PUBLIC REVIEW DRAFT REMEDIAL INVESTIGATION REPORT

8th Avenue Terminals, Inc. Site
Seattle, Washington

Prepared for:

Washington State Department of Ecology

On Behalf of:

8th Avenue Terminals, Inc.

Project 101.00205.00037

August 2019

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This document has been prepared by SLR International Corporation; however, portions of the document were included in the Draft Remedial Investigation Report, dated August 2016, that was prepared by Anchor QEA, LLC. The material and data in this report were prepared under the supervision and direction of the undersigned.

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ACRONYMS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
8th Avenue	8th Avenue Terminals, Inc.
Anchor	Anchor QEA, LLC
AO	agreed order
AMEC	AMEC Environmental & Infrastructure, Inc.
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
bgs	below ground surface
BEHP	bis(2- ethylhexyl)phthalate
BMP	best management practice
CAP	cleanup action plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm/s	centimeters per second
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	cleanup screening level
CSM	conceptual site model
CSO	combined sewer outfalls
Crowley	Crowley Marine Services, Inc.
CUL	cleanup levels or remediation levels
CV	conveyance vault
cy	cubic yard
cy/s	cubic yards per second
DCAP	draft cleanup action plan
DeNovo	DeNovo Seattle LLC
D/F	dioxins and furans
DO	dissolved oxygen
DOF	Dalton Olmstead Fuglevand, Inc.
DRO	diesel-range organices
DSOA	Duwamish Sediment Other Area
DW	dry weight
EAA	early action area
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
Facility	Duwamish Reload Facility
FS	feasibility study
GC/FID	gas chromatograph/flame ionization detector

g/d	grams per day
GMA	Growth Management Act
GRO	gasoline-range organics
GS	grain size
GTSP	Georgetown Steam Plant
HRO	heavy oil-range organics
HHRA	human health risk assessment
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
IA	interim action
IHS	indicator hazardous substance
KC	King County
KRS	Kelly Ryan Services
Landau	Landau Associates, Inc.
LDC	Laboratory Data Consultants, Inc.
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg	milligrams per kilogram
mg/kg-OC	milligrams per kilogram organic carbon normalized
MLLW	mean lower low water
MTCA	Model Toxics Control Act
ng/kg	nanogram per kilogram
NAVD88	North American Vertical Datum 1988
NPDES	National Pollutant Discharge System
OCA	operations containment area
OFP	Organic Fuel Processors, LLP
ORO	oil-range organics
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PCP	Pentachlorophenol
PQL	practical quantitation limit
PPT	parts per thousand
PSDDA	Puget Sound Dredged Disposal Analysis
PTI	PTI Environmental Services
RACR	removal action completion report
RAL	remedial action level
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	remedial investigation
RM	river mile
ROD	record of decision
SAP	sampling and analysis plan

SCO	sediment cleanup objectives
Site	area of contamination from sources at Subject Property
SLR	SLR International Corporation, Inc.
SMS	sediment management standards
SPU	Seattle Public Utilities
STM	sediment transport model
Subject Property	7400 8th Avenue South, Seattle, Washington
SVOC	semivolatile organic compound
SWAC	spatially-weighted average concentration
SWPPP	stormwater pollution prevention plan
TBT	tributyltin
TDS	total dissolved solids
TEE	terrestrial ecological evaluation
TEQ	toxic equivalency quotient
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPH-Dx	diesel range hydrocarbons
TPH-G	gasoline range hydrocarbons
TS	total solids
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish & Wildlife Service
UST	underground storage tank
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code
Weston	Weston Solutions, Inc.
Windward	Windward Environmental, LLC
WMNS	Waste Management National Services, Inc.

EXECUTIVE SUMMARY

In compliance with Agreed Order (AO) No. DE 6721, a remedial investigation (RI) was conducted at the 8th Avenue Terminals, Inc. Site (the Site) to characterize the nature and extent of the Site-related chemicals in both upland and aquatic areas, and to evaluate the risks that these chemicals may pose to human health and the environment. The RI was conducted in two phases to address critical questions, focus the sampling on data gaps, prevent the collection of unnecessary data, and increase the efficiency of the investigation.

SLR International Corporation (SLR) completed the first phase of the RI (Phase 1) from May 2013 through February 2014. The work consisted of collecting the data necessary to assess potential contaminant source areas, to better understand contaminant fate and transport and associated potential receptors, and to further review the applicable or relevant and appropriate requirements (ARARs) for the Site. Phase I of the RI included drilling and sampling 31 soil borings; completing 11 of the borings as shallow groundwater monitoring wells and 5 of the borings as intermediate-depth groundwater monitoring wells; measuring depths to groundwater and collecting groundwater samples from all of the Site monitoring wells during two low-tide events and one high-tide event in the neighboring Lower Duwamish Waterway (LDW); collecting stormwater samples from all of the Subject Property outfalls during two qualifying storm events; collecting two catch basin solids samples from each of the six stormwater conveyance lines on Parcel D; inspecting the sheet pile seawall and riprap for groundwater seeps and collecting samples from 5 seeps that had sufficient flow; and collecting 5 intertidal sediment samples near each end of the Subject Property pier and near stormwater outfalls OF2, OF3, and OF4. In October 2014, SLR prepared a Final Data Gaps Report that described the field activities completed during Phase 1 of the RI, presented the results of the work, including a preliminary conceptual site model, and identified the remaining RI data gaps to be addressed during the second phase of the RI. The results of Phase 1 of the RI are also included in this report.

Prior to conducting the second phase of the RI (Phase 2), Anchor QEA, LLC (Anchor) conducted interim action (IA) sampling activities to support implementation of planned Facility development actions. The IA sampling consisted of drilling and sampling 42 soil borings and collecting groundwater samples from 3 shallow groundwater monitoring wells. The results of the IA sampling activities are included in this Report.

From November 2014 through January 2015, Anchor conducted Phase 2 of the RI to address the remaining investigation data gaps. The Phase 2 work consisted of drilling and sampling 31 soil borings; completing 4 of the borings as shallow groundwater monitoring wells and 4 of the borings as deep groundwater monitoring wells; measuring depths to groundwater and collecting groundwater samples from all of the Site monitoring wells during a low-tide event in the LDW; conducting a tidal study at 20 monitoring wells, as well as at a stilling well in the LDW, for a period of one week; and collecting 18 surface sediment samples and advancing and sampling 6 subsurface sediment cores in the LDW at locations near the Subject Property. The results of Phase 2 of the RI are included in this report.

The results of the groundwater monitoring and tidal study data collected during the RI indicate that the shallow groundwater flow during low tides is primarily to the southeast towards Slip 4. The relatively flat

horizontal gradients behind the seawall and the mean downward vertical gradients along the seawall indicate that the seawall is retarding shallow groundwater flow as the groundwater abuts against the seawall and then the majority of the water flows to either end or under the wall. During high tides, waterway surface water flows inland primarily around the ends and beneath the seawall and recharges the groundwater beneath the Subject Property. Holes and cracks in the seawall allow some groundwater and surface water to flow through the wall. During low tide conditions, the unconfined groundwater at depths below 43 feet bgs (the bottom of the seawall) flows to the southeast towards Slip 4, and then under the seawall and riprap areas into the waterway. During high tide conditions, the deeper groundwater flows under the seawall and riprap areas, and inland at northwestern and northern directions.

To evaluate the nature and extent of chemicals at the Site that may pose a potential risk to human health and the environment, SLR developed conservative Site screening levels for soil, groundwater, and sediment that addressed the full range of potentially applicable exposure pathways and receptors under current and foreseeable future uses of the Site. The RI and pre-RI soil and catch basin solids sample analytical results were compared to the soil and sediment screening levels, respectively. The RI groundwater and sediment sample analytical results were compared to the groundwater and sediment screening levels, respectively. The RI stormwater sample analytical results were compared to the groundwater screening levels, which are primarily based on protection of surface water or sediment.

Chemicals that were present at concentrations exceeding media-specific screening levels with detected results or undetected results (method reporting limit exceeded the screening level) in one or more samples were identified as chemicals of potential concern (COPCs). Based on the large list of COPCs, SLR conducted statistical analyses for each medium to identify the Site chemicals of concern (COCs). Consistent with Model Toxics Control Act (MTCA) regulations (WAC 173-340-708), indicator hazardous substances (IHSs) were used as selected COCs for soil and groundwater to focus the characterization of the nature and extent of Site contamination. The identified IHSs for the Site include the following:

- Soil: metals (arsenic, copper, lead, and selenium), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), total PCBs, total dioxins/furans (D/F) TEQ, and petroleum hydrocarbons (total sem-volatile petroleum hydrocarbons [sum of DRO and ORO] and GRO).
- Groundwater: metals (dissolved arsenic and dissolved copper), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), and total PCBs.

All soil data were used to evaluate the lateral and vertical extents of the soil IHSs at the Site. Most of the soil IHSs occur at concentrations greater than the screening levels in the shallow soil beneath large areas of Parcel D and localized areas of Parcel F (if present). The IHS concentrations typically decrease with depth. The lateral and vertical extents of each of the soil IHSs have been delineated, except for the western extents of arsenic, total PCBs, and total D/F TEQ at the western part of Parcel D (at locations near the western border of the Subject Property), and the vertical extents of arsenic, lead, total cPAH TEQ, total PCBs, and semi-volatile petroleum hydrocarbons at localized areas of the Subject Property.

The RI groundwater data were used to evaluate the lateral and vertical extents of the groundwater IHSs at the Site. Most of the groundwater IHSs are present in the shallow groundwater beneath large areas of

Parcel D and localized areas of Parcel F. The IHS concentrations typically decrease with depth. The lateral and vertical extents of each of the groundwater IHSs have been delineated, except for the lateral (eastern) extent of vinyl chloride near the eastern border of Parcel F (east of shallow well EMW-2S) and the vertical extents of total cPAH TEQ at the western part of Parcel D (at deep well EMW-19D) and near the sheet pile seawall (at deep well EMW-20D).

The Site COCs for surface sediment are SVOCs (benzyl alcohol), PAHs [benzo(a)anthracene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, total benzofluoranthenes(b,j,k), and total HPAH], and total PCBs. The Site COCs for subsurface sediment are benzyl alcohol, PAHs [anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, total benzofluoranthenes(b,j,k), total HPAH, total LPAH, and total cPAHs TEQ], total D/F TEQ, and total PCBs. The greatest sediment COC concentrations typically occurred at sampling stations located over 160 feet downriver of the Subject Property or approximately 100 feet south of the Subject Property shoreline. Due to the complexities associated with the LDW Superfund Site, such as numerous contaminant sources and sediment mobility, the RI sediment data from the 8th Avenue Site were not evaluated for lateral and vertical extents of the COCs. Based on the RI sediment sample analytical results, the previous sediment dredging on the Subject Property, the extensive sediment sampling that has been conducted in the LDW and Slip 4, including on the Subject Property, and the EPA's planned remedial action for the LDW Superfund Site, the surface and subsurface sediments have been adequately characterized for the RI.

At least one of the stormwater samples contained metals (total arsenic, copper, nickel, and zinc), chloroform, BEHP, and/or chrysene concentrations greater than the groundwater screening levels. At least one of the catch basin solids samples contained zinc, SVOCs (BEHP, butylbenzyl phthalate, m&p-cresol, benzoic acid, and benzyl alcohol), and/or total D/F TEQ concentrations greater than the sediment screening levels. Of the stormwater and catch basin solids COCs, only benzyl alcohol, chrysene, and total D/F TEQ are sediment COCs for the Site. For the purposes of the RI, the catch basin solids and stormwater at the Site have been adequately characterized.

Based on the results of the RI, the Site data (a combination of historical data and RI data) are of sufficient quantity and quality to characterize the nature and extent of the Site-related chemicals, and to understand the potential risks that these chemicals may pose to human health and the environment. The Site data can be effectively used to develop Site cleanup levels and the cleanup action alternatives that will be evaluated in the feasibility study (FS). Although there are some remaining investigation data gaps that may need to be addressed prior to completing the FS, these data gaps are not critical to the understanding of the overall Site conditions. Based on the data presented in this report, the RI has met the requirements of WAC 173-340-350 and WAC 173-204-560, as defined in the AO.

