutional controls will require coordination and/or approval by DSL and the Oregon State Marine Board. Zidell has initiated discussions with DSL regarding these issues. As part of the Phase 1 final design, Zidell will work with the Coast Guard, DSL, and the Oregon State Marine Board to refine the implementation of in-water institutional controls.

4 REMEDIAL DESIGN COMPONENTS

4.1 Surveying and Base Map Development

MFA has combined topographic surveys from Olson Engineering, Inc. (2007b), and bathymetry mapping from Solmar Hydro (2007) and Olson Engineering, Inc. (2007a), to construct a master base map of the site. The master base map includes topography and bathymetry for the areas immediately surrounding the site, which were compiled from the sources above as well as from topography from Metro Data Resource Center (Metro, 2001), as-built survey data for the south waterfront central district (OTAK, 2007), and bathymetry data from the Lower Willamette Group (LWG, 2004). All surveys included in the master base map are referenced to the COP.[13]

The base map is being used in both Geographic Information Systems (GIS) and AutoCAD Civil 3D software formats as a basis for all design work. Drawing C0.1 shows the existing topography and bathymetry from the master base map.

4.1.1 Piling Survey

The Olson Engineering, Inc. survey completed in April 2007 included a survey of piling (see Drawing C0.1). Olson surveyed 2,160 piles, with elevations ranging from approximately 4 to 30 feet COP. Most of the piles are located in the downstream reach where a dock formerly occupied approximately 1,430 lineal feet of the site. The dock was built in 1942 and was destroyed by fires in 1957 and 1983. Some stringers are still located on top of the former dock piles. The elevations of the top of the piles and the top of the stringers in the former dock area range from 6.66 to 11.7 feet COP.

4.1.2 High-Resolution Multibeam Sonar Bathymetric Survey

In December 2007, Solmar Hydro, Inc. completed a high-resolution, multibeam bathymetric sonar survey of the river along the site. Solmar Hydro generated a digital terrain model and image of the multibeam data at 1-meter pixel resolution, which MFA has incorporated into Figure 2-2. The image is color-coded by depth and was artificially illuminated, using a hillshade effect. The color-coded pixels in the imagery demonstrate the extent of coverage over the survey area and present a detailed image of the high-resolution multibeam bathymetric data. The resolution of the image is such that debris larger than 1 meter should be visible in the graphic. Based on the image, no subsurface features, other than the City Water Bureau water line, were

[13] Elevation 0.0 COP is elevation -1.375 NGVD.

identified at the site. The final bathymetric data set was also exported as an ASCII point file, containing XYZ locations on a 1-meter grid, and as a 1-foot contour AutoCAD format drawing.

It should be noted that the multibeam sonar survey by Solmar Hydro was unable to cover much of the shallow bench located near shore in the downstream reach because of shallow water and obstructions related to the former dock structure (see Figure 2-2); however, much of this area has been surveyed by Olson Engineering.

4.1.3 In-Water Presurvey of Utilities

MFA requested a presurvey of all in-water utilities from the Oregon Utility Notification Center and received responses from the City Water Bureau, Bureau of Environmental Services (storm and sanitary sewer), and Signals and Street Lighting; AT&T/TCG; and Portland General Electric. The only currently identified utility line potentially impacted by the proposed in-water activities at the site is a water line on the river bottom with a 20-foot easement that crosses the river near the Marquam Bridge in the northern portion of the sediment cap area (see Figure 1-3 and Drawing C0.1). This line can also be observed on the Solmar Hydro bathymetry survey (see Figure 2-2). As part of the final design, the City Water Bureau will be contacted to coordinate construction work over its water line.

4.2 Ordinary High Water

This initial remedial design report and the attached plans use 18 feet COP for the OHW elevation. The COE has published tabulated OHW elevations, which at the Zidell site correspond to elevation 18 COP (COE, 2004). COE personnel have told Zidell that the 18-foot COP elevation is used as the OHW elevation for the COE Section 10 Permit for work in navigable waters, but the OHW elevation that is used in the COE Section 404 Permit for discharge of dredge or fill material into water is established based on field indicators of seasonally high river levels. The field indicators include observations of visible changes in soil, vegetation, and other physical conditions. The 2004 riverbank characterization report for Zidell (MFA, 2004a) identified OHW based on field indications to be at approximately 13 feet COP. DSL has indicated to Zidell that they consider elevation 17.2 feet National Geodetic Vertical Datum of 1929 (NGVD 29 (18.6 feet COP) to be the elevation of OHW.

Based on a review of the Willamette River gauge at the Morrison Bridge, a recurring maximum daily river stage elevation of 13 to 15 feet COP is observed on an annual basis (see Figure 4-1 and Table 4-1). Considering the field observations of OHW and the maximum daily river stage, this design includes rock armoring of the bank up to a maximum elevation of 15 feet COP, with alternate soil bioengineering techniques utilized above elevation 15 feet COP in some areas of the site.

4.3 Bank Cap Design

4.3.1 Bank Armor Delineation

Much of the existing bank armoring, consisting of construction debris, ballast rock from ship dismantling activities, paving stones, and other material, is similar aesthetically and functionally to designed and constructed riprap (MFA, 2004a). As part of the remedial design, it was necessary to map the top and bottom extents of the existing bank armoring, which will function as a portion of the bank cap in the slipway and north bridge reaches (see Figure 2-3).

Because of the nature of the bank fill history, the limits of the top and bottom of the armor are very apparent and abrupt in some locations, while in others the armor density diminishes less dramatically (see the appendix for bank photographs). Professional judgment was required to estimate the armor limits, with engineering and bank stability issues in mind. The bank armor delineation was completed by MFA civil engineers and GeoDesign, Inc. geotechnical engineers through an iterative process, beginning with spray painting temporary markers at the top of the existing armor. The bottom of the existing armor was also marked where accessible, which was only within the downstream reach. These points were then surveyed by Olson Engineering, Inc.

A determination was then made that further refinement of the armor limits would be useful. The engineering team returned to the bank with the Olson Engineering survey crew and surveyed points over a two-day period with transects located as close as practicable, considering access/safety issues and topographic variations. A total of 64 top-of-armor points were located in this manner. Much of the bottom of armor, including in the slipway and bridge reaches, was below water, so fewer bottom-of-armor points (42) were surveyed. The surveyed points were used by MFA to create lines representing the locations of top and bottom of existing armor (see Figure 2-3).

The bank armor delineation was augmented with high-definition photography of the bank taken from a small tugboat traveling parallel to the bank (see Appendix A). This produced a continuous, panoramic, high-definition photographic representation of the bank, with the temporary armor limit markings visible. Using these surveyed markings, the photographs were then "wrapped" onto the bank topography as a reference to further assist in delineating the bank armor.

4.3.2 Geotechnical Investigation of Bank

In order to address DEQ comments regarding the methodology used in the geotechnical model of the debris fill layer for slope stability analysis, GeoDesign completed explorations along the bank armor adjacent to the Willamette River. Ten exploratory borings were advanced to depths of 47 to 57 feet bgs between January 19 and 21, 2009 (GeoDesign, 2009). Boring locations are shown on Figure 4-2.

Results have been incorporated into the slope stability analyses and the liquefaction and lateral spread analyses completed by GeoDesign and discussed in general in Section 4.3.3.

4.3.3 Slope Stability Design

The geotechnical evaluation (GeoDesign, 2009) included an analysis of existing and proposed bank slopes and alternatives for protection of the bank. Specifically, GeoDesign evaluated the stability of the proposed slope configurations under seismic and static loading, as well as the potential for liquefaction and liquefaction-induced lateral spreading. The results of the stability analyses indicate that slope configurations described in Section 3.6 are stable under both static and seismic conditions (GeoDesign, 2009). Additional information on relevant evaluations for each reach is summarized below. The seismic analysis uses a design-level event with a 10 percent chance of an exceedance in 50 years or a return interval of approximately 500 years. The maximum accelerations considered are typical for a near source magnitude 6.0 crustal earthquake. The minimum factor of safety targeted for long-term slope stability at the site is 1.5 for static conditions and 1.1 for seismic conditions.