1. INTRODUCTION

In compliance with Agreed Order (AO) No. DE 6721, this Remedial Investigation Report (Report) presents the findings of a Remedial Investigation (RI) at the 8th Avenue Terminals, Inc. (8th Avenue) property located at 7400 8th Avenue South in Seattle, Washington (the Subject Property) and at portions of the adjacent Lower Duwamish Waterway (LDW). The Subject Property is located along the northeastern bank of the LDW and the western bank of Slip 4, and includes the southwestern part of Slip 4 (see Figure 1).

1.1 OVERVIEW

On October 12, 2009, 8th Avenue entered into an AO with the Washington State Department of Ecology (Ecology) to complete an RI/Feasibility Study (FS) and prepare a cleanup action plan (CAP) for the 8th Avenue Site (the Site). The Site is defined by the extent of contamination caused by the release of hazardous substances at the Subject Property. On April 18, 2014, the Subject Property was purchased by DeNovo Seattle, LLC (DeNovo), and DeNovo signed the AO as a liable party. During 2016, DeNovo Constructors, Inc., the holding company of DeNovo, began the process of liquidating its assets and assigned its shares of DeNovo to certain creditors of DeNovo Constructors, Inc. On July 17, 2017, the assets of DeNovo, including the Subject Property, were placed in receivership. On March 11, 2019, 8th Avenue acquired the Subject Property from receivership.

This RI/FS process is part of Ecology's effort to investigate upland properties adjacent to the federal LDW Superfund Site for potential ongoing sources of contamination to the Superfund Site. The purpose of the RI is to summarize the environmental conditions at the Site by adequately characterizing the nature and extent of Site-related chemicals in both upland and aquatic areas (including any hazardous substances and associated risks that these may pose to human health and the environment). This will enable potential cleanup action alternatives to be developed and evaluated in an FS, in agreement with applicable requirements under the Model Toxics Control Act (MTCA) regulations (Washington Administrative Code [WAC] 173-340-350). This RI is also consistent with the final LDW Record of Decision (ROD; EPA, 2014), which presents the cleanup remedy selected for sediments within the LDW[1].

After lengthy discussions with Ecology regarding the RI scope of work, 8th Avenue agreed to conduct the scope of work in Ecology's RI/FS Work Plan dated October 2012 (Ecology, 2012) after modifications to the scope were accepted by both parties (Ecology, 2013). In accordance with WAC 173-340-350(6) and (7)(a), the RI was conducted in phases to address critical questions, focus the sampling on data gaps, prevent the collection of unnecessary data, and increase the efficiency of the investigation. The first phase of the RI (Phase 1) was conducted from May 2013 through February 2014 by SLR, and consisted of collecting the data necessary to assess potential contaminant source areas, to better understand contaminant fate and transport and associated potential receptors, and to further review the ARARs for the Site. A Final Data Gaps Report was prepared by SLR in October 2014 that described the field activities completed during Phase 1 of the RI, presented the results of the work, including a preliminary conceptual site model (CSM), and identified the remaining RI data gaps to be addressed during Phase 2 of the RI.

[1] The aquatic area of the Subject Property is located within the LDW Superfund Site.

In July 2014, after the sale of the Subject Property to DeNovo, Anchor conducted additional sampling to support implementation of planned Subject Property re-development activities (i.e., rail construction). Ecology required the re-development work to be completed under an Interim Action (IA) process, as part of the AO. In August 2014, Ecology withdrew their Determination of Non-Significance as part of the MTCA State Environmental Policy Act process, and the planned IA was not implemented.

In November 2014, a draft Sampling and Analysis Plan (SAP) Addendum for the second phase (Phase 2) of the RI was submitted to Ecology (Anchor, 2014). The SAP Addendum identified remaining RI data gaps for the Site, and proposed additional data collection activities to complete the RI. The Phase 2 RI sampling activities began (concurrent with Ecology's review of the SAP Addendum) in November 2014 and were completed in January 2015. The completed Phase 2 sampling activities were conducted in accordance with the SAP Addendum.

1.2 SITE CONTACT INFORMATION

This section provides contact information for the Site. Ecology's Facility/Site Identification Number for the Site is 1940187 and the Cleanup Site Identification Number is 2520.

The project coordinator for Ecology is:

Victoria Sutton
Washington Department of Ecology
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The project coordinator for 8th Avenue is:

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8th AvenueTerminals, Inc.
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The consultant for 8th Avenue is SLR, and the project manager for SLR is:

Mike Staton
SLR International Corporation
22118 – 20th Avenue SE, Suite G202
Bothell, Washington 98021
(425) 420-9854

Email: mstaton@slrconsulting.com

The Subject Property is currently leased by Waste Management National Services, Inc. (WMNS). The property contact for WMNS is:

Jim Denson
Waste Management
7400 8th Avenue South
Seattle, Washington 98108
(602) 757-3352
Email: jdenson@wm.com

1.3 REPORT ORGANIZATION

This RI report is organized as follows:

- Section 2 – Background
- Section 3 – Historical and Current Uses of Subject Property
- Section 4 – Environmental Setting
- Section 5 – Remedial Investigation Activities
- Section 6 – Site Screening Levels
- Section 7 – Nature and Extent of Contamination
- Section 8 – Conceptual Site Model
- Section 9 – Remaining RI Data Gaps
- Section 10 – Conclusions
- Section 11 – References

Appendices to this Report include key supporting documents (Appendix A), a figure showing the locations of stormwater outfalls into Slip 4 (Appendix B), historical dredging and sediment sampling information (Appendix C), field logs (including soil boring and sediment core logs) and sampling details from the RI (Appendix D), RI tidal study data (Appendix E), historical groundwater sample analytical data (Appendix F), terrestrial ecological evaluation documents (Appendix G), the Phase 2 RI laboratory reports (Appendix H), the data validation reports for the Phase 2 RI analytical data (Appendix I), and a summary of the derivation process for identifying Site indicator hazardous substances (Appendix J).

2. BACKGROUND

2.1 GENERAL PROPERTY INFORMATION

The Subject Property is located in the southern part of Seattle, Washington, along the LDW (see Figure 1). The property is located north of the waterway, between Slip 4 and 8th Avenue South, and south of South Garden Street (see Figure 2). The Subject Property includes the southwestern part of Slip 4.

The Subject Property is located in an industrial/manufacturing area of Seattle, Washington, and comprises approximately 16 acres of industrial waterfront property. The Subject Property (King County [KC] Parcel No. 2136200641) is currently in receivership, and is subdivided into two parcels, Parcel D and Parcel F. Parcel F includes the northern portion of the property, and Parcel D includes the remainder of the property (see Figure 2).

Since 2014, the Subject Property has been leased to WMNS, who operates the property as a materials reload and transfer facility (Duwamish Reload Facility [Facility]). The Facility operations primarily include offloading, transloading, loading, and temporary storage of non-hazardous contaminated dredge sediments and upland soil, as well as containerized non-hazardous contaminated materials.

2.2 CURRENT PHYSICAL CHARACTERISTICS

The topography of the upland portion of the Subject Property is relatively flat, ranging in elevation from approximately 15 to 17 feet above the North American Vertical Datum 1988 (NAVD88). Except for the northern part of Parcel F, the entire upland portion of the Subject Property is paved with asphalt or concrete. The unpaved areas at the northern end of Parcel F include a stormwater infiltration area, and an area at the northeast corner of the property that is covered with gravel and vegetation. No wetlands are located on the property (U.S. Fish & Wildlife Service [USFWS], 2016). Approximately 1.5 acres of the property extend into the LDW (including Slip 4) to the south-southeast (see Figure 2).

Except for along the waterway, the Subject Property is bounded by a chain-link fence, and two access gates are located along 8th Avenue South. The upland infrastructure at the Subject Property is related to Facility operations and includes several aboveground office trailers and a scale house near the southwestern entrance gate to the property, and one steel canopy at the north-central part of the property. A wooden pier is located along Slip 4, and there are two loading ramps located in the southern part of the pier (see Figure 2). In 2012, the northern portion of the pier was removed as part of the City of Seattle's remediation of the sediments in the northern part of Slip 4.

The central portion of the Subject Property includes WMNS' Operations Containment Area (OCA), which is designated for Facility offloading and materials handling and loading operations (see Figure 2). The OCA is defined by a 6-inch containment berm and includes a variety of operational equipment used to support offloading, handling, and loading activities, including storm/process water pre-treatment systems, sediment de-watering systems, and processing equipment.

In 2015, a temporary railroad spur was constructed by WMNS to support Facility operations. The railroad spur extends from the Union Pacific Railroad spur adjacent to East Marginal Way, north to southwest through the Subject Property, and splits into three on-property railroad tracks that terminate in the southwestern part of the property, within the OCA (see Figure 2). A second, existing railroad spur (single railroad track) runs along the east side of the property, adjacent to the Slip 4 shoreline.

Utilities at the Subject Property include electricity, natural gas, phone, sewer, and water. Electricity is carried to the property from overhead electric lines along 8th Avenue South that feed into an electric panel located near the southwestern entrance gate. Similarly, underground and overhead utilities connect to the property near the southwestern entrance gate, including underground natural gas, storm sewer, and water lines, and overhead phone lines. Stormwater runoff at the property is collected through a series of catch basins and drains, as described in Section 2.4 below.

Currently, there are not any aboveground storage tanks (ASTs) or known underground storage tanks (USTs) at the Subject Property. However, there is not any documentation of the removal of a 5,000-gallon fuel-oil UST that was located in the northwestern part of Parcel F.

2.3 PROPERTY SHORELINE

The southern and eastern edges of the upland portion of the Subject Property, along Slip 4, are bordered with a sheet pile seawall that is approximately 1,135 feet long and extends to a depth of 43 feet below ground surface (elevation of the bottom of the seawall is approximately -29 feet [approximately 15 feet below the bottom of Slip 4]). The seawall was built in the early 1980s to allow for the construction of an adjoining pier. The location of the seawall is shown on Figure 3. The plan drawings do not show the seawall extending from the western end of the pier to the western property line; however, sheet pile that is similar to the seawall is visible above the riprap to the west of the pier. SLR and 8th Avenue have not been able to locate as-built drawings of the wall; therefore, the depth of the 100-foot-long westernmost section of the wall is not known. The seawall consists of interlocking sheets of steel.

The construction of the seawall included excavating soil along the inland side of the wall. After the seawall was installed, clean sand and gravel fill was placed along the outside of the seawall (on the water side) and covered with riprap that was supported by a toe trench. The excavated area on the inland side of the seawall was backfilled. The backfill type was not specified on the design drawings. An unnamed Crowley Marine Services, Inc. (Crowley) drawing shows that sand and dredge fill was used to backfill two parts of the excavated area on the inland side of the seawall (see Figure 3).

2.4 STORMWATER DRAINAGE SYSTEM

The stormwater drainage system on Parcel D was installed in the early 1980s after the installation of the seawall and the placement of approximately 20,000 cubic yards (cy) of fill material across the upland portion of Parcel D. After the installation of the drainage system, most of the Subject Property surface was paved with asphalt or concrete. Until 2016, there were 32 stormwater catch basins on Parcel D that were connected to six stormwater conveyance lines with outfalls into the LDW and Slip 4 (Outfalls 1, 2, 3, 4, 5, and 6; designated as OF1 through OF6, respectively). Prior to 2014, Organic Fuel Processors (OFP) closed four of the catch basins (SLR, 2014). The approximate locations of the catch basins, conveyance lines, and outfalls are shown on Figure 2.

The northern portion of the previous stormwater drainage system on Parcel F (northern conveyance line), which included the unpaved portion of the Subject Property, was installed prior to 1946. The installation date of the southern portion of the previous drainage system on Parcel F (southern conveyance line) is not known. Prior to August 2012, the drainage system on Parcel F consisted of three stormwater catch basins that were connected to the northern conveyance line, and four catch basins that were connected to the southern conveyance line (see Figure 2). Based on the results of a video inspection in September 2010, both conveyance lines were blocked with soil at several locations (SLR, 2010). According to a Layrite Concrete Products drawing (titled "Plant Layout") dated June 1946, and an unnamed preliminary drawing, dated approximately 1990 in Crowley's files, there were previously three additional catch basins on the northern conveyance line (see Figure 2). There is no field evidence of those catch basins.