Slipway Reach

The analyses showed that the existing slope near Station 250 in the slipway reach[14] is marginally stable and could fail during a design-level seismic event. To correct the situation, the geotechnical analyses reviewed several bank scenarios in the slipway area. The design selected for the slipway requires constructing a 2:1 in-water slope or rock armoring (to protect the low-profile cap), which continues up to elevation 12. At elevation 12 feet COP, the bank slope transitions to 3:1. Above 12 feet COP, the bank is capped with either 2 feet of Type D rock armor or 2 feet of soil. This configuration, as described in Section 3.6.1 and Table 3-1 and shown on Drawing C2.3, will result in a static slope stability factor of safety of 1.47 and a seismic slope stability factor of safety of 1.12, which is a significant improvement over the existing conditions.

An alternate slope configuration that had a 3:1 slope starting at elevation 3 feet resulted in a static slope stability factor of safety of 1.52. Only a minor increase in safety results from the change in configuration; however, excavation of a significant (nearly double) amount of additional soil would be required with this alternate configuration. In addition, the alternate slope configuration could impact a portion of the foundation of the existing barge building. The multi-slope configuration is preferred over the alternate 3:1 slope configuration because it meets the safety factor requirement (with rounding) and because it reduces the amount of excavated soil that must be managed on or off site.

[14] The geotechnical evaluation used different stationing than that used in this initial design report. Station 250 in the initial design report is referenced as Station 300 in the geotechnical report; similar stationing offsets occur for the remainder of the sections.

South Bridge Reach

The geotechnical analyses indicated that modifying the slope in the south bridge reach such that a 2:1 cut slope begins at OLW (elevation 3) with in-water fill (sediment cap) at the bottom of the cut slope will result in suitable factors of safety for slope stability and improved stability over the existing conditions.

The slope configuration described in Section 3.6.2 and Table 3-1 and shown on Drawing C2.3 is consistent with GeoDesign's recommendations and results in a static slope stability factor of safety of 1.51 and a seismic slope stability factor of safety of 1.24.

North Bridge Reach

The geotechnical analyses indicated that modifying the slopes in the north bridge reach such that a 2:1 slope is cut above the top of the existing rubble armoring with in-water fill (sediment cap) at the bottom of the existing rubble armoring will result in suitable factors of safety for slope stability and improved stability over the existing conditions.

The slope configuration described in Section 3.6.3 and Table 3-1 and shown on Drawing C2.4 is consistent with GeoDesign's recommendations and results in a static slope stability factor of safety of 1.51 and a seismic slope stability factor of safety of 1.20.

Downstream Reach

Results of the geotechnical analyses indicated that the 3:1 filled slope proposed in the downstream reach over the existing riverbank and sediment results in a significant improvement to the existing riverbank slope stability.

The slope configuration described in Section 3.6.4 and Table 3-1 and shown on Drawings C2.4 and C2.5 is consistent with GeoDesign's recommendations and results in a static slope stability factor of safety of 1.61 and a seismic slope stability factor of safety of 1.14.

4.3.4 Riverbank Protection Design

The geotechnical evaluation (GeoDesign, 2009) evaluated riverbank cap protection measures (e.g., armoring) from erosive forces caused by waves, river flow velocities, and propeller wash. The evaluation recommended that the riverbanks be protected from waves by 1) repairing the existing rubble armoring (in the slipway and north bridge reaches), 2) placing a minimum of 24 to 36 inches of Type E rock armor (in the slipway and south bridge reaches), or 3) placing turf reinforcement matting on the slope.

GeoDesign initially recommended a minimum of Type C rock armoring for all sediment cap surfaces to protect the sand cap from erosion. However, GeoDesign modified their recommendation for this design in the South Bridge Reach, North Bridge Reach, and Downstream Reach because the cap is considerably thicker than the minimum of 2 feet required for chemical isolation. A significant amount of erosion would be necessary to compromise the cap to the point where it would no longer isolate contaminants. Additionally, GeoDesign acknowledged that a lower level of protection against propeller-wash-induced erosion may be acceptable for fill slopes in the downstream reach because the area is to be heavily vegetated, providing additional erosion resistance.

For areas near the main channel of the river (i.e. the north and south bridge reaches), GeoDesign recommended a well graded, 8-inch-minus, angular to subangular rock with a minimum thickness of 16 inches (i.e. Type B rock armor). For the downstream reach, GeoDesign recommended an 8-inch-minus, subrounded to rounded (e.g., alluvial) rock with a minimum thickness of 16 inches. Provided that a small amount of erosion from propeller wash is allowable, a 12-inch-thick layer of 6-inch-minus rock (i.e. Type A rock armor) may be used in place of the 8-inch-minus rock. Given that the thickness of the cap in the downstream reach is generally much more than 2 feet, that it is understood that this area is generally depositional in nature, and that the likelihood of pleasure craft operating over the riparian planting area is small because of the submerged vegetation and potential use restrictions, it is assumed that a small amount of uncertainty with regard to erosion is tolerable, and therefore the 6-inch-minus rock will be used.

4.4 Sediment Cap Design

4.4.1 Sediment, Pore Water, and Surface Water Sampling

MFA completed supplemental sediment sampling in 2007 to gather additional data to delineate the boundary of the sediment cap (MFA, 2007d). Thirty-nine sediment samples (WRS-55 to WRS-93) were collected along the length of the Zidell waterfront property between the riverbank and approximately 300 feet riverward of the bank, using a boat-mounted grab sampler (Ponar). Results of the sampling were incorporated into the sediment cap boundary determination described in Section 4.4.2. Information on sediment chemistry and toxicity is summarized in Section 2.6.

Sediment, pore water, and surface water were sampled in 2008 (WRS-94 to WRS-97) to calculate site-specific partitioning coefficients, which describe a chemical's tendency to partition between organic carbon in sediment and the interstitial pore water (MFA, 2009c). The partitioning coefficients that were calculated were then incorporated into the sediment cap chemical isolation layer model described in Section 4.4.6.

4.4.2 Sediment Cap Boundary Determination

The spatial dimensions of the sediment cap (i.e., the chemical isolation cap) were selected because the cap configuration met RAOs and optimized risk reduction, as described in greater detail below. The Sediment Cap Boundary Report (MFA, 2009b) provides a detailed description of how the sediment cap boundary was selected. Three technical meetings were held with the DEQ and representatives of Zidell to select the final cap boundary. Zidell and the DEQ agreed at the first meeting that reduction of the risks that PCBs in sediment may pose to human health and the environment is a primary objective of the cap. However, it is necessary that the cap adequately address risk from other COCs.

During the meetings, Zidell and the DEQ reviewed data and evaluations of ambient PCB concentrations, mean probable effects concentration quotients, sediment cleanup levels, sediment toxicity test results, habitat quality, and cap engineering constraints. For each of the meetings, MFA prepared evaluations of how different capping scenarios reduce site-wide PCB concentrations in sediment.

After an extensive and careful evaluation of the information, the boundary of the sediment cap shown on Figure 3-2 was selected by the DEQ. The selected sediment cap boundary lies between the maximum and minimum sediment management area (SMA) boundaries described in the ROD and provides the following attributes:

- The cap covers almost all sediment in the DEQ SMA[15] where concentrations of COCs are above ROD cleanup levels.
- The cap covers almost all sediment in the DEQ SMA where mean probable effects concentrations are above threshold effect levels.
- The cap covers all sediment in the DEQ SMA where bioassay results were classified as toxic to benthic organisms.
- Following completion of the cap, average PCB concentrations, inside and outside the DEQ SMA, will be within the range of ambient levels (10 to 20 micrograms per kilogram).
- The cap reduces exposed average PCB concentrations by more than 90 percent over existing conditions in the vicinity of the DEQ SMA.
- The cap will provide areas of shallow water habitat with uncontaminated sediment.