In October 2010, SLR inspected two pipes from the easternmost known catch basin (previously designated FSCB4) on the southern conveyance line to try to find an outfall line from the Parcel F drainage system that extends to Slip 4. An 8-inch-diameter pipe ran to the east from FSCB4 to a buried catch basin, where two, 4-inch-diameter pipes exited the basin (SLR, 2010). The 4-inch pipes extended to the east or northeast of the buried catch basin and at distances of approximately 10 and 25 feet, the pipes were blocked with soil. There was also an 8-inch-diameter pipe that exited the eastern part of FSCB4 (at a depth above the other 8-inch-diameter line) and extended approximately 50 feet to the northeast, where it was blocked with soil. Since the direction of the 8-inch-diameter line was to the north of Slip 4 and it was located above the other 8-inch-diameter line in FSCB4, it is unlikely that this line was an outfall line to Slip 4 (see Figure 2). During the City of Seattle's sediment removal action at the northern part of Slip 4 in 2011 and 2012, two 6-inch-diameter outfall lines were encountered along the northwestern bank of the slip. The lines were cut below the final grade of the bank and capped (Integral Consulting, 2012). The approximate locations of the caps on both of the former outfall lines are shown on Figure 2. Based on the locations of the outfall lines, it appears that both of the 4-inch-diameter pipes from the buried catch basin were expanded to 6 inches in diameter and extended to Slip 4.

Due to poor stormwater drainage on Parcel F, 8th Avenue constructed a replacement stormwater drainage system on Parcel F in July and August 2012, and abandoned the previous system. The replacement system consisted of three catch basins along a northern conveyance line and three catch basins along a southern conveyance line that were connected at a conveyance vault (CV1) that was located approximately 45 feet southeast of the eastern former container repair shop (see Figure 2). The northern and southern conveyance lines were located near the previous conveyance lines. To discharge the water from Parcel F, a conveyance line was installed between CV1 and the existing northern stormwater drain line (D Line #6) on Parcel D, and a deeper CV2 was installed and connected to D Line #6 to allow for stormwater flow via gravity from Parcel F. The collected stormwater from Parcel F was discharged to Slip 4 via outfall OF6 (SLR, 2012).

During the installation of the replacement drainage system, partially buried stormwater catch basins were discovered approximately 6 feet northeast of conveyance vault CV2 and approximately 60 feet south of the eastern former container repair shop (see Figure 2). The catch basin near CV2 was plumbed to D Line

#6, and the catch basin to the south of the eastern former container repair shop was connected to the previous southern conveyance line. After constructing the replacement system, the previous drainage system on Parcel F, including the two discovered catch basins, was abandoned. The lid and ring of each basin were removed, the solids in each basin were extracted and hauled off-site for disposal, and the basins, including the ends of the conveyance lines, were filled with cement (SLR, 2012).

In addition to the stormwater drainage system described above, there are three inactive or abandoned equipment wash water collection sumps in the northern and central portions of Parcel F (see Figure 2). Based on an inspection by SLR in September 2010, each of the sumps contained limited solids and there were no inlet or outlet lines (SLR, 2010). In the walls of the sump beneath the canopy, there is evidence of several 6-inch-diameter holes (possible inlets and/or outlets) that were filled with concrete. The sumps are up to 5 feet deep. During the abandonment of the previous stormwater drainage system on Parcel F, the northeastern wash water collection sump was abandoned by removing the lid and filling it with cement (SLR, 2012).

In November 2009, all of the previous stormwater catch basins and portions of the previous conveyance lines on Parcel F were cleaned by Gary Merlino Construction Company. Alaska Logistics, LLC, a previous Subject Property tenant, cleaned the catch basins in the southern portion of Parcel D in 2006 and 2008 (SLR, 2008).

In 2015, WMNS discovered that the conveyance line to the north of conveyance vault CV1 had been vandalized by someone cutting numerous holes in the line. WMNS plugged the catch basins along the northern conveyance line, as well as the damaged line, and constructed a stormwater infiltration area at the northern part of Parcel F (see Figure 2) that allows stormwater to drain into the subsurface.

WMNS currently operates and maintains the stormwater drainage system under the conditions of an Ecology Industrial Stormwater General Permit (Permit #WAR302034). WMNS has rehabilitated many of the stormwater catch basins, and repaired sections of several underground drain lines. In addition, WMNS has installed a filter insert (Cleanway Metalzorb filter) and/or sediment trap in most of the active catch basins as part of the stormwater protection best management practices (BMPs) that are being conducted at the Subject Property (SoundEarth Strategies, Inc. [SES], 2016). Within the OCA, WMNS plugged the 9 catch basins (see Figure 2), as well as Outfall OF3, and the stormwater that collects in most of those catch basins is pumped into a stormwater pre-treatment system prior to discharge to the sanitary sewer system (under the conditions of KCIW Wastewater Discharge Permit No. 7928-01).

During 2018, WMNS installed a stormwater treatment system at the southwestern part of the property (see Figure 2) to treat the stormwater from the paved areas of the Facility located outside of the OCA. After installation of the stormwater treatment system, WMNS capped all of the existing outfalls, except OF1, and the drain lines located outside of the OCA were re-routed, via forcemain lines and lift stations, to the treatment system. The forcemain line was installed primarily along the surface water side of the sheet pile seawall. The modifications to the stormwater drainage system are shown on Figure 2.

2.5 ADJACENT PROPERTIES

The Subject Property is bounded to the west by 8th Avenue South, a City of Seattle park (Georgetown Pump Station Park), and a Recology Cleanscapes facility; to the northwest by a Provisioners Warehouse and Transportation Services facilty; to the north by South Garden Street, a Markey Machinery Company facility, and a Drywall Recycling Services, Inc. (Drywall Recycling Services) facilty; to the east by City of Seattle property and Slip 4 (including portions of the slip owned by the City of Seattle and The Boeing Company [Boeing]); and to the south by the LDW. The City of Seattle property, which was purchased from 8th Avenue in 2007, includes a narrow strip of land between Parcel F and Slip 4 that extends around the north end of Slip 4, and also includes the northern part of Slip 4 (see Figure 4). Across Slip 4 to the east and southeast are an Emerald Services facility, and the Boeing Plant 2 facility.

A description of the current operations at the adjacent properties is presented below.

2.5.1 RECOLOGY CLEANSCAPES

The Recology Cleanscapes property is located to the west of the Subject Property, across 8th Avenue South, at 7303 8th Avenue South. Current operations at the property include parking of recycling fleet vehicles and compressed natural gas fueling services.

2.5.2 PROVISIONERS WAREHOUSE AND TRANSPORTATION SERVICES

The Provisioners Warehouse and Transportation Services property is located to the northwest of the Subject Property, across 8th Avenue South, at 660 South Othello Street. Current operations at the property include loading/unloading of containers.

2.5.3 MARKEY MACHINERY COMPANY

The Markey Machinery Company property is located to the north of the Subject Property at 7266 8th Avenue South. The Markey Machinery Company provides a variety of services for marine equipment, including rebuilds, refurbishments, and updates.

2.5.4 DRYWALL RECYCLING SERVICES

The Drywall Recycling Services facility is located to the north of the Subject Property at 7201 East Marginal Way South. Drywall Recycling Services is a full-scale commingled material recovery facility that is capable of processing up to 60,000 tons of recyclable materials per year. The facility accepts a variety of materials, including wood, metals, cardboard, paper, drywall, hard and soft plastics, dry carpeting, cloths and rags, mattresses, tires, concrete, asphalt, brick, ceramics, styrofoam, polyurethane foam, and plate glass and windows.

2.5.5 CITY OF SEATTLE AND BOEING PROPERTIES (SLIP 4)

Slip 4 is a 6.4-acre navigational slip located to the east and southeast of the upland portion of the Subject Property. The northern part of the slip is owned by the City of Seattle, and the southeastern portion of the slip is owned by Boeing. The northern part of Slip 4 was the location of an Early Action Area (EAA) within the LDW Superfund Site. Cleanup of the EAA was completed in 2012 by the City of Seattle and the U.S. Environmental Protection Agency (EPA) to address polychlorinated biphenyl (PCB)-contaminated sediment (Integral Consulting, 2012).

2.6 OFF-PROPERTY DRAINAGE INTO SLIP 4

In the LDW area, there are both public and private storm drain systems that convey collected stormwater runoff into the waterway (including into Slip 4). Most of the waterfront properties use privately-owned systems that discharge directly into the waterway.

Prior to the formation of the Municipality of Metropolitan Seattle (now part of KC) in 1958, Seattle and other surrounding communities operated small treatment plants that discharged to Lake Washington, the LDW, and Puget Sound (Ecology, 2006). One of these treatment plants, the Diagonal Treatment Plant, was constructed on East Marginal Way in 1939. In 1966, KC's East Marginal Way pump station was constructed near the north end of Slip 4 (see Figure 4), and was connected to the Duwamish interceptor, a sewer system that conveyed stormwater and municipal and industrial wastewater along East Marginal Way South to the Diagonal treatment plant (Ecology, 2006). The pump station included a 36-inch emergency overflow and stormwater bypass that discharged at the head of Slip 4 (Id.).

There are currently five public stormwater outfalls located at the head of Slip 4 and six private stormwater outfalls located along the eastern end of Slip 4. The locations of the outfalls are shown on a figure by Ecology that is presented in Appendix B. The private outfalls are from the Boeing Plant 2 facility and from the First South Properties site that is operated by Emerald Services. The public outfalls that discharge stormwater into Slip 4 include the following:

1. KC Airport Storm Drain #3/PS44 Emergency Overflow (60-inch-diameter pipe) – Conveys stormwater runoff from the northern portion of KC International Airport and encompasses approximately 290 acres of the Slip 4 drainage area.
2. North Boeing Field Storm Drain (24-inch-diameter pipe) – Collects stormwater runoff from an approximate 1-acre area at the northern end of KC International Airport.
3. I-5 Storm Drain (72-inch-diameter pipe) – A Highway I-5 storm drain collects runoff from approximately 1.5 miles of highway, from 44 acres of single-family residential property located east of I-5, and from 1 to 2 acres at the north end of the KC International Airport.
4. Georgetown Flume (72-inch-diameter pipe) – The Georgetown Flume was originally constructed to discharge cooling water from the Georgetown Steam Plant (GTSP) after the Duwamish River was straightened in 1916 (Ecology, 2006). The 6.5-foot-wide flume, which was replaced with underground piping in 2009, previously consisted of concrete, wooden, and piped sections. The flume extended approximately 2,500 feet across the north end of KC International Airport from

the GTSP to the head of Slip 4. The new 72-inch-diameter pipe also discharges to the head of Slip 4.

5. East Marginal Way Emergency Overflow (36-inch-diameter pipe) – As described above, KC's East Marginal Way pump station is connected to the East Marginal Way emergency overflow. There has not been a recorded overflow from this pump station since record keeping began in the 1970s (KC, 2018).

The combined sewer service area in the Slip 4 basin encompasses approximately 6,200 acres, and the storm drain basin covers approximately 467 acres (Ecology, 2006). The Slip 4 drainage basin is depicted in a figure by Ecology that is presented in Appendix B.

In 2005, Seattle Public Utilities (SPU) installed solids traps at 10 locations in the KC Airport Storm Drain #3/PS44 Emergency Overflow and in the I-5 Storm Drain to passively collect solids samples. In addition, in-line solids samples were collected from several of the trap locations, as well as an additional location. The sample results showed that at least one of the solids samples contained total PCB, bis(2-ethylhexyl)phthalate (BEHP), and mercury concentrations greater than the Ecology's cleanup screening levels (CSLs), and two of the samples contained zinc concentrations greater than the sediment cleanup objective (SCO; Ecology, 2006). SPU also collected in-line solids samples from several locations along the Georgetown Flume. The sample results showed that at least one of the samples contained total PCB, lead, mercury, and zinc concentrations greater than the CSLs, and BEHP and polycyclic aromatic hydrocarbons (PAHs) concentrations greater than the SCOs (Id.). The total PCB concentrations in the samples were up to approximately 43 times greater than the CSL.