4.4.3 Geotechnical Investigation of Sediment

GeoDesign investigated subsurface sediment conditions in the Willamette River by advancing eight in-water borings (B-l through B-8) to depths of 14.0 to 3l .5 feet bgs on December 10 through 13, 2007, and performing 12 vibracore borings (VC-l

[15] The DEQ SMA was identified in the ROD as the maximum extent of capping, with the understanding that the final remedy might cover a smaller area.

through VC-l2) to depths of approximately 8 feet bgs on December 5 and 7, 2007 (GeoDesign, 2009) (see Figure 4-2). The purpose of these explorations was to obtain physical properties for use in the sediment cap chemical isolation modeling effort, and to obtain engineering strength and consolidation parameters for design of the cap. Samples were tested for percent fines, grain-size distribution, and flexible-wall permeability (for estimates of hydraulic conductivity, which were used in the chemical isolation layer model).

GeoDesign also prepared estimates of the maximum consolidation settlement of the native sediments resulting from the cap and armor fill (GeoDesign, 2009). This information was incorporated into the sediment cap chemical isolation layer model that is described in Section 4.4.6.

4.4.4 Sediment Cap Armor Design

The geotechnical evaluation (GeoDesign, 2009) evaluated sediment cap protection measures (e.g., armoring) from erosive forces caused by waves, river flow velocities, and propeller wash.

Slipway Reach

GeoDesign recommended articulated concrete block mats or Type C, D, and E rock armoring in the slipway reach because of the potential for erosion from the propeller wash of the tugboats and barge launching disturbance. The proposed rock armor for the slipway reach, as described in Section 3.6.1 and Table 3-2 and shown on Figure 3-3, is consistent with GeoDesign's recommendations. As part of the final design, additional evaluation of the barge launch forces will be completed.

Bridge Reaches

GeoDesign recommended that the sediment cap armoring in the bridge reaches consist of angular, well-graded, 8-inch-minus rock with a mean grain size of at least 4 inches (GeoDesign, 2009). The proposed sediment cap armor for the bridge reaches as described in Sections 3.6.2 and 3.6.3 and Figure 3-3 is consistent with GeoDesign's recommendations.

Downstream Reach

For areas in the downstream reach, GeoDesign recommended 8-inch-minus rock between an elevation of 18 feet COP and an elevation of -5 feet COP. GeoDesign recommended 6-inch-minus rock below -5 feet COP. GeoDesign indicated that subrounded to rounded (e.g., alluvial) rock may be used. The 8-inch-minus rock should have a minimum thickness of 16 inches and the 6-inch-minus rock should have a minimum thickness of 12 inches. Because the thickness of the cap over the sediment in the downstream reach is generally much more than 2 feet at elevations above -5 feet COP, it is assumed that a small amount of uncertainty regarding the potential for erosion is tolerable and thus 6-inch-minus rock will be adequate up to elevation 18 feet COP. As described in Section 3.6.4, 6-inch-minus rock is proposed for the downstream reach in all areas below elevation 18 feet COP (see Figure 3-3).

4.4.5 Groundwater Seepage Rate

MFA estimated the site-specific groundwater seepage velocity in an attachment to the chemical isolation layer model report (MFA, 2009e). The seepage velocity is one of the critical input parameters of the chemical isolation layer model in determining the required sediment cap thickness. The sensitivity analysis of the chemical isolation layer model shows that seepage velocity has a significant effect on the predicted contaminant breakthrough times (i.e., length of time predicted by the model for a specific contaminant to be transported from the underlying sediment to the surface of the sand cap via groundwater discharge). The seepage rates were estimated using the hydraulic gradients between upland wells and the Willamette River, taking seasonal variation into account. Seepage velocity was calculated using hydraulic conductivity values from tests on sediment core samples collected offshore of Zidell. The calculated velocities ranged between 0.043 and 0.13 centimeters per day with a weighted average of 0.065 centimeters per day. Several other methods of calculating seepage velocity for the site were presented as verification of the estimated seepage value.

4.4.6 Sediment Cap Chemical Isolation Layer Design

The Sediment Cap Chemical Isolation Layer Model Report provides a detailed description of the cap chemical isolation layer design (MFA, 2009e). To complete the design, MFA used a numerical model to predict sediment contaminant transport through the cap. Dr. Danny Reible and Mr. David Lampert of the University of Texas at Austin developed the model for the site. The model predicts the amount of time it will take for contaminants to move through a 2-foot sand cap to a point of compliance (i.e., the top of the sand cap) at a ROD-based performance criteria concentration. The results of the model indicate that concentrations of sediment COCs will not exceed cleanup levels[16] at the top of a 2-foot sand cap within 1,000 years of placing the sand cap. It is important to note that for much of the total cap area, actual thickness ranges between 6 and 18 feet, much more than the 2-foot cap that was modeled (see Figure 3-4).

The low-profile cap in the slipway will be permeable to groundwater but will isolate contaminants by sorbing them using a custom mixture of treatment media contained in a geotextile RCM. Activated carbon (75 percent) will be used to adsorb organic compounds and tributyltin, and the mineral apatite (25 percent) will be used for the adsorption of metals. Modeling of slipway COCs through the 1-centimeter-thick RCM was completed with the same numerical model described above. Modeling of the low-profile RCM cap predicts breakthrough for most COCs in excess of 1,000

[16] For the purposes of the modeling, sediment cleanup levels were converted to pore water concentrations using partitioning coefficients.

years. However, tributyltin is predicted to break through after approximately 200 years, and breakthrough of copper is predicted after approximately 700 years. The design life of the materials in the low-profile cap is at least 200 years.

4.5 Hot Spot Excavation Modeling

As part of the FS, Environmental Visualization System (EVS) visualization software (C Tech, 2001) was used to model the total volume of soil exceeding the site hot spot criteria for each COC, based on data from the RI. Hot spot volumes were documented in the ROD and are represented on Figure 2-4. For the initial remedial design, EVS (C Tech, 2009), Civil 3D, and GIS software were used to develop a model of hot spots requiring excavation (i.e., those hot spots located within 5 feet of the final grade in the ROD greenway area and all hot spots within 5 feet of current grade in the interior site area). The modeled extent of hot spots was then expanded slightly into shapes that can be readily staked by a contractor for excavation (e.g., shapes with fewer vertices and with vertical side walls). Excavation volumes are summarized in Section 3.3.4.

4.6 Landscaping Plan

The recommended planting plan consists of native plant communities, with a plant list based on recommendations of the South Waterfront Greenway Development Plan, Design Component—Phase I, Appendix F, December 8, 2004 (City Bureau of Parks and Recreation). The planting plan was developed through consideration of plant location in relation to river water depth, depth of the fill (i.e., cap) material, and steepness of slope. Trees and large shrubs are located where there is at least 6 feet of fill to support the plant without compromising the integrity of the cap if the tree later topples. The proposed soil bioengineering planting techniques, in conjunction with the engineered bank armoring, will protect against bank erosion and provide additional bank stability. The plant material additionally will provide fish and wildlife habitat and a variety of ecological functions. Habitat diversity and complexity will be greatly increased compared to the existing condition. Where slopes are steeper than 3:1 (generally the slopes cut at 2:1), the plants will be limited to grasses, herbaceous material, and smaller shrubs.

As part of the final design, a planting medium appropriate for each particular elevation relative to the OHW and OLW elevations will be developed consistent with applicable City Greenway objectives. The planting medium specified may include compost-amended soil. Below the OHW elevation, the fill material will be covered with either a TRM or a 12- to 16-inch rock armoring layer. Plants will be planted into the underlying fill through TRM or the rock armoring layer, depending on the class or type of rock armor used.

The recommended plants are listed below according to their planting groups. The planting plan is shown in Drawings L1.0 through L1.6. Although not shown on the current plan set, planting of Type E armor above elevation 12 in the slipway and south bridge reaches is being considered as a potential habitat improvement measure that may be added to the design before the submittal of the permit application package. Several plants overlap from one group to another to reflect the natural transitioning in the riparian environment.