In 2005, SPU collected solids samples from an oil/water separator and two stormwater catch basins at the First South Properties site. The analytical results showed that the samples collected from the oil/water separator and one of the catch basins contained zinc, BEHP, butyl benzyl phthalate, dimethyl phthalate, and/or di-n-octyl phthalate concentrations that exceeded the sediment management standards (SMS; Ecology, 2006).

Based on the elevated contaminant concentrations in the solids samples from the Georgetown Flume, the City of Seattle removed the solids in the flume, replaced the flume with an underground storm drain pipe that discharges into Slip 4, and removed PCB-impacted soil from two Seattle City Light substations located next to the flume. In August 2008, the City of Seattle, KC, and Boeing entered into an Agreed Order with Ecology to complete an RI/FS at the North Boeing Field/GTSP site. The purposes of the RI are to define the nature and extent of the soil and groundwater contamination at the site, to try to identify the sources of the known impacted solids in the site stormwater drainage systems, and to determine if contamination at the site is contributing to the sediment impacts in the LDW. The results of the ongoing investigation activities have shown that elevated concentrations of PCBs are present in the storm drain system at North Boeing Field, and that stormwater from North Boeing Field is a source of PCBs in the Slip 4 sediments (EPA, 2010). To limit further impacts to the sediments in Slip 4, Boeing installed and operates a stormwater treatment system at North Boeing Field to remove PCBs and other hazardous substances from the stormwater prior to discharge to Slip 4.

3. HISTORICAL AND CURRENT USES OF SUBJECT PROPERTY

3.1 PROPERTY HISTORY

From approximately 1889 to 1916, the Subject Property was agricultural land, primarily open field pasture (Roy F. Weston Inc., 1988), which was adjacent to a meander of the Duwamish River (presently Slip 4). A private residence appears to have occupied the northern part of Parcel F (Hart Crowser, 1989a). With the dredging of the east and west waterways, the LDW was established in its present course and Slip 4 was isolated in its present configuration by 1916. Beginning in approximately 1918, the southern part of Parcel D was used for the manufacturing of hydraulic equipment and metal pipes (primarily by Washington Supply & Manufacturing Company and Hydraulic Supply Manufacturing Company), and the central part of Parcel D was occupied by sawmill operations (primarily by Pankrantz Lumber Company). By 1922, the southeastern part of Parcel F (and the northeastern part of Parcel D) was occupied by an excelsior (wood shavings) manufacturing company (Washington Excelsior and Manufacturing Company), and the northern part of Parcel F was used for the manufacturing and storage of concrete products (Peerless Concrete Products) (Hart Crowser, 1991).

By 1950, the hydraulic equipment and metal pipe manufacturing operations on Parcel D had added a chain manufacturing facility at the southern end of the Subject Property, and the sawmill operations were no longer present (Hart Crowser, 1989b). Puget Timber Company's creosote treatment facility, which started in the early 1940s and included wood pole and post treatment in a dip tank operation, occupied the western portion of the former sawmill site on Parcel D. By 1950, the Washington Excelsior and Manufacturing Company operations and the concrete products manufacturing operations (replaced by Layrite Concrete Products) on Parcel F were still present; however, the concrete storage area had expanded to the southwestern part of Parcel F and the northwestern end of Parcel D, and an aluminum window and sash manufacturing facility was present in the eastern part of Parcel F. By 1981, all of the structures on Parcel D and a few of the structures on Parcel F had been demolished. Figures 5 and 6 depict the historical activities and operations on Parcels D and F from approximately 1918 to 1949 and 1950 to 1981, respectively.

There were three petroleum USTs and one oil AST located on Parcel F, and an oil AST (in a vault) was located on Parcel D. The former locations of the tanks are shown on both Figures 5 and 6. An 8,000-gallon diesel UST and a 2,000-gallon gasoline UST on Parcel F were removed in 1989 (Hart Crowser, 1989a). The oil AST associated with the excelsior manufacturing operations on Parcel F was removed by 1985, and the oil AST associated with the pipe manufacturing operations on Parcel D was removed prior to 1981. There is no documentation of the removal of a 5,000-gallon fuel-oil UST that was in the northwestern part of Parcel F (SLR, 2014).

By 1985, the Parcel D surface and the southern part of the Parcel F surface had been paved, and the seawall and pier along Slip 4 had been constructed. From the mid-1980s through September 2009, Crowley Marine Services, Inc. (Crowley) used the Subject Property for cargo storage and distribution. From October 2009 to approximately June 2014, Organic Fuel Processors, LLP (OFP) used the south-central portion of the upland part of Parcel D to receive, grind, and store wood used to make compost or produce alternative fuel. OFP subleased the southern and southeastern portions of the upland part of Parcel D to Kelly Ryan Services (KRS) Marine to load/unload cargo from barges and to maintain equipment. From December 2009 to November 2014, Parcel F and the northern part of Parcel D were leased to First Student, Inc., to schedule, stage, and park school buses. From October 2010 to June 2014, OFP expanded their lease area to the eastern part of Parcel D and the southeastern part of Parcel F for equipment storage. Figures 7 and 8 depict the historical activities and operations on Parcels D and F from approximately the mid-1980s to 2009 and from 2010 to 2014, respectively.

Crowley leased the Subject Property from the mid-1980s to 1992. After purchasing the property in 1992, Crowley owned the property until 2008. In October 2008, Crowley transferred the property to 8th Avenue. On April 18, 2014, the property was purchased by DeNovo. During 2016, DeNovo Constructors, Inc., the holding company of DeNovo, began the process of liquidating its assets and assigned its shares of DeNovo to certain creditors of DeNovo Constructors, Inc. On July 17, 2017, the assets of DeNovo, including the Subject Property, were placed in receivership. On March 11, 2019, 8th Avenue acquired the Subject Property from receivership.

Since April 2014, the Subject Property has been leased to WMNS for operation as a materials reload and transfer facility. The current and planned Facility operations are detailed in the Facility's Plan of Operation (Landau, 2017), and include the following industrial activities:

- Offloading, loading, transloading, and storage of bulk non-hazardous contaminated dredge sediments
- Processing of bulk dredge sediments by screening, stabilization, dewatering, and/or mechanical methods
- Unloading, storage, and transloading of contaminated upland soil
- Offloading, loading, transloading, and storage of bulk and containerized non-putrescible, solid and semi-solid wastes
- Offloading, loading, transloading, and storage of marine cargo and equipment
- Offloading, loading, transfer, and storage of containerized non-hazardous contaminated materials in closed rigid containers and closed non-rigid containers
- Storage of trucks, vehicles, rail cars, and equipment
- Mooring of marine vessels
- Offloading, loading, transloading, and storage of clean bulk soils, sands, and gravels
- Offloading, loading, transloading, and storage of non-hazardous bulk liquids
- Processing and treatment of contaminated stormwater for discharge to sanitary sewer
- Offloading, loading, transloading, storage, processing, and treatment of bulk and containerized wastewater

In 2014 and 2015, WMNS installed the OCA in the cental part of the Subject Property for materials offloading, handling, and loading operations (see Figure 2). The OCA includes a variety of operational equipment, including a storm/process water pre-treatment system, sediment de-watering systems, and processing equipment. WMNS has also installed a perimeter chain-link fence around all sides of the Subject Property, except along the LDW and Slip 4 (see Figure 2). All of the existing Facility improvements by WMNS have been temporary and may be removed to facilitate Site cleanup where necessary. WMNS' previous improvements at the Subject Property are depicted on Figure 2. In addition to the stormwater treatment system installation and associated drainage system modifications described in Section 2.4, WMNS has recently implemented several facility improvements, including adding a third railroad track to the primary rail spur in 2018, upgrading the electrical infrastructure in 2019, and replacing fender piles on the piers in 2019. WMNS plans to expanding the OCA and pave the stormwater infiltration area at the northern end of Parcel F during 2020. WMNS' stormwater treatment system and associated drainage system modifications, as well as the third railroad track on the primary spur, are shown on Figure 2.

Table 1 summarizes the land use history of the Subject Property. The following sections describe in detail the historical operations at the Subject Property through the early 1980s. There were limited potential contaminant sources at the Subject Property after the early 1980s.

3.1.1 FORMER CONCRETE PRODUCTS MANUFACTURING AND STORAGE OPERATIONS

From the 1920s through the early 1980s, a concrete products manufacturing operation was present on Parcel F (see Figures 5 and 6). The operations were initially located only in the northern part of Parcel F, but by the mid-1940s, concrete products were also stored at the southwestern part of Parcel F and the northwestern end of Parcel D. By the mid-1940s, a building that housed the drying kiln and boiler, as well as four additional small buildings that housed mixers, were located in the northwestern part of Parcel F. By 1960, an office building, three aggregate storage silos, and a storage shed were located in the northeastern part of Parcel F. By 1969, the existing canopy and a storage shed (designated on Figure 7 as the western Former Container Repair Shop due to post-1980 property operations) were constructed in the southern and west-central parts of Parcel F, respectively. A fuel-oil UST was located in the northwestern part of Parcel F and a gasoline UST was located in the northeastern part of Parcel F. The gasoline UST was removed in 1988, but it is not known if the fuel-oil UST was removed. All of the structures were demolished in the early 1980s, except the office, two of the silos, the canopy, and the western storage shed. The office building, the silos, and the western storage shed were demolished within the past four years as part of property redevelopment.

3.1.2 FORMER ALUMINUM WINDOW MANUFACTURING OPERATION

From the late 1940s through the 1970s, an aluminum window and sash manufacturing operation was present at the eastern end of Parcel F. The operation included one building that was constructed in the late 1940s, along with a diesel UST at the northern end of the building (see Figure 5). The UST was removed in 1988 and the building was demolished during the 1990s.

3.1.3 FORMER SAWMILL OPERATIONS AND EXCELSIOR FACTORY

From 1917 to 1941, sawmill operations were present in the central part of Parcel D. The structures associated with the operations consisted of a mill building, a boiler house, three wood bins, a fuel bin, and a refuse burner (see Figure 5). All of the structures, which were constructed prior to 1920, were demolished before 1946.

From the 1920s through the 1970s, an excelsior (wood shavings) manufacturing operation was present at the southeastern part of Parcel F and the northeast corner of Parcel D. The structures associated with the operation included a warehouse, three factory and press buildings, a chimney, and two cottonwood storage sheds that were constructed in the 1920s (see Figure 5). An oil AST (likely heating oil) was located along the northwestern part of the warehouse building, and a pole-mounted electrical transformer was located along the northern end of the northern factory and press building.

The southern factory and press building, and associated chimney were demolished in the late 1940s or the 1950s. All of the other structures were demolished, and the AST and the transformer were removed during the early 1980s.

3.1.4 FORMER WOOD TREATING OPERATIONS

From the early 1940s to approximately 1957, a wood treating operation was present in the northwestern part of Parcel D. Information is not available about the type of wood treatment process or the chemicals used in the process. The structures initially associated with the operation consisted of an office, a garage, a boiler building, two creosote tanks, and a pole dipping tank (see Figure 5). In 1954, a pump house building that contained some tanks was constructed. A treated pole storage area was located to the east of the structures. The pole dipping tank was removed prior to 1960, and the garage and boiler building were demolished prior to 1969. All of the other structures were demolished by the early 1980s.

3.1.5 FORMER PIPE AND CHAIN MANUFACTURING OPERATIONS

From 1918 to the mid-1970s, a hydraulic equipment and metal pipes manufacturing operation was present in the southern part of Parcel D. The initial structures associated with the operations consisted of two offices, a garage, a pipe manufacturing building, a blacksmith shop, and a pipe dipping shop (see Figures 5 and 6). The pipe dipping shop included a furnace and two dipping kettles. Pipe drying and storage skids were located to the west of the pipe dipping shop. In the late 1930s, the operations were expanded to include chain manufacturing at the southern end of the Subject Property, and a chain manufacturing and coating building, a compressor house, and an acetylene generator shed were constructed. In the 1940s, the pipe manufacturing building was expanded to the south, the two office buildings were expanded, and a travelling crane was installed to the north of the pipe manufacturing building (see Figure 6). An annealing oven was installed at the southwest corner of the chain manufacturing building and a sandblast operation was located at the eastern end of the building. The blacksmith operations were discontinued during the 1940s. A 1,000-gallon oil AST (likely heating oil) was located along the east side of the southern office building. All of the structures were demolished and the oil AST was removed during the late 1970s.