SCIENTIFIC NAME	COMMON NAME
Wetland Grasses	
Carex aperta	Columbian sedge
Carex obnupta	Sough sedge
Eragrostis hypnoides	Creeping lovegrass
Glyceria occidentalis	Western mannagrass
Grindelia integrifolia	Willamette Valley gumweed
Sagittaria latifolia	Broadleaf arrowhead
Scripus microcarpus	Small-fruited bullrush
Riparian Shrubs and Grasses	
Aster subspicatus	Douglas aster
Carex aperta	Slough sedge
Carex obnupta	Sough sedge
Glyceria occidentalis	Western mannagrass
Grindelia integrifolia	Willamette Valley gumweed
Scripus microcarpus	Small-fruited bullrush
Salix fluviatilis	Columbia River willow
Salix lasiandra	Pacific willow
Salix piperi (hookeriana)	Piper's (Hooker) willow
Salix sitchensis	Sitka willow
Riparian Trees, Shrubs, and Grasses	
Carex obnupta	Sough sedge
Deschampsia cespitosa	Turfed hairgrass
Elymus glaucus	Blue wildrye
Glyceria ssp.	Mannagrass
Hordeum brachyantherum	Meadow barley
Juncus ensifolius	Dagger-leaf rush
Leersia oryzoiders	Rice cutgrass
Cornus sericea spp sericea	Red-osier dogwood
Crataegus douglasii	Black hawthorn
Physocarpus capitatus	Pacific ninebark
Rosa nutkana	Nootka rose
Rosa pisocarpa	Pea-fruit rose
Rubus spectablis	Salmonberry
Salix fluviatilis	Columbia River willow
Salix sitchensis	Sitka willow
Spiraea douglasii	Douglas spirea
Symphoricarpos albus	Common snowberry
Alnus rubra	Red alder
Fraxinus latifolia	Oregon ash
Populus balsamifera var. Trichocarpa	Black cottonwood
Salix lasiandra	Pacific willow
Midslope Herbaceous Plants	
Carex obnupta	Sough sedge
Deschampsia cespitosa	Turfed hairgrass
Elymus glaucus	Blue wildrye

SCIENTIFIC NAME	COMMON NAME
Geum macrophyllum	Avens
Glyceria ssp.	Mannagrass
Hordeum brachyantherum	Meadow barley
Juncus ensifolius	Dagger-leaf rush
Leersia oryzoiders	Rice cutgrass
Lotus purshiana	Spanish clover
Oregon Oak Community	
Achillea millefollium	Yarrow
Aster subspicatus	Douglas's aster
Bromus carinatus	California brome
Bromus sitchensis	Alaska brome
Deschampia cespitosa	Turfed hairgrass
Eriophyllum lanatum	Wooly sunflower
Elymus glaucus	Blue wildrye
Festuca idahoensis	Idaho fescue
Lotus purshiana	Spanish clover
Poa secunda	Pine bluegrass
Amelanchier alnifolia	Western serviceberry
Corylus cornuta	Hazelnut
Holodiscus discolor	Ocean spray
Mahonia aquifolium	Tall oregongrape
Symphoricarpos albus	Common snowberry
Symphoricarpos mollis	Trailing snowberry
Acer macrophyllum	Big-leaf maple
Prunus emarginata	Bitter cherry
Quercus garryana	Oregon white oak
Maple-Douglas Fir-Cedar Community	
Bromus carinatus	California brome
Bromus sitchensis	Alaska brome
Danthonia californica	California oatgrass
Elymus glaucus	Blue wildrye
Elymus trachycaulus	Slender wheatgrass
Gilia capitata	Bluefield gilia
Hordeum brachyantherum	Meadow barley
Lotus purshiana	Spanish clover
Amelanchier alnifolia	Western serviceberry
Gaulteria shallon	Salal
Mahonia aquifolium	Tall oregongrape
Mahonia nervosa	Dull oregongrape
Philadepphus lewisii	Mock orange
Polystichum munitum	Sword fern
Symphoricarpos albus	Common snowberry
Spiraea douglasii	Douglas spirea
Acer macrophyllum	Big-leaf maple
Arbutus menziesii	Pacific madrone
Prunus emarginata	Bitter cherry
Pseudotsuga menziesii	Douglas fir
Rhamnus purshiana	Cascara
Thuja plicata	Western red cedar
Lower Midslope Shrubs and Herbs (2:1 slopes)	
Bromus carinaus	California brome

SCIENTIFIC NAME	COMMON NAME
Deschampsia cespitosa	Turfed hairgrass
Elymus glaucus	Blue wildrye
Danthonia californica	California oatgrass
Hordeum brachyantherum	Meadow barley
Juncus ensifolius	Dagger-leaf rush
Leersia Oryzoiders	Rice cutgrass
Cornus sericea spp sericea	Red-osier dogwood
Rosa nutkana	Nootka rose
Rubus spectablis	Salmonberry
Salix ccouleriana	Scouler willow
Symphoricarpos albus	Common snowberry
Upper Midslope Shrubs and Herbs (2:1 Slopes)	
Achillea millefollium	Yarrow
Aster subspicatus	Douglas's aster
Bromus carinatus	California brome
Bromus sitchensis	Alaska brome
Deschampia cespitosa	Turfed hairgrass
Eriophyllum lanatum	Wooly sunflower
Elymus glaucus	Blue wildrye
Festuca idahoensis	Idaho fescue
Hordeum brachyantherum	Meadow barley
Lotus purshiana	Spanish clover
Poa secunda	Pine bluegrass
Gaultheria shallon	Salal
Mahonia nervosa	Dull oregongrape
Polystichum munitum	Word fern
Rosa nutkana	Nootka rose
Symphoricarpos albus	Common snowberry
Symphoricarpos mollis	Trailing snowberry
Spiraea douglasii	Douglas spirea
Upper-Slope Shrubs and Herbs	
Achillea millefollium	Yarrow
Aster subspicatus	Douglas's aster
Bromus carinatus	California brome
Bromus sitchensis	Alaska brome
Deschampia cespitosa	Turfed hairgrass
Eriophyllum lanatum	Wooly sunflower
Elymus glaucus	Blue wildrye
Festuca idahoensis	Idaho fescue
Hordeum brachyantherum	Meadow barley
Lotus purshiana	Spanish clover
Poa secunda	Pine bluegrass
Amelanchier alnifolia	Western serviceberry
Corylus cornuta	Hazelnut
Gaulteria shallon	Salal
Mahonia aquifolium	Tall oregongrape
Mahonia nervosa	Dull oregongrape
Philadepphus lewisii	Mock orange
Polystichum munitum	Word fern
Ribes sanguineum	Red-flowering currant
Rosa nutkana	Nootka rose
Symphoricarpos albus	Common snowberry

SCIENTIFIC NAME	COMMON NAME
Symphoricarpos mollis	Trailing snowberry
Spiraea douglasii	Douglas spirea
Drought-Tolerant Meadow Mix	
Achillea millefollium	Yarrow
Agrostis exarata	Spike bentgrass
Ascelpias speciosa	Showy milkweed
Aster subspicatus	Douglas's aster
Bromus carinatus	California brome
Bromus sitchensis	Alaska brome
Danthonia californica	California oatgrass
Deschampia cespitosa	Turfed hairgrass
Eriophyllum lanatum	Wooly sunflower
Elymus glaucus	Blue wildrye
Festuca idahoensis	Idaho fescue
Gilia capitata	Bluefield gilia
Lotus purshiana	Spanish clover
Poa secunda	Pine bluegrass

4.7 Hydrodynamic Analysis

As required by City code 24.50.060, Zidell is performing a floodway hydraulic analysis using the COE HEC-RAS hydraulic modeling software (v4.0) to determine whether the proposed site modifications will impact the 100-year floodway water surface elevations in the Willamette River. The HEC-RAS model includes the conceptual mitigation riparian terrace feature in the downstream reach as a "worst case" for the modeling, even though inclusion of this feature in the final design depends on the as-yet unknown need for project mitigation for potential adverse environmental impacts. Preliminary model runs based on the current design show a reported slight rise (i.e., 0.02 feet or less) in the water surface elevations for the 100-year flood event following the proposed site modifications. It should be noted that it is likely that the accuracy of the model being used is less than the reported slight rise resulting from the preliminary model runs (i.e., model accuracy is likely closer to 0.1 foot than 0.01 foot). In fact, the floodway values for the Willamette River that are published by FEMA are presented to only the nearest tenth of a foot (0.1 foot). In addition, the ROD (page 5-10) indicates that "Some minor elevation rise may be acceptable if the environmental benefit is substantial."