3.1.6 DREDGE FILL AREAS

Based on a plan drawing of the seawall construction (Marine Power & Equipment Co., Inc., 1982), approximately 5,500 cy of sloughed material from the top of the bank along Slip 4 and the LDW were dredged during the construction of the seawall. The dredged material and approximately 14,500 cy of imported material were used to regrade the upland surface of Parcel D in the early 1980s. According to an unnamed drawing that was included in Crowley's files, there are three areas of dredge fill and two areas of dredge and sand fill at the Subject Property. The dredge and sand fill was used to backfill portions of the excavated area inland of the seawall. The approximate locations where the dredged material was backfilled are shown on Figure 3.

During the dredging activities, potentially impacted soil from the bank and potentially impacted sediment in Slip 4 and the LDW could have also been excavated and used as fill.

3.2 PREVIOUS UPLAND INVESTIGATIONS AND REMEDIAL ACTIONS

Several previous investigations have been conducted at the Subject Property to identify and assess potential contaminant source areas, and a remedial action was conducted in association with removals of USTs. A brief description of each investigation and remedial action is presented below. A summary of the field and analytical methods applied during the previous investigations and remedial action is presented in Table 2. The sampling locations from the previous investigations are shown on Figure 3.

3.2.1 1988 HART CROWSER REMEDIAL ACTION

In November 1988, Hart Crowser directed the removal of the 8,000-gallon diesel UST and the 2,000-gallon gasoline UST from the northeastern part of Parcel F. The former locations of the tanks are shown on Figure 3. During the excavations, a total of 50 cy of petroleum hydrocarbon-impacted soil was removed and hauled off-site for disposal at a landfill (Hart Crowser, 1989a). Sidewall and floor samples were collected from each excavation for laboratory analysis of total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene, and total xylenes (BTEX). The sample analytical results showed that xylenes were detected in four of the samples at concentrations above the method reporting limits (MRLs).

3.2.2 1989 HART CROWSER INVESTIGATION – PARCEL F

During November 1988, Hart Crowser conducted soil and groundwater investigation activities to assess the environment conditions at various locations on Parcel F of the Subject Property where past industrial uses could have potentially caused contamination. The investigation included installing one monitoring well (designated MW-1) in the former diesel UST excavation, collecting five composite surface soil samples (designated SS-1 to SS-5), and drilling and sampling one soil boring and completing the boring as a monitoring well (designated HC-2) (Hart Crowser, 1989a). The investigation locations are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of volatile organic compounds (VOCs), Extraction Procedure (EP) toxicity metals (currently referred to as Toxicity Characteristic Leaching Procedure [TCLP] metals), PCBs, gas chromatograph/flame ionization detector (GC/FID) screen for base, acid, and neutral (BAN) compounds, and pesticides. The groundwater samples from the wells were submitted for laboratory analysis of dissolved metals, VOCs, semi-volatile organic compounds (SVOCs), pesticides, and PCBs.

The soil sample analytical results showed that at least one sample contained concentrations of metals (cadmium, selenium, and zinc), VOCs (acetone, ethylbenzene, methylene chloride, toluene, and total xylenes), pesticides (endosulfan I), and/or PCBs (Aroclor-1248 and Aroclor-1254) above the MRLs. The groundwater sample analytical results showed that at least one sample contained concentrations of EP toxicity metals (antimony, arsenic, copper, and zinc) and/or BEHP above the MRLs (Hart Crowser, 1989a).

3.2.3 1988 - 1989 HART CROWSER INVESTIGATION – PARCEL D

Between November 1988 and June 1989, Hart Crowser conducted soil and groundwater investigation activities to assess the environment conditions at various locations on Parcel D of the Subject Property where past industrial uses could have potentially caused contamination. The investigation included drilling and sampling 18 soil borings (designated HC-1 and HC-4 through HC-20), completing four of the soil borings as groundwater monitoring wells (HC-1, HC-4, HC-19, and HC-20), and collecting groundwater samples from the newly installed wells (Hart Crowser, 1989b). The locations of the borings and wells are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of VOCs, total arsenic, EP toxicity metals, phenol compounds, PCBs, GC/FID screen for BAN compounds, and/or pesticides. The groundwater samples were submitted for laboratory analysis of dissolved metals, VOCs, SVOCs, pesticides, and PCBs.

The soil sample analytical results showed that at least one or more samples contained concentrations of total arsenic, extractable arsenic, extractable zinc, extractable copper, phenanthrene, acetone, and/or PCBs (Aroclor-1254) above the MRLs. The groundwater sample analytical results showed that at least one sample contained concentrations of dissolved antimony, dissolved arsenic, dissolved cadmium, dissolved chromium, dissolved copper, dissolved nickel, dissolved zinc, and/or BEHP above the MRLs (Hart Crowser, 1989b).

3.2.4 1990 LANDAU ENVIRONMENTAL SITE ASSESSMENT

During April 1990, Landau Associates, Inc. (Landau) performed supplemental investigation activities to provide “a more complete and comprehensive assessment of environmental conditions on the First Interstate Property.” The Landau investigation included Parcels D and F of the Subject Property, in addition to Slip 4 and Parcel E (which is located to the south of Slip 4 and is not part of the Subject Property). This summary only includes the investigation activities performed on Parcels D and F.

The investigation activities on Parcels D and F included drilling and sampling 19 soil borings (designated DB1 to DB14 and FB1 to FB5) on Parcels D and F, collecting 3 surface soil samples (designated FSS1 to FSS3) on Parcel F, completing 6 of the borings on Parcels D and F as groundwater monitoring wells (designated DMW2, DMW3, DMW6, FMW1, FMW2, and FMW3), and collecting groundwater samples from the newly installed monitoring wells (Landau, 1990). The locations of the borings and wells are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of VOCs, SVOCs, PCBs, TPH, chlorinated phenolics, and/or metals (arsenic, cadmium, chromium, copper, lead, nickel, and zinc). The groundwater samples were submitted for laboratory analysis of VOCs, SVOCs, TPH, chlorinated phenolics, and/or metals (arsenic, cadmium, chromium, copper, lead, nickel, and zinc). The soil sample analytical results showed that at least one or more samples contained at least one the following analytes at concentrations above the MRLs:

- Metals - arsenic, cadmium, chromium, copper, lead, nickel, and zinc
- PCBs – Aroclor 1254 and Aroclor 1260
- SVOCs – Phenol, 1,4-dichlorobenzene, 2-methylphenol, 4-methylphenol, 2,4-dimethylphenol, 4-chloro-3-methylphenol, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, dibenzofuran, fluoranthene, fluorene, pentachlorophenol, phenanthrene, anthracene, di-n-butylphthalate, fluoranthene, pyrene, benzo(a)anthracene, BEHP, chrysene, benzo(b,k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene
- Chlorophenolics - pentachlorophenol, 3,4,5-trichlorophenol, 2,3,5,6-tetrachlorophenol, and 2,3,4,6-tetrachlorophenol
- VOCs – vinyl chloride, methylene chloride, acetone, carbon disulfide, 1,1-dichloroethane, cis-1,2-dichloroethene, 2-butanone, trichloroethene, benzene, 4-methyl-pentanone, 2-hexanone, tetrachloroethene, toluene, chlorobenzene, ethylbenzene, styrene, and total xylenes
- TPH

The groundwater sample analytical results showed that at least one or more samples contained at least one of the following analytes at concentrations above the MRLs:

- Metals – arsenic, cadmium, chromium, copper, lead, nickel, and zinc
- SVOCs – pentachlorophenol, naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, dibenzofuran, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, BEHP, and chrysene
- VOCs – methylene chloride, acetone, cis-1,2-dichloroethene, ethylbenzene, and total xylenes

3.2.5 1990 HART CROWSER SUPPLEMENTAL SITE CHARACTERIZATION – PARCEL D

During August and September 1990, Hart Crowser conducted supplemental investigation activities on Parcel D to provide additional data that could refine their estimated remediation costs. The investigation included drilling and sampling 10 soil borings (designated HC-101 to HC-110) and collecting groundwater samples from seven monitoring wells on Parcel D (HC-1, HC-4, HC-19, HC-20, DMW2, DMW3, and DMW6) and from one upgradient well on Parcel F (F-MW02; Hart Crowser, 1990). The locations of the borings and wells are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of arsenic, PAHs, TPH, and/or TCLP. The groundwater samples were submitted for laboratory analysis of total and/or dissolved arsenic, and PAHs. The soil sample analytical results showed that at least one or more samples contained concentrations of total arsenic, total cPAHs, naphthalene, and/or TPH above the MRLs. The groundwater sample analytical results showed that at least one or more samples contained concentrations of dissolved arsenic, total arsenic, naphthalene, total carcinogenic PAHs (cPAHs), and/or total PAHs above the MRLs (Hart Crowser, 1990).

3.2.6 1994 SEACOR INVESTIGATION

During July 1994, SEACOR conducted soil and groundwater investigation activities to evaluate potential areas of environmental concern associated with historical use of the Subject Property. In particular, the investigation focused on the former USTs, historical operational areas of concern, and the distribution of lead in subsurface soils. The investigation included advancing and sampling 13 hand auger borings (designated HA-1 to HA-13); drilling, sampling, and installing 3 monitoring wells (designated MW-1, MW-2, and MW-3); and collecting groundwater samples from the newly installed wells (SEACOR, 1994). The locations of the borings and wells are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of hydrocarbon identification (HCID), VOCs, alcohols, SVOCs (cresols, nitrobenzene, and pyridine only), and/or lead. The groundwater samples were submitted for laboratory analysis of gasoline-range organics (GRO), diesel-range organics (DRO), oil-range organics (ORO), BTEX, VOCs, alcohols, SVOCs (cresols, nitrobenzene, and pyridine only), and/or dissolved lead. The soil sample analytical results showed that multiple samples contained lead concentrations above the MRL. The groundwater sample analytical results showed that at least one sample contained concentrations of TPH in the gasoline-range, diesel-range, and heavy oil-range, and/or toluene above the MRLs (Id.).

3.2.7 2008 SLR INVESTIGATION

In June and July 2008, SLR conducted investigation activities on the Subject Property to evaluate the potential for hazardous substance releases on the property to impact the sediments in Slip 4. The investigation included drilling and sampling seven soil borings, completing the borings as groundwater monitoring wells (designated CMW-1 through CMW-7), and collecting groundwater samples from the newly installed wells (SLR, 2008). The locations of the wells are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of DRO, ORO, GRO, PCBs, VOCs, Resource Conservation and Recovery Act (RCRA) 8 metals, PAHs, and SVOCs. The groundwater samples were submitted for laboratory analysis of DRO, ORO, GRO, PCBs, VOCs, total and dissolved RCRA 8 metals (and copper), PAHs, and SVOCs. The soil sample analytical results showed that one or more samples contained the following analytes at concentrations above the MRLs:

- Metals – arsenic, barium, cadmium, chromium, lead, and mercury
- VOCs – 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and naphthalene
- SVOCs – acenaphthene, acenapthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzyl butyl phthalate, carbazole, chrysene, dibenzofuran, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene
- Petroleum hydrocarbons – DRO, ORO, and GRO
- PCBs (Aroclor-1254)

The groundwater sample analytical results showed that one or more samples contained the following analytes at concentrations above the MRLs:

- Total metals – arsenic, barium, chromium, copper, lead, and selenium
- Dissolved metals – arsenic, barium, chromium, copper, and selenium

- SVOCs – naphthalene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, carbazole, chrysene, dibenzofuran, fluoranthene, fluorene, 2-methylnaphthalene, phenanthrene, and pyrene
- VOCs – chloromethane
- Petroleum hydrocarbons – DRO

3.2.8 2009 STRATA BASELINE ASSESSMENT

In December 2009, Strata Environmental (Strata) conducted an environmental baseline assessment at the northern part of the Subject Property. The purpose of the assessment was to evaluate the soil conditions prior to First Student leasing and operating on the property. The investigation activities included drilling and sampling 11 soil borings (designated SB-1 through SB-11) (Strata, 2010). The locations of the borings are shown on Figure 3. The selected soil samples were submitted for laboratory analysis of DRO, ORO, GRO, VOCs, PAHs, and RCRA 8 metals. The soil sample analytical results showed that one or more samples contained concentrations of metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, and mercury), VOCs (acetone, benzene, chloromethane, 2-butanone, tetrachloroethene, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, and 1,3,5-trimethylbenzene), GRO, DRO, ORO, and/or PAHs (anthracene, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene) above the MRLs (Id.).

3.2.9 2010 SLR SOIL SAMPLING ALONG STORMWATER DRAINAGE SYSTEM

In October 2010, a test pit (designated TP100810) was excavated near the eastern end of Parcel F to try to locate the stormwater drainage line downstream of a blockage in the line. The location of TP100810 is shown on Figure 3. Stained soil was observed during excavation of the test pit, and a soil sample was collected from the stained zone for laboratory analysis of DRO, ORO, PAHs, and PCBs. The soil sample analytical results showed that the sample contained DRO, ORO, and PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene) at concentrations above the MRLs (SLR, 2010).

3.2.10 2011 - 2012 SLR INVESTIGATION ASSOCIATED WITH STORMWATER DRAINAGE SYSTEM REPLACEMENT

In August 2011 and August 2012, SLR performed investigation activities to assess the potential soil and groundwater impacts from the previous stormwater drainage system and to further evaluate potential contaminant sources on Parcel F. The investigation included drilling and sampling seven soil borings (designated SLR-1 through SLR-7), completing five of the borings as groundwater monitoring wells (designated SLR-1, SLR-2, SLR-3, SLR-6, and SLR-7), collecting groundwater samples from the five newly installed wells and two existing monitoring wells (CMW-1 and CMW-2), and collecting five soil samples (designated SCV-12’, Trench 1-1-8’, Trench 1-2-9’, Trench 2-1-8’, and Trench 4-1-3.0’) from the trenching during construction/replacement of the drainage system. The locations of the soil borings, monitoring wells, and trench soil samples are shown on Figure 3. The soil and groundwater samples were submitted for laboratory analysis of PCBs, SVOCs, PAHs, priority pollutant metals, VOCs, GRO, DRO, ORO, and salinity (groundwater only).

The soil sample analytical results showed that one or more samples contained concentrations of PAHs (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene), SVOCs (4-methylphenol, pentachlorophenol, BEHP, butyl benzyl phthalate, di-n-butyl phthalate, and diethyl phthalate), metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), VOCs (acetone and methylene chloride), and/or petroleum hydrocarbons (GRO, DRO, and ORO) above the MRLs. The groundwater sample analytical results showed that one or more samples contained concentrations of PAHs (fluoranthene, 2-methylnaphthalene, naphthalene, and phenanthrene), metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), and/or VOCs (acetone, methylene chloride, tetrachloroethylene, and total xylenes) above the MRLs (SLR, 2012).

3.2.11 PREVIOUS SAMPLING OF STORMWATER CATCH BASIN SOLIDS

Prior to the RI, catch basin solids samples were collected in 2004, 2008, and 2009 from at least one stormwater catch basin on Parcel D. Catch basin solids samples were not collected from any of the catch basins on Parcel F. A brief description of each catch basin solids sampling event is presented below.

During a joint Seattle Public Utilities (SPU)/Ecology inspection of the 8th Avenue Terminals operations in 2004, a solids sample was collected from one of the stormwater catch basins (DP4CB3; designated by SPU as CB37) on Parcel D. DP4CB3 is located in the central part of Parcel D (see Figure 2). The sample was analyzed for PAHs, phthalates, PCBs, metals (arsenic, copper, lead, mercury, and zinc), and petroleum hydrocarbons. The analytical results showed that the sample contained detected concentrations of PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, acenaphthene, anthracene, fluorene, fluoranthene, pyrene, and phenanthrene] metals (copper, lead, mercury, and zinc), BEHP, butyl benzyl phthalate, dimethyl phthalate, DRO, ORO, and GRO (Ecology, 2006).

In July 2008, SPU collected a composite solids sample (designated CB123-071908) from two catch basins (DP3CB1 and DP5CB1) on Parcel D. Catch basins DP3CB1 and DP5CB1 are located at the southern and southeastern ends of the upland portion of the Subject Property (see Figure 2). The sample was analyzed for PAHs, phenols, phthalates, PCBs, metals (arsenic, copper, lead, mercury, and zinc), and petroleum hydrocarbons. The analytical results showed that the sample contained detected concentrations of PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, anthracene, fluoranthene, naphthalene, 2-methylnaphthalene, phenanthrene, and pyrene], metals (arsenic, copper, lead, and zinc), butyl benzyl phthalate, DRO, and ORO (Ecology, 2009).

In December 2009, Strata collected solids samples (designated STORM-5, STORM-13, and STORM-14) from three catch basins (DP6CB1, DP3CB5, and DP4CB3, respectively) on Parcel D to assess the environmental conditions in the catch basins prior to First Student leasing and operating at the Subject Property. The locations of the catch basins are shown on Figure 2. The samples were analyzed for PAHs, metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), VOCs, and petroleum hydrocarbons. The analytical results showed that all of the samples contained detected concentrations of metals (arsenic, barium, cadmium, chromium, lead, and mercury), VOCs (acetone, benzene, and 2-butanone), petroleum hydrocarbons (DRO and ORO), and PAHs (fluoranthene and pyrene). The sample from DP3CB5 also contained concentrations of VOCs (p-isopropyltoluene, styrene, trichlorofluoromethane, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, 1,3,5-trimethylbenzene, and total xylenes), petroleum hydrocarbons (GRO), and PAHs (anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, 2-methylnaphthalene, and phenanthrene) above the MRLs. The sample from DP4CB3 also contained VOCs (p-isopropyltoluene, styrene, toluene, trichlorofluoromethane, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, and total xylenes), petroleum hydrocarbons (GRO), and PAHs (anthracene, chrysene, 2-methylnaphthalene, naphthalene, and phenanthrene) above the MRLs (Strata, 2010).

3.3 PREVIOUS SEDIMENT DREDGING ON 8TH AVENUE TERMINALS PROPERTY

In 1981, Marine Power & Equipment Company, Inc. (Marine Power & Equipment) dredged approximately 85,000 cy of sediment from the western side of Slip 4 (PTI Environmental Services [PTI], 1995). This dredging was part of the construction of the pier and berthing facility on the Subject Property. The dredging activities deepened Slip 4 and the LDW, within the entire Subject Property area and beyond the current property line to the west, southwest, and north, by more than 12 feet (to an elevation of -15.2 feet Mean Lower Low Water [MLLW]). Figures that depict the dredging area are presented in Appendix C. Cross sections of the slip prior to dredging indicated that the maximum depth of the slip was approximately -3 feet MLLW. The post-dredging depth of the western portion of the slip was -15.2 feet MLLW. Based on the cross sections of the dredging activities that are presented in Appendix C, it appears that the dredging removed all of the sediments above the top of the underlying native soil. The dredged material was disposed in open water at the 4-Mile Rock disposal site in Elliott Bay. There are no known records of any sampling associated with the work, except for a letter by the EPA that states that the material to be dredged had relatively high concentrations of sulfides (EPA, 1980). Copies of the U.S. Army Corps of Engineers (USACE) records for the dredging permit, including figures that show plan and cross-sectional views of the planned dredging area are presented in Appendix C.

In 1996, American Construction Co., Inc., under the supervision of Hartmann and Associates, Inc., and on behalf of 8th Avenue, dredged a total of approximately 10,977 cy of sediment and underlying material from the southwestern part of Slip 4. The approximate area of dredging is shown on Figure 9. The dredging, which was a maintenance activity to allow for continued pier access by barges and tugboats, deepened the 8th Avenue-owned portion of the slip to approximately -15 feet MLLW. Prior to the dredging, sediment samples were collected in 1994 and 1995 to characterize the material for potential open-water disposal under the Puget Sound Dredged Disposal Analysis (PSDDA) program. In 1994, PTI collected surface sediment samples from eight locations (designated 1 through 8) in the southern part of Slip 4, including three (locations 1, 2, and 3) from the planned dredging area. The approximate locations of the surface sediment samples are shown on Figure 9. The samples were analyzed for metals, SVOCs, and PCBs. None of the samples from the planned dredging area contained contaminant concentrations that exceeded the PSDDA maximum levels (PTI, 1995); however, samples 7 and 8, which were located east and northeast of the Subject Property, contained total PCB concentrations that exceeded Ecology's cleanup screening level (CSL). All of the samples, including the three samples from the planned dredging area, contained total PCB concentrations that exceeded Ecology's sediment cleanup objective (SCO). In 1995, the planned dredging area was divided into four dredged material management units (DMMUs), and two sediment cores were collected and composited from each DMMU. The approximate locations of the sediment cores are shown on Figure 9. The samples were analyzed for metals, SVOCs, PCBs, and VOCs, and only the composite sample from DMMU 1 contained a contaminant (fluoranthene) concentration that exceeded a PSDDA maximum level (PTI, 1996). The sample analytical results also showed that all four samples contained total PCB concentrations that exceeded the SCO. The sample from DMMU 1 also contained PAH [benzo(g,h,i)perylene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, chrysene, dibenz(a,h)-anthracene, indeno(1,2,3-cd)pyrene, and phenanthrene] concentrations that exceeded the SCOs. All four samples were subsequently analyzed for bioassay and/or bioaccumulation testing, and based on the toxicity results, only the sediments from DMMU 2 were suitable for disposal at a PSDDA site. A total of 2,285 cy of dredged material from DMMU 2 was disposed at a PSDDA open water disposal site, and 8,692 cy of material from the other three DMMUs were disposed at the Columbia Ridge Landfill in Arlington, Oregon. There are no records of any post-dredging sediment sample analytical results.

The navigation channel in the LDW is maintained by the USACE. Waterway maintenance has been performed since completion of the channel in 1916 to maintain the appropriate depths in the federal navigation channel for commercial vessel traffic (Weston Solutions, Inc. [Weston], 1999).

3.4 PREVIOUS SEDIMENT INVESTIGATIONS

As described in Section 3.3, Marine Power & Equipment dredged approximately 85,000 cy of sediment from the western side of Slip 4 in 1981. Since the dredging removed all of the sediments and extended to the top of the underlying native soil, the dredging activities likely removed any sediment on the Subject Property that had been impacted by historic sources at the property or by neighboring historic sources. Since 1981, a number of sediment investigations have been conducted in Slip 4, in conjunction with the LDW Superfund Site. In addition, sediment dredging actions have been conducted in Slip 4 to remove PCB contaminated sediments. A brief description of the sediment investigation and dredging activities are presented below.

From 1983 through 1988, a total of 11 surface sediment samples (designated DR-07, DR-08, DS4-1, DS4-2, DS4-3, E19, E19A, E19B, LTSL01, LTSL02, and LTTK01) were collected from Slip 4 during investigations by the EPA, Metro, PTI and Tetra Tech, and HartCrowser (Landau, 1990). Seven of the samples were located on or adjacent to the Subject Property. The investigation results showed that the total PCB concentrations were highest at the head of Slip 4 and decreased with distance towards the LDW. A figure by Landau that shows the surface sediment sample locations and the total PCB concentrations (in milligrams per kilogram [mg/kg] dry weight [DW]) is presented in Appendix C. Since the total organic carbon concentrations in the samples are not known, the total PCB data were compared to Ecology's marine sediment apparent effects thresholds (AET) SCO and CSL (Table 8-1 of WAC 173-204), which are referred to as the lowest AET

(LAET) and the 2nd lowest AET (2LAET), respectively. Each of the surface sediment samples contained total PCB concentrations (ranging from 0.25 to 4,100 mg/kg DW) that exceeded the LAET (0.13 mg/kg DW), and eight of the samples contained total PCB concentrations that exceeded the 2LAET (1.0 mg/kg DW) (Landau, 1990).