Zidell will finalize the hydraulic analysis as part of the final design. If modeling based on the final design does, in fact, indicate a slight rise in the 100-year flood elevation, Zidell will work to resolve the issue, either by making design revisions to reduce the modeled water surface elevations, or by working with the City through its variance process and, if necessary, pursuing a letter-of-map-revision through FEMA.

4.8 Construction Methods

The construction methods being considered for the site are described below. Construction techniques for work performed above the OHW line will differ considerably from those used for work below it. The construction methods are generally discussed by construction stage: site preparation, construction above the OHW line, construction below the OHW line, and planting.

It should be noted here that implementation of this remedial action could be done as two separate projects: an upland project (inland of top-of-bank), and an in-water project (below top-of-bank).

4.8.1 Site Preparation and Erosion Control

Site preparation will begin before the start of earth-moving activities. Generally, site preparation will include the installation of turbidity and erosion controls consistent with the best management practices (BMPs) described in the City Erosion Control Manual (City, 2008) and with the requirements of the DEQ 1200C NPDES permit for construction activities, which will be obtained before the start of construction. Turbidity and erosion control plans and details are shown on Drawings C1.0 and C1.1, respectively.

4.8.1.1 Perimeter Sediment Control BMPs

Perimeter sediment control BMPs will prevent sediment from entering roadways, adjacent properties, and the Willamette River. Perimeter sediment controls that may be used at the site include silt fencing and straw bales.

Silt fencing will be placed along the property line and/or the limits of construction for work completed in the upland areas.

If bank-related earthwork is to occur outside of the in-water work window (the work window is between July 1 and October 31), straw bales will be placed along the riverbank at about elevation 19, just above the OHW line. The straw bales will provide turbidity control of runoff from storm events and will provide a visual boundary to limit work above the OHW line. Straw bales are not a perimeter sediment control described in the City erosion control manual, but were selected as the most appropriate perimeter sediment control for placement on the steep bank slopes, which are constructed of debris fill. Straw bales would have an added benefit of providing a barrier that can better contain loose soils and prevent them from eroding into the Willamette River. Note that in-water turbidity controls (i.e., turbidity control devices described in Section 4.8.1.4) will be used for bank earthwork completed below the OHW line and for work completed above the OHW line during the in-water work window.

4.8.1.2 Erosion Prevention BMPs

Earthwork that occurs within the City's wet season work timeframe (October 1 through April 30) will be covered by erosion control blankets or plastic sheeting during periods of extended rain, or if the area is to be left exposed for more than two days. Erosion control blankets and plastic sheeting BMPs are described in detail in Sections 4.5.4 and 4.5.5 of the City's erosion control manual.

4.8.1.3 Site Entry BMPs

Construction access to the site will be directly from Moody Avenue. In order to prevent the tracking of mud, dirt, rocks, etc., onto the public right-of-way, a rock construction entrance will be built. The construction entrance will consist of a 12-inch layer of quarry spalls placed on a separation geotextile fabric. The rock will extend 50 feet from Moody Avenue and will be operated consistent with the City's erosion control manual (City, 2008).

To further prevent the spread of potentially contaminated materials onto the public right-of-way, the remedial design will require the construction and regular use of a truck tire wash. The tire wash will be located immediately behind the rock entrance and all trucks leaving the site will be required to use it. The tire wash will incorporate the recommendations in the City's erosion control manual.

4.8.1.4 In-Water Turbidity Control

As part of the final design, Zidell will develop a turbidity management plan for work completed below the OHW line and during the in-water work window. Part of the turbidity management plan may include the use of floating turbidity control curtains around the in-water construction area. The need for turbidity control curtains will be coordinated with water quality control requirements and recommendations from the biological assessment that will be completed as part of the permitting process.

Turbidity curtains are designed specifically to contain and control the dispersion of turbidity and silt in a water body during in-water construction activities. The turbidity control curtain will be deployed before the start of in-water construction activities. The curtain may be deployed in a configuration that protects specific portions of the work area from river currents. The curtain may also be deployed to encompass an entire work area or the entire sediment cap area at once, based on the contractor's input and schedule. Deployment of the turbidity curtain will involve a boat and divers.

Rather than using City standard details for turbidity curtains, the turbidity curtain will be designed to be appropriate for this specific project. A Type III turbidity control curtain will likely be used during the construction of the in-water sediment cap at Zidell. Type III curtains consist of heavy-duty vinyl-coated fabric skirt supported by a flotation encased in vinyl-coated fabric, and include load-carrying cables below the flotation and a galvanized chain ballast at the bottom of the skirt. The turbidity curtain will be anchored as recommended by the manufacturer.

For the duration of the construction activities, the turbidity curtain will be regularly inspected and maintained as necessary to control turbidity resulting from the placement of the sediment cap. Special attention must be paid to the load-carrying components (e.g., cables), and retensioning may be necessary. Curtains may require cleaning to remove algae or other growth. Damaged sections may require repair or replacement to restore the integrity of the containment.

4.8.2 Construction above OHW Line

Construction above the OHW line includes removal of ecological hot spots in the ROD greenway, removal of human health hot spots in the ROD greenway and interior site area, bank cuts for stability, and placement of the ROD greenway area soil cap. Construction work above the OHW line may occur at any time as long as the preconstruction controls are in place.

4.8.2.1 Vegetation Clearing

Vegetation in areas being excavated or capped will be cleared before soil is moved. General brush and nonnative vegetation will be containerized and transported to a composting facility. Large, woody, and/or native vegetation may be stockpiled for later use as habitat features in the riparian area. Woody debris to be kept for later reuse will be identified and flagged by the project biologist.

4.8.2.2 Debris Identification, Removal, and Management

All debris fill and deleterious materials (e.g., rebar, wood scrap, wire, rubber) identified during construction activities will be managed as specified in the SMP that will be developed as part of the final design. In general, excavation areas will not be overexcavated to remove debris fill or deleterious materials, unless it is necessary to complete the selected remedy and ensure stability. If large pieces of unanticipated debris are encountered, Zidell will consult with the DEQ on the planned management before taking action. Additional details are included in Section 3.3 of this report.

4.8.2.3 Soil Hot Spot Removal

Ecological and human health hot spot excavation areas described in Section 3.3 will be staked by surveyors and verified by the field engineer. Excavation of the soils into stockpiles or directly into road trucks will generally involve an excavator, backhoe, front-end loader, and/or bulldozer. Soil will be managed as designated in the SMP, which will be prepared as part of the final design. Screening maybe employed to separate human health hot spot soil from inert oversize material, as described in

Section 3.3. Human health hot spot soil must be disposed of off-site, but the oversized rocks and concrete may be used for on-site fill or crushed and used as base rock, and oversized pieces of bulk metal may be recycled off site.

Soils from each type of hot spot excavation (human health or ecological) will be managed separately.[17] If soil is temporarily stockpiled, it will be placed on plastic sheeting to prevent contact with underlying soils. A stake indicating the type of soil will be placed on each pile. Following placement, the stockpile will be covered with plastic sheeting at the end of each working day to prevent or minimize wind erosion or stormwater contact. Soil stockpiled for a longer term (e.g., for incorporation into redevelopment during Phase 3) will be placed on and covered with a geotextile liner. Stockpiling management will be addressed in the SMP.

Completed hot spot excavations will be lined with a demarcation geosynthetic before they are backfilled with clean soil. The demarcation layer will provide a visible indicator for future workers that underlying soils may contain hazardous materials. The demarcation layer may be a geogrid, brightly colored geotextile, or orange construction fencing.

4.8.2.4 Bank Cuts

Bank cuts are required in the slipway and bridge reaches to increase slope stability and/or to allow for placement of the bank caps. Before July 1 (the start of the in-water work window), bank cuts may proceed only as long as work does not extend below the OHW elevation.

Bank cuts will generally be made using excavators. Soil from a bank cut that is not a hot spot may be placed on site or will be hauled to a permitted landfill for disposal. The excavator will finish the bank cut with a keyed (benched) surface to accommodate the placement of the cap soil (described below), per the geotechnical design recommendations. Soil will be managed as designated in the SMP, which will be prepared as part of the final design. Excavated soils will either be loaded directly into a transport truck for disposal at a landfill or will be stockpiled on a plastic liner. If the soil is stockpiled, the pile will be covered with erosion control matting or plastic at the end of each working day to prevent or minimize wind erosion or stormwater contact.

Once the bank cut is completed, a demarcation geogrid will be placed on the slope to provide a visual indicator to future workers that the soils below may contain potentially hazardous materials.

4.8.2.5 Soil Cap Placement

The ROD requires a 2-foot soil cap (or equivalent) in the ROD greenway area as part of this phase of the scope of work. Clean cap soil will be brought to the site by

[17] Soil that is considered both ecological and human health hot spot soil will be managed with the human health hotspot soil.

trucks with trailers and then spread, using a grader or bulldozer, in the flat areas of the site. It is anticipated that possible sources of cap soil will include various commercial sources or nearby development sites that may have excess clean soil. Cap soil will be placed in two 1-foot lifts and loosely compacted into place using track equipment. Before revegetation, the flat surfaces of the cap will be disked to loosen the soil and increase its permeability. In riverbank slope areas the surface will not be disked; however, a TRM will be installed over the soil cap in these areas as recommended in the geotechnical report (GeoDesign, 2009).

The specification for the cap soil will be developed as part of the final design. It will require the contractor to provide certification that the soil is not contaminated.

4.8.3 Construction below OHW Line

Construction below the OHW line may be conducted only during the in-water work window (July 1 through October 31), and may be started following the deployment of the turbidity control curtain. Construction below the OHW line includes bank excavation and rock armor placement, placement of a new concrete ramp in the slipway, and placement of the bank and sediment caps. Following the start of the in-water work window, bank excavations will be completed before the start of any of the sediment capping work.

4.8.3.1 Bank Excavation and Rock Armor Placement

The bank cuts in the slipway and bridge reaches, described in Sections 3.6 and 4.3, will be completed as the first step of work below the OHW line. Soil will be managed as designated in the SMP, which will be prepared as part of the final design. Excavated soils will either be loaded directly into a transport truck for disposal at a landfill or will be stockpiled on a plastic liner. If the soil is stockpiled, the pile will be covered with plastic at the end of each working day to prevent or minimize wind erosion or stormwater contact.

The design calls for the repair of certain areas of existing armor and the placement of new rock armor in other areas, as described in Section 3.6. In the southern portion of the slipway reach and in the north bridge reach, repair of the existing armor will require the contractor to work at the direction of the field engineer to identify areas where gaps in the armor exist. These gaps will be filled with filter material and then appropriately-sized pieces of rock armor will be hand-placed to completely cover the exposed soils.

The existing armor on the north bank of the slipway reach and throughout the south bridge reach was determined to be inadequate to support the placement of additional rock armor. Therefore, the construction of a new rock armor slope will be required, as described in Section 3.6.Rock armor will be placed over a filter fabric in a 2- or 3-foot-thick layer as recommended by the geotechnical engineer. Placement may involve a mass dump and/or placement using an excavator.

4.8.3.2 Concrete Ramp

A new concrete ramp will be poured in the slipway ramp area, while maintaining the existing rails. The ramp will tie into the existing asphalt surface of the outside barge construction area and extend down to an approximate elevation of 5 feet COP. The placement of suitable base material will require the excavation/dredging of sediments between existing bents supporting the rails. Concrete will be poured into forms after the base rock is placed and compacted. The design of the concrete ramp will be developed as part of the final design.

4.8.3.3 Low-Profile Cap

The low-profile cap will be placed before construction of the sand cap. It is currently anticipated that the RCM and heavyweight cushion geotextile will be attached before placement. The RCM/geotextile assembly will then be rolled out into the water and placed by divers. The diver crews will anchor the RCM in place and ensure proper overlap prior to the placement of the rock armoring. Rock armoring will be carefully placed using a clamshell bucket.

4.8.3.4 Bank and Sand Cap Placement

Clean dredge sand fill will likely be brought to the site by barge for construction of the sand cap occurring beneath the daily high water elevation. It is anticipated that possible sources of the sand cap material will include clean mid-channel dredge sand from the Columbia River supplied by various commercial sources. A lead time of as much as six months may be necessary for securing the large quantity of material required. The sand cap may be placed using several different methods. Measures will be taken to minimize mixing of the cap sand with the contaminated sediment during placement. At other capping sites, the slow placement of a thin layer of clean cap sand (on the order of 6 to 12 inches) kept the mixing to a zone of 1 to 2 inches. Placement of the thin layer, or "lift," also helps to dewater the surface of the existing contaminated sediment and prevent the likelihood of a sliding failure. The initial 2 to 3 lifts of the sediment cap will be placed using a spreading method that gradually builds the thickness of the lift while minimizing the potential for a sliding slope failure. Sand spreaders (from road applications) and shaker boxes have been used successfully at other sites to gradually build the first thin lifts. The thin lift placement will progress from upstream end to downstream end of the site so that the placement of clean fill is not occurring downstream of any portion of the site that has not yet received the initial thin lift.

Bulk placement of the sediment cap will proceed in lifts no thicker than 2 feet, as specified by the geotechnical engineer (GeoDesign, 2009). Bulk placement of cap sand may utilize GPS-guided clamshell placement from a barge, reverse-dredge, or other similar technique. Although it is anticipated that additional specificity on the construction method will be developed during the permitting and final design process, Zidell also intends to allow the contractor maximum flexibility in construction methods, as long as the basic requirements described above are met.

In the downstream reach, bank fill occurring above the daily high water elevation (assumed to be approximately 5 feet COP) may consist of clean general soil fill, as long as the filled areas are adequately armored before it is inundated. It is anticipated that the clean general soil fill will be brought to the site by trucks or barge and that potential sources of this material will include nearby borrow sites and other large-scale excavation sites (uncontaminated). Fill along the riverbank will proceed in 2-foot compacted lifts, as specified by the geotechnical report (GeoDesign, 2009). Placement of general bank fill will involve standard earthwork equipment: excavators, graders, rolling compactors, bulldozers, and dump trucks.

All areas below the OHW line will receive from 1 to 3 feet of rock armor (Type A, B, C, D, or E) as specified in the geotechnical report (GeoDesign, 2009) and as shown on Drawings C2.0 through C2.4 and described in Table 3-2. The rock armor will likely be placed and spread to a uniform thickness using excavators, bulldozers, and/or clamshell dredge buckets.

4.8.4 Planting

Planting will take place as major construction areas are completed or during the next low-water season. If planting is to be done during the next low-water season following cap and bank construction, the rock armor and TRM layers will prevent erosion of the cap during the interim. Planting in a specific work area will not occur until the other construction activities in that area have been completed. Live plants will generally be placed by hand by digging a planting hole or by making a bar-hole within the armor, as appropriate. Revegetated areas requiring the application of grass/herbaceous seed mixes will be addressed through hydroseeding. The planting plan is shown on Drawings L1.0 through L1.6.