In 1990, Landau collected surface sediment samples (SL-4-1 through SL-4-12) at 12 locations throughout Slip 4, including at 4 locations (SL-4-1 through SL-4-4) within or adjacent to the Subject Property. Landau also collected subsurface sediment cores (SL-4-1A through SL-4-12A) that were up to 10 feet deep at 12 locations throughout Slip 4. Most of the core locations (including the 4 cores located within or adjacent to the Subject Property) were at the same locations as the surface sediment samples. Figures by Landau that show the approximate locations of the surface sediment samples and sediment cores are presented in Appendix C. The samples were analyzed for metals, PCBs, and SVOCs. The sample analytical results showed that the highest total PCB concentrations in the surface and subsurface samples were at the head of the slip and decreased with distance toward the LDW (Landau, 1990). Lead and BEHP were also present at the head of the slip at concentrations greater than the SCOs. The four surface sediment samples located within or adjacent to the Subject Property contained total PCB concentrations that exceeded the SCO. Surface sediment samples SL-4-3 and SL-4-4 also contained phenol concentrations above the SMS cleanup screening level (CSL), and SL-4-4 contained a benzoic acid concentration greater than the CSL. Subsurface sediment samples from SL-4-3A (at 2 to 3 feet deep) and SL-4-4A (at 2.5 to 4 feet deep) contained total PCB concentrations that exceeded the CSL, and samples from SL-4-2A (at 2 to 3.75 feet deep) and SL-4-3A (at 4 to 6 feet deep) contained total PCB concentrations that exceeded the SCO. The sample from SL-4-2A (at 2 to 3.75 feet deep) also contained PAH [acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, fluoranthene, dibenzofuran, and phenanthrene] concentrations above the CSLs and benzo(g,h,i)perylene and anthracene concentrations greater than the SCOs. The sample from SL-4-3A (at 2 to 3 feet deep) also contained a BEHP concentration that exceeded the SCO.

During several investigations that were conducted in 1998 and 1999, surface sediment samples were collected from a total of 29 locations in Slip 4, including at the mouth of the slip (Integral, 2005). Three of the samples were located on the Subject Property. Figures by Integral that show the locations of the 1998 and 1999 surface sediment samples are presented in Appendix C. Total PCBs concentrations exceeded the CSL in nearly all of the surface samples located in the northern part of the slip, and exceeded the SCO (but less than the CSL) in several of the samples located in the southern part of the slip. On the Subject Property, a total PCB concentration greater than the CSL was detected in a sample (DR181) located at the northeast corner of the property, and a total PCB concentration greater than the SCO (but less than the CSL) was detected in a sample (EST170) located at the east-central part of the property (see Integral Figure 2 in Appendix C).

In 2004, additional surface sediment samples were collected at 29 locations, and sediment cores (up to 12 feet deep) were collected at 11 locations in Slip 4. In addition, one intertidal sample was collected along the eastern shore of Slip 4 and bank samples were collected at six locations. Eight of the surface sediment samples and three of the core samples were located on the Subject Property. Figures by Integral that show the locations of the 2004 samples are presented in Appendix C. The total PCB concentrations in six of the surface samples, including in one sample (SG16) at the northern part of the Subject Property, exceeded the SCO but were less than the CSL (Ecology, 2006 and Integral, 2005). Total PCB concentrations exceeded the CSL at three surface sample locations at the head of the slip and at the intertidal area along the eastern bank of the slip (Integral, 2005). At two surface sediment sample locations in the northeastern part of Slip 4, BEHP and/or PAH concentrations exceeded the CSLs. At sample SG16 (at the northern part of the Subject Property), BEHP and phenol concentrations were above the SCOs.

In 2004, subsurface sediment samples were analyzed at 9 of the 11 core locations, including at 1 of the core locations on the Subject Property. Total PCB concentrations exceeded the CSL in six of the cores and exceeded the SCO (but were less than the CSL) in two of the cores (including the core [SC06] at the northern end of the Subject Property). The total PCB concentrations greater than the CSL occurred at locations in the northern part of Slip 4, at depths ranging from 0 to 8 feet. Mercury concentrations exceeded the CSL at three cores located near the head of the slip, and silver concentrations exceeded the CSL at one core location near the head of the slip (Integral, 2004).

The total PCB concentrations in the 2004 surface sediment samples were typically lower than the concentrations in the surface sediment samples collected during the 1990s. In all cases, the total PCB concentrations in the 2004 surface sediment samples were lower than the concentrations in the top interval (0 to 2 feet) of the collocated core (Integral, 2006). The top interval core samples contained composited surface and subsurface sediment. Within Slip 4, the highest PCB concentrations were found at the head of the slip (near the five public stormwater outfalls described in Section 2.6), with concentrations decreasing toward the LDW (Ecology, 2006).

In 2010, as part of the RI/FS at the North Boeing Field/Georgetown Steam Plant, SAIC collected surface sediment samples (0 to 10 centimeters depth) at 20 locations in the northern part of Slip 4. None of the samples were located on the Subject Property. A figure by SAIC that shows the 2010 surface sediment sample locations is presented in Appendix C. The purpose of the work was to model the potential for recontamination of the sediments after the City of Seattle's planned remediation of the northern part of Slip 4 was completed. All of the samples were analyzed for PCBs, metals, and SVOCs, and six composited samples were analyzed for dioxins/furans (D/F). The sample analytical results showed that the PAHs, PCBs, lead, mercury, zinc, BEHP, and total D/F toxicity equivalent (TEQ) concentrations decreased with distance away from the head of the slip, and that the stormwater drainage system discharges at the head of Slip 4 were the primary sources of the sediment contamination in the slip (SAIC, 2010).

In addition to the sediment sampling in Slip 4, a subsurface sediment core (SC45) was collected in 2006 from the LDW, approximately 110 feet south of the southwestern corner of the Subject Property, and a surface sediment sample (741) was collected from the waterway, approximately 80 feet southwest of the southwestern corner of the Subject Property. A figure by SAIC that shows the locations of SC45 and 741 is presented in Appendix C. The 2- and 4-foot-deep samples from SC45 contained total PCB concentrations that exceeded the SCO (SAIC, 2008). Sample 741 contained PAH (fluorene and phenanthrene) concentrations that exceeded the CSL, and benzo(a)anthracene, fluoranthene, chrysene, dibenzofuran, and indeno(1,2,3-cd)pyrene concentrations that exceeded the SCOs, but were below the CSLs. The sources of the PCBs and PAHs at SC45 and 741, respectively, are not known.

After Ecology determined that the sources of the impacted sediments in the northern part of Slip 4 had been adequately controlled, the City of Seattle conducted a cleanup of the contaminated sediments in the Slip 4 Early Action Area (EAA) of the LDW Superfund Site. From October 2011 through February 2012, cleanup of the EAA was conducted within the City of Seattle property at the northern part of Slip 4. The work included: 1) dredging and off-site disposal of sediments from the northern end of Slip 4, 2) installing a sand/gravel cap over the remaining impacted sediments within the City of Seattle property, and 3) bank excavation and surface capping (Integral, 2007). A total of approximately 10,256 cy of contaminated nearshore bank soils and bottom sediments were excavated, transloaded, and disposed in a Subtitle D landfill. The work also included the removal of the northern 440-foot-long section of the pier along Parcel D. Prior to and immediately after cleanup of the EAA, the City of Seattle collected surface sediment samples from four locations (designated BD-1, BD-2, BD-3, and BD-4) at the northern end of the Subject Property (within the EAA boundary sampling area) to assess the potential impacts from the remedial action to the neighboring sediments. Total PCB concentrations exceeded the SCO at two of the sample locations (BD-2 and BD-4) prior to construction (in August 2011), and at all four sample locations following construction on February 2, 2012 (Integral, 2012). Following the City of Seattle's placement of 9 inches of waterway cap material over the boundary area on the Subject Property in February 2012, the total PCB concentrations in the four surface sediment samples collected on February 14, 2012, were less than the SCO at each sample location.

In October 2012, the City of Seattle collected eight surface sediment samples (SG-18, SB-20, SG-21, SG-22, SG-24, SG-25, SL4-2, and SL4-3) on the Subject Property to determine if the EA construction activities impacted the surface sediments further southwest of the EAA boundary area. Only the five northernmost samples were analyzed and the other three samples were archived. The two northernmost samples (SG-18 and SL4-3) contained total PCB concentrations that exceeded the SCO (Integral, 2013). A figure by Integral that shows the locations of the 2011 and 2012 surface sediment samples on the Subject Property is presented in Appendix C. The sediment sample analytical results showed that the City of Seattle's dredging activities in Slip 4 adversely impacted surface sediments on the Subject Property.

In 2014, as part of the Duwamish Sediment Other Area (DSOA) Corrective Measure, Boeing dredged four areas within the Boeing-owned portion of Slip 4 to a nominal depth of 2, 3, or 4 feet (AMEC, 2015). Prior to backfilling the dredge areas, Boeing collected post-construction core samples as detailed in the EPA-approved Post-Construction Core Sampling Work Plan (AMEC et al., 2012). The results from the core samples indicated that total PCB concentrations were below the SCO in three of the four areas (AMEC, 2015). In one area, concentrations of PCBs were elevated at the bottom of the dredge cut. As approved by EPA, additional core samples were collected within the Boeing-owned portion of Slip 4 to determine the horizontal and vertical extents of the elevated PCB concentrations. Based on the results of the additional core sampling, additional dredging was conducted in February 2015 within the Boeing-owned portion of Slip 4. Figures that show the Boeing core sample locations and dredge areas are presented in Appendix C.

Based on the previous surface sample analytical results and the subsurface sediment/soil sample analytical results, the stormwater drainage system discharges at the head of Slip 4 were the primary sources of the sediment contamination in the slip. Based on the distribution of the contamination, there is no evidence of any significant contaminant source from the historic or current operations at the Subject

Property, or the 1981 dredging removed any historic sediment contamination from the property. The only potential exception is that the PCB and PAH contamination in the LDW (at samples SC45 and 741) may have been due to sources at the Subject Property; however, there are numerous known upriver sources of PCBs and PAHs that could have impacted the sediments at samples SC45 and 741.

4. ENVIRONMENTAL SETTING

This section describes the environmental setting of the Site. Information discussed in this section includes the geology and hydrogeology at the Subject Property, and LDW surface water and sediment characteristics.

4.1 GEOLOGY AND HYDROGEOLOGY

4.1.1 REGIONAL GEOLOGY

The Subject Property is located in the Duwamish Valley, which is a former marine embayment that extended as far south as Auburn (Fabritz et al., 1998). Approximately 5,700 years ago, a large mudflow from Mount Rainier filled the upper portion of the embayment. Sediment historically carried by the White River and Green River, and erosion of the extensive mudflow deposits, filled the embayment over time and shifted the marine shoreline to the north. With time, silt, sand, and gravel filled the valley and created the modern river environment and floodplain. As the river continued to flood and migrate across the valley, sediments were re-worked and ongoing river sedimentation took place from upriver (Id.).

The geologic units underlying the Duwamish Valley include bedrock, glacial deposits, marine deposits, and river/floodplain deposits. The bedrock beneath the Subject Property area (beneath the North Boeing Field/Georgetown Steam Plant [NBF-GTSP] site) is probably a few hundred feet deep (Fabritz et al., 1998; and Booth and Herman, 1998). Glacial deposits in the area predominantly include those from the last glacial advance, referred to as the Vashon stage (approximately 15,000 years ago) (Leidos, 2013). The Duwamish Valley is bounded to the east and west by uplands covered by Vashon glacial till and outwash deposits. To the east of the Subject Property, at Boeing Plant 2, a number of deep boreholes identified the top of the glacial units at depths that range from 70 to more than 130 feet below ground surface (bgs) (Leidos, 2013).

Marine embayment sediment deposits overlie the glacial deposits in the Duwamish Valley, and the sediment deposits are overlain by river/floodplain deposits. In the area of Boeing Plant 2, borehole data show that a silt-rich layer typically overlies the Vashon glacial deposits, including silt, clay, and sand with common shell fragments (Leidos, 2013). The top of the marine sediment deposits range in the depth from approximately 65 to 100 feet bgs. The marine sediments unit grades upward into an alluvial deposit that consists of a lower zone of fine sand with silt or silty sand. Above a depth of approximately 30 to 60 feet bgs is an upper alluvial zone that generally consists of fine to medium sand with minor silt or gravel (Id.). Fill material of sand, silt, and gravel typically occupies the upper 3 to 20 feet bgs.