4.9 Preliminary Construction Schedule

Table 4-2 describes a conceptual schedule for construction activities associated with implementation of Phase 2 remedial actions. The schedule assumes that in-water construction permits will be available prior to the 2011 in-water work window (July 1 through October 31). If in-water permits become available later, it will be necessary to adjust the construction schedule. It is possible that the upland work will be completed as a separate project from the bank and sediment work, allowing the upland work to be completed earlier. However, Table 4-2 assumes that the upland, bank, and sediment work will be completed together as one project.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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TABLES

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Slipway Reach Station -2+00 to Station 3+00 (500 LF)	Standard Sediment Cap or Armored Thin Sand Cap	Eastern cap boundary to -22	3:1 to 50:1	2 feet min. sand for standard cap (10 inch min. sand for thin cap); 6 inches filter gravel; 2 feet Type D Rock Armor; additional gravel to fill rock armor voids	1.47*	1.12*	Small rock armor, voids filled with gravel	The slope of the sediment cap and slipway ramp will generally match the existing slope. Rock armor is necessary based on potential scour from tugboat propeller wash during low water; gravel to provide resistance to sand washing through rock armor voids.	Generally flat (flatter than 5:1), mostly surface gravels with some sand immediately in front of slipway ramp. High-energy area.
	Low-Profile Sediment Cap	-22 to 5*	2:1	1 cm RCM, a geotextile cushion, and 3 feet Type E rock armor used in steeper areas; 12 inches Type C Rock Armor used in slipway embayment/rail area			Large rock armor (700 pound max rock size) in steeper areas; Small rock armor (100 pound max rock size) in slipway embayment rail area	Type E rock armor is necessary for scour protection from tugboat propeller wash. The thicker rock armor layer is required for the 2:1 slope and also provides additional weight, which improves the overall slope stability. Smaller Type C rock armor is used in the slipway rail area, where the rock armor will be confined by the rails for the slipway and slopes are flatter. An inspection of the armoring will be completed following each barge launch, and rock armor will be maintained as necessary. Following barge construction operations, Type C rock armor will provide adequate armoring for the wave and propeller wash forces expected in the slipway embayment rail area.	Very steep (2:1 to 1.5:1) outside of rail area, primarily sand and gravel. Silt is present in the rail area.
	Bank Excavation and Armor Replacement Cap on Lower Bank or Repair of Existing Lower Bank Armor	3* to 12	2:1	9 inches filter gravel and 3 feet Type E Rock Armor north of the slipway embayment; Existing engineered rock armor south of the slipway embayment			Large rock armor (700 pound max rock size) with existing medium rock armor south of the slipway embayment	The existing unclassified armor north of the slipway embayment is replaced with Type E Rock Armor, which is necessary based on the maximum vessel generated waves and the 2:1 bank slope.	Very steep slope (varies 2:1 to 1:1), non-classified armor north of the slipway with some bare soil gaps, top elevation of nonclassified armor ranges between 10 and 15 feet.
	Bank Excavation and Armor Replacement Cap on Lower Bank	12 to 15	3:1	6 inches filter gravel, 2 feet Type D Rock Armor north of slipway embayment; TRM with hydroseed and plantings south of the slipway embayment			Medium rock armor (200 pound max. rock size) north of the slipway embayment. Planting of armor is being considered. Shrubs and grasses on a soil slope with TRM obscured by plantings south of the slipway embayment	Type D rock armor has been sized to provide adequate protection for wave forces. Because the river velocities are aligned more directly into the north side of the slipway, rock armor was specified to provide extra protection for debris that may be mobilized in the river during extreme high flow events. Existing armor south of slipway embayment that is above elevation 12 feet (COP) will be replaced with a bioengineering technique that incorporates TRM and heavily planted vegetation. The TRM is necessary to provide protection from river velocities and wave forces during initial establishment and to prevent long-term soil erosion of the cap.	Very steep slope (varies 2:1 to 1:1), non-classified armor north of the slipway with some bare soil gaps, top elevation of non-classified armor ranges between 10 and 15 feet.
	Bank Cut and Soil Cap on Upper Bank	15 to 18	3:1	2 feet min. soil and TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	TRM is necessary to provide long-term certainty of adequate erosion control to the soil bioengineering techniques proposed for areas below OHW.	Very steep slope (varies 2:1 to 1:1), bare soil and vegetation

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Slipway Reach Station -2+00 to Station 3+00 (500 LF) ***continued***	Bank Cut and Upper Bank Soil Cap	18 to top of bank	3:1	2 feet min. soil; hydroseed and planting	1.47*	1.12*	Shrubs and grasses on a soil slope.	Soil bioengineering techniques provide adequate stability and erosion control above OHW.	Very steep slope (varies 2:1 to 1:1), bare soil and vegetation
Inner Slipway—South Slope	Repair of Existing Bank Armor	Varies; ramp to top of armor (~15)	2:1	Existing engineered rock armor	NA	NA	Medium rock armor	Geotechnical stability modeling was not deemed necessary by the geotechnical engineer because of the relatively short slope height down to the slipway ramp. The 2:1 slope is expected to be stable. A flatter slope would compromise the barge construction operations at the top of the slope. The size of the existing rock armor was previously engineered and will not be modified.	2:1 to 1.75:1 slope, existing engineered rock armor and vegetated soil slope
	Bank Excavation with Soil Cap	Varies; top of armor (~15) to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.		1.75:1 vegetated slope
Inner Slipway—North Slope	Repair of Existing Bank Armor	Varies; slipway ramp to building foundation	2:1	6 inches filter gravel; 2 feet Type C and Type D	NA	NA	Small rock armor	Geotechnical stability modeling was not deemed necessary by the geotechnical engineer because of the relatively short slope height down to the slipway ramp. The 2:1 slope is expected to be stable. A flatter slope is not possible because of the presence of the barge construction building at the top of the slope. The rock armor provides bank erosion control and stability, but is not meant to support the building, which is supported by existing piles. The proposed Type C and D rock armor is expected to be sufficient because the existing building piles should help increase stability and shield the rock armor from waves. Class C Rock Armor is the largest size expected to be possible to place by hand under the building and is expected to be sufficient since there should not be any significant wave action at these locations.	2:1 slope, bare soil and nonclassified armor
South Bridge Reach Station 3+00 to Station 7+50 (450 LF)	Standard Sediment Cap	Eastern cap boundary to 5*	5:1	2 foot min. sand (thickness varies); 16 inches of Type B Rock Armor	1.51	1.24	Angular cobbles with gravel	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. Type B rock armor is required because of close proximity of main river channel and higher potential for vessel-generated waves.	Very steep nearshore slope (2:1 to 1:1), flattening at depth (5:1 to <25:1), primarily sand and gravel with some silt

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
South Bridge Reach Station 3+00 to Station 7+50 (450 LF) ***continued***	Bank Excavation and Armor Replacement Cap on Lower Bank	3* to 15	2:1	Filter fabric or 9 inches filter gravel, 3 feet Type E Rock Armor	1.51	1.24	Large rock armor	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. Discontinuous existing unclassified armor is replaced with Type E rock armor, which is required based on vessel-generated waves.	Very steep slope (generally 2:1 to 1:1), nonclassified armor with some bare soil gaps, top elevation of nonclassified armor ranges from 10 to 20 feet COP
	Bank Excavation and Soil Cap on Upper Bank	15 to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. TRM is necessary to provide long-term erosion control certainty for the required soil cap.	Very steep slope (generally 2:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 10 to 20 feet COP
North Bridge Reach Station 7+50 to Station 11+50 (400 LF)	Standard Sediment Cap	Eastern cap boundary to 5*	5:1	2 foot min. sand (thickness varies); 16 inches of Type B Rock Armor	1.51	1.20	Angular cobbles with gravel	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. Type B rock armor is required because of close proximity of main river channel and higher potential for vessel-generated waves.	Steep nearshore slope (5:1 to 2:1), flattening at depth (5:1 to flatter than 25:1); primarily silt and sand with some gravel, transitional energy area
	Repair of Existing Bank Armor on Lower Bank	3* to 15	2:1 to 1:1	Existing armor			Large rock armor	Existing unclassified armor slope is consistent with ROD remedy and provides a stable slope configuration if the bank above an elevation of 15 feet is cut at a 2H:1V as determined by stability modeling by the geotechnical engineer. The armor will be repaired as necessary.	Very steep slope (generally 2:1 to 1:1), nonclassified armor with some bare soil gaps, top elevation of nonclassified armor ranges from 13 to 28 feet COP
	Bank Excavation and Soil Cap on Upper Bank	15 to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. Any existing armor will be replaced with bioengineering techniques that incorporate TRM. TRM is necessary to provide long-term certainty of adequate erosion control to the soil bioengineering techniques proposed.	Very steep slope (generally 2:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 13 to 28 feet COP

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Downstream Reach Station 11+50 to Station 28+59 (1709 LF)	Thin Sand Cap	Limited areas: Eastern cap boundary to standard sediment cap boundary	follows existing contours (5:1 max)	10 inches clean sand (no armor)	1.61	1.14	Clean dredge sand	Contaminant concentrations are of lesser concern. Thin sand cap included at request of DEQ, contaminant migration through the cap is not modeled. Clean material placed as new substrate for benthic community.	Generally flat shallow area near shore (25:1 to 5:1); mostly silt with some sand; low-energy area
	Standard Sediment Cap	Eastern cap boundary to 10	5:1	2 foot min. sand (thickness varies); 12 inches of Type A Rock Armor			Round river rock (cobbles and gravel)	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. The geotechnical engineer's analysis indicates that Class C rock armor would be required for the resistance to waves on the bank down to an elevation of -1 foot, and Type B rock armor would be required for resistance to propeller wash from -1 down to an elevation of -5 feet. However, the armor size was reduced to Class A because the thickness of the cap is generally much more than 2 feet (which allows for some erosion), because the area is generally depositional in nature, and because of the low likelihood of pleasure craft operating over the wetland planting area.	Generally flat shallow area near shore (25:1 to 5:1); mostly silt with some sand; low-energy area
	Fill and Cap	10 to 18	3:1	2 foot min. soil (thickness varies); 12 inches of Type A Rock Armor			Dense vegetation consisting of grass, shrubs, and trees that obscure the view of round river rock (cobbles and gravels)	3:1 slope is used for the fill placed above water, based on a stable slope configuration as determined by stability modeling by the geotechnical engineer. The geotechnical engineer 's analysis indicates that Type C rock armoring is required because of wave forces, but the armoring size was reduced to Type A since the maximum wave forces will be very infrequent, the thickness of the cap is generally much more than 2 feet (which allows for some erosion), and because the area is generally depositional in nature.	Generally steep slope (3:1 to 1:1); vegetation, non-classified armor, and some bare soil gaps; top elevation of non-classified armor ranges from 10 to 20 feet COP
	Fill and Cap	18 to top of bank	3:1	2 foot min. soil (thickness varies); hydroseed and planting			Shrubs and grasses on a soil slope.	3:1 slope is used for the fill placed above water based on a stable slope configuration as determined by stability modeling by the geotechnical engineer. No rock is placed above 18 feet (OHW), as vegetation alone will provide adequate stability and erosion control.	Generally steep slope (3:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 10 to 20 feet COP

cm = centimeter.
COP = City of Portland Datum.
FOS = minimum calculated factor of safety for reach, as determined by geotechnical stability analysis for worst-case cross section within the reach (GeoDesign, 2009).
LF = linear feet.
min = minimum.
OHW = ordinary high water.
RCM = reactive core mat.
TRM = turf reinforced mat.
xx:1 = slope in feet horizontal to feet vertical.
*The sediment cap overlaps the bank cap in these areas. Bank armor generally extends down to elevation 3 feet, and the sediment cap extends up to elevation 5 feet.

Table 3-2
Rock Armor Descriptions
Zidell Waterfront Site
Portland, Oregon

Rock Armor Type	Description	Maximum Diameter of Rock (inches)	Mean Diameter	Gradation
Type A Rock Armor	6" Minus Rounded to Subrounded	6	3	Well Graded
Type B Rock Armor	8" Minus Angular to Subangular	8	4	Well Graded

Rock Armor Type	Description	Approximate Maximum Diameter of Rock (inches)	Maximum Weight of Rock (Pounds)	Gradation—Percent by Weight			
				20%	30%	40%	10%
Type C Rock Armor	ODOT Class 100 Riprap	10	100	100-60	60-25	25-2	2-0
Type D Rock Armor	ODOT Class 200 Riprap	15?	200	200-140	140-80	80-8	8-0
Type E Rock Armor	ODOT Class 700 Riprap	24?	700	700-500	500-200	200-20	20-0

Table 3-3
Material Quantities Summary
Zidell Waterfront Property
Portland, Oregon

Material	Location				
	Slipway Reach	South Bridge Reach	North Bridge Reach	Downstream Reach	Upland Greenway (Phase II)
Volume Calculations (Cubic Yards)					
Hotspot Backfill[a]	30	50	80	700	12,000
General Fill (Soil Cap and Bank Fill)	900	1,200	1,400	60,400	13,200
Clean Sand (for standard sand cap	4,200	28,800	10,600	17,000	- -
Type A Rock Armor (New)	- -	- -	- -	8,100	- -
Type B Rock Armor (New)	- -	4,200	3,500	- -	- -
Type C Rock Armor (New)	300	- -	- -	- -	- -
Type D Rock Armor (New)	8,300	- -	- -	- -	- -
Type E Rock Armor (New)	2,600	1,600	- -	- -	- -
Type C or D Rock Armor (Repair)	300	- -	100	- -	- -
Area Measurements (Square Feet)[b]					
Hotspot Backfill	2,000	4,400	6,900	0	112,000
General Fill (Soil Cap and Bank Fill)	10,800	16,100	15,100	197,500	173,800
Sediment Cap (Total)	69,200	82,200	67,400	209,600	- -
Clean Sand (for standard sand cap)	34,100	83,600	70,600	98,700	- -
Thin Cap (Armored and Standard)	23,400	- -	- -	50,100	- -
Type A Rock Armor (New)	- -	- -	- -	221,400	- -
Type B Rock Armor (New)	- -	84,900	71,900	- -	- -
Type C Rock Armor (New)	8,400	- -	- -	- -	- -
Type D Rock Armor (New)	87,400	- -	- -	- -	- -
Type E Rock Armor (New)	18,500	8,300	- -	- -	- -
Type C or D Rock Armor (Repair)	15,700	- -	5,000	- -	- -
Reactive Core Mat	18,500	- -	- -	- -	- -

NOTES:
- - not applicable.
[a]Hot spot backfill does not represent total hot spot disposal volume, only that portion requiring backfill.
[b]Area measurements were obtained from plan view dimensions.

Table 4-1
Maximum Daily Willamette River Stage
ZRZ Realty Company
Portland, Oregon

River Stage	Approximate Number of Days Exceeding River Stage	Approximate Number of Events Exceeding River Stage	Approximate Number of Water Years Exceeding River Stage
12 feet	2,064	182	32
15 feet	662	84	23
18 feet	174	32	11
20 feet	78	13	8
25 feet	6	1	1
30 feet	2	1	1
Total on Record	**12,236**	**NA**	**37**

Daily maximum Willamette River stage values obtained from the U.S. Army Corps of Engineers Morrison Bridge gauge (USGS ID: 14211720) database and converted to the City of Portland elevation datum.
http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?k=id:prto

The dataset included river stages well above the February 1996 flood elevations. The U.S. Army Corps lists the February 1996 flood elevations as the highest river stage on record; therefore, all river stage elevations above the 1996 flood were considered suspect and excluded from analysis.

An event was defined as a continuous number of days during which a particular river stage was exceeded.

Table 4-2
Preliminary Construction Schedule
Zidell Waterfront Property
Portland, Oregon

Item	Schedule
Final Design, Permitting, and Preconstruction	August 2009 through early 2011
Site Preparation and Erosion Control	Early 2011 for work below OHW; July 1, 2011 for work below OHW
Construction above OHW	Early 2011 through late 2011
Construction below OHW	July 1, 2011 through October 31, 2011
Planting	Late spring 2011 through fall 2011

NOTE:
OHW = ordinary high water.

FIGURES

DRAWINGS

APPENDIX

BANK PHOTOGRAPHS