The portion of the Duwamish River valley where the Subject Property is located has undergone extensive excavation and filling since the early 1900s. The extent of excavation and filling varies from property to property. The Subject Property is located along the original shoreline of the Duwamish River, such that the extent of fill activity is less than at other nearby properties (i.e., fill thicknesses are greater at properties located in former river bends and side channels).

4.1.2 SITE GEOLOGY

The Site geology has been determined by the previous subsurface investigation activities and the borings completed as part of the RI. The surficial geology beneath the upland portion of the Subject Property generally consists of approximately 5 to 17 feet of sand, gravel, or silty sand/sandy silt fill. The uppermost part of the fill unit primarily consists of gravel fill that intermittently occurs near the ground surface and is typically less than 3 feet thick. The sand fill typically occurs beneath the gravel fill, where present, and it can extend to the base of the fill unit (up to approximately 17 feet thick). Silty sand to sandy silt fill occurs at the bottom of the fill unit, where present, and it is up to approximately 9 feet thick. There are also localized thin layers of silt, silty gravel, or organic soil fill within the fill unit. The fill contains concrete, brick, wood, and other debris along the southern and eastern edges of the Subject Property, near the seawall. The fill is underlain by a native sand unit that extends to a depth of at least 80 feet bgs. There are localized thin silty sand, sandy silt, and silt layers within the sand unit. Cross sectional views of the geology beneath the upland portion of the Subject Property (Sections A-A' and B-B') are shown on Figures 10 and 11. The locations of cross sections A-A' and B-B' are shown on Figure 12.

4.1.3 REGIONAL HYDROGEOLOGY

In general, the groundwater within the Duwamish Valley is unconfined within the valley alluvium at depths up to 10 feet bgs (Booth and Herman, 1998). Regionally, the valley alluvium is a single, large aquifer system. The maximum depth of the alluvial aquifer in the LDW basin extends to roughly 100 feet bgs.

Site-specific studies in the LDW basin often subdivide the alluvial aquifer into shallow, intermediate, and deep zones (Windward Environmental, LLC [Windward], 2010). The shallow zone is generally located within the fill and/or younger alluvium, and the deep zone is generally located within the older alluvium. Shallow aquifer zones in the LDW basin are predominantly located in silty layers within interbedded sandier aquifer soils. In many areas, these shallow aquifers contain large amounts of organic material associated with the original river delta.

The flow characteristics of the aquifer zones vary depending on the nature of the materials that make up the local alluvium, the proximity to the river, and local tidal fluctuations. The elevation gradient between the glacially overridden deposits in the uplands and the LDW sediments creates a regional flow system with significant hydraulic potential for the transport of groundwater from the upland areas to the LDW.

4.1.4 SITE HYDROGEOLOGY

The upland portion of the Subject Property is mostly paved, and stormwater is directed into Slip 4 and the LDW through catch basins, underground and above-ground piping, a stormwater treatment system, and an outfall. As a result, the local groundwater flow system beneath the property does not receive significant recharge from precipitation, except at the northern end of Parcel F. The groundwater beneath the property is unconfined and occurs in the fill soils and the underlying sand unit to a depth of at least 80 feet bgs (the maximum depth of investigation). During the first phase of the RI, the hydrogeologic characteristics of the unconfined groundwater were assessed by using shallow monitoring wells screened across the groundwater table (screened from approximately 5 to 20 feet bgs) and intermediate-depth monitoring wells (previously designated as deep wells during the first phase of the RI) screened at depths of approximately 40 to 50 feet bgs. During the second phase of the RI, four deeper groundwater monitoring wells (designated as deep wells) were installed, and these wells were screened at depths of approximately 75 to 80 feet bgs.

As discussed in Section 2.3, a sheet pile seawall and associated pier were constructed along the eastern and southern perimeter of the upland portion of the Subject Property. The location of the seawall is shown on Figure 12. The plan drawings do not show the seawall extending from the western end of the pier to the western property line; however, sheet pile that is similar to the seawall is visible above the riprap to the west of the pier. The seawall consists of interlocking sheets of steel plate. The design elevation of the bottom of the seawall was approximately -29 feet, which is approximately 43 feet bgs along the pier (see Figure 10).

4.1.4.1 2008 Tidal Study

In July 2008, SLR conducted a tidal study to assess the interactions between the LDW (including Slip 4) and the shallow groundwater beneath the Subject Property. Groundwater elevations were monitored at wells CMW-4, CMW-5, CMW-6, CMW-7, DMW-3, and DMW-6, and in a Slip 4 stilling well through at least one full tidal cycle. The stilling well is located at the current northeastern end of the pier (see Figure 12). Depths to water varied from approximately 7 to more than 16 feet bgs (SLR, 2008). At the highest high tide on July 17, 2008, the water elevation in Slip 4 (in a stilling well) was 9.29 feet above the NAVD 88 datum, and the groundwater elevations in the monitoring wells ranged from 4.99 to 6.33 feet above the NAVD 88 datum. At the lowest low tide on July 18, 2008, the water elevation in Slip 4 was 4.01 feet below the NAVD 88 datum, and the groundwater elevations in the monitoring wells ranged from 0.79 to 3.66 feet above the NAVD 88 datum.

Groundwater and surface water elevations measured during the 2008 tidal study demonstrated that the seawall was retarding flow between the shallow groundwater and the water in Slip 4 (SLR, 2008). During high tide conditions, the monitoring well with the greatest tidal response and shortest response time (time lag) was CMW-7, located approximately 80 feet east of the southwestern end of the seawall (see Figure 12). In the wells located further toward the middle of the seawall (CMW-6, CMW-5, and CMW-4), the tidal response decreased and time lag increased with distance away from the southwestern end of the seawall. During low tide conditions, the greatest tidal response was also at CMW-7, and the response lessened with distance away from the southwestern end of the seawall. For both rising and falling tides, the slowest response was observed at CMW-5, suggesting that shallow groundwater flow occurs around both the northern and southern ends of the seawall and that these flows converge near CMW-5 (Id.).

A discussion regarding groundwater flow directions and gradients at the Subject Property is presented in Section 5.2.

4.2 LDW SURFACE WATER

The LDW is a stratified, saltwater wedge estuary influenced by freshwater flow and tidal effects that generally flows north to Elliott Bay, though the river flow is subject to periodic reversal due to tidal influences. The waterway receives the majority of its flow from the Green River, which originates at the crest of the Cascade Mountains near Stampede Pass and flows through the Howard Hanson Dam (River Mile [RM] 65) and the Tacoma Headworks Dam (RM 61). The average annual discharge from the Duwamish Waterway is 65.2 to 66.7 cy per second (cy/s), measured at the U.S. Geological Survey Tukwila gauging station, with flow rates varying from 5.6 to 430 cy/s at the Auburn gauging station from 1962 to 1994 (NOAA, 1998).

Most of the LDW discharge (i.e., 80 percent) enters Elliott Bay via the Duwamish West Waterway due to the presence of a sill on the East Waterway (Weston, 1999). Flow rates are greatest in the winter because of seasonal precipitation and lowest throughout the late summer dry season. Streamflow can be increased by surface water sources, such as storm drains, combined sewer overflow (CSO) outfalls, industrial effluents, and nonpoint source inputs, although these sources of flow are expected to be less than 1 percent of total discharge, even during peak flow events (Windward, 2003).

4.3 LDW SEDIMENT TRANSPORT

The estuarine features and sediment transport characteristics of the LDW are presented in the following sections. These topics are discussed further in the LDW RI Report (Windward, 2010).

4.3.1 ESTUARINE FEATURES

The LDW is a stratified, saltwater wedge estuary influenced by freshwater flow and tidal effects (Stoner, 1972). The saltwater wedge, which has its source in Elliott Bay, oscillates upstream and downstream with the tide and stream flow. During periods of low freshwater inflow and high-tide stage, the saltwater wedge has extended as far upstream as the Foster Bridge at RM 8.7. The relative influence of freshwater flow is highly seasonally dependent. Freshwater moving downstream overlies the tidally driven saltwater wedge. Typical of saltwater wedge estuaries, the LDW has a sharp interface between the freshwater outflow at the surface and saltwater inflow at depth. A 25-part-per-thousand salinity layer near the river mouth occupies most of the water depth, but tapers toward the upriver portion of the estuary. Freshwater inflow exerts a strong influence on the relative thicknesses of the two layers. The thickness of the freshwater layer increases with increasing river flow rates throughout the LDW.

Saltwater principally enters the LDW through the lower water column of the West Waterway. The saltwater wedge discharges into the flowing surficial freshwater lens as a result of upward entrainment of saline water across the interface, separating the two layers. To replace the entrained saltwater, the net transport of the saltwater wedge is in the upstream direction, even if the saltwater wedge is stationary. Dye studies indicate that downward vertical mixing over the length of the saltwater wedge is almost nonexistent (Schock et al., 1998). Tidal forcing superimposes an additional velocity component associated with the migration of the saltwater wedge upstream and downstream in response to tidal cycles. Santos and Stoner (1972) described how the upstream location or “toe” of the saltwater wedge, which is typically located between Slip 4 and Turning Basin 3, is determined by both tidal elevation and freshwater inflow.

4.3.2 SEDIMENT TRANSPORT

Sediment transport within the LDW is influenced by many variables, including hydrodynamic forces attributable to the saltwater wedge, sediment loading from upstream and upland sources, channel morphology, and resuspension processes, such as propeller scour, bioturbation, bed shear stress, and dredging. Sediment deposition and resuspension have been assessed in the LDW during previous investigations. The LDWG Phase 1 RI Report (Windward, 2003) and subsequent Draft Phase 2 RI Report (Windward, 2004) compiled and summarized these assessments.

The following sections summarize the LDWG findings with respect to sediment transport properties river-wide and in the vicinity of the Subject Property.

4.3.2.1 River Currents and Propwash

Several organizations have independently measured current velocities within the LDW as part of a wide range of environmental investigations (Santos and Stoner, 1972; Stevens, Thompson & Runyan, 1972; Stoner et al., 1975; Prych et al., 1976; Harper-Owes, 1983; Weston, 1993; and KC, 1999). The most extensive current velocity measurements within the LDW were collected by KC for a 3-month period beginning in August 1996, recording currents at approximately 3 feet above the mudline at 15-minute intervals at two stations using acoustic Doppler methods (KC, 1999). The net flow velocities and short-term velocity fluctuations within the upper (freshwater) and lower (saltwater) layers were characterized. The velocity profiles showed a net seaward flow (positive values) in the upper freshwater half of the water column and net upstream flow in the lower saline half of the water column. No bottom water speed greater than 60 centimeters per second (cm/s; the upper range of assumed threshold current for sediment bed movement) was observed during the recording interval. The 50th, 90th, and 95th percentile speeds for station SBW were 17, 33, and 37 cm/s, respectively. Measured currents exceeded 40 cm/s (the bottom range of assumed threshold current for sediment bed movement) less than 3 percent of the time at station SBW.

LDW RI studies have demonstrated that under all tidal conditions and design flood events (i.e., 2-, 10-, and 100-year storms), the saltwater wedge in the Duwamish Waterway extends upstream beyond the Subject Property. Sediment deposition is facilitated by the interaction of the saltwater wedge with the overlying freshwater (Windward, 2003). Freshwater moving downstream overlies the tidally driven saltwater wedge. When fresh river water encounters the saltwater wedge, the freshwater no longer applies a shear stress to the riverbed, but instead applies a stress to the top of the saltwater wedge, causing the bed load to deposit. This results in sediment movement (with associated chemicals) upstream during flood tide conditions, and potential deposition on and adjacent to the Subject Property under the appropriate hydraulic and tidal conditions discussed above. The salinity also increases sediment deposition by increasing particle flocculation (Windward, 2003).

4.3.2.2 Sediment Transport Evaluations

The LDWG Phase 1 RI evaluated previous sediment transport investigations conducted in the LDW to determine which parameters contribute to sediment transport. The results of the evaluation indicate that the sources of sediment in the reach of the LDW in the vicinity of the Subject Property potentially originate from both upstream and downstream locations depending on the tidal cycle and the hydraulic characteristics.

The most long-term sediment mobility study was conducted by Harper-Owes (1983), which compiled and synthesized the available flow and suspended sediment loading data collected within the LDW from 1960 to 1980 to assess river-wide sediment sources. During this period, the Green River upstream of the Subject Property was the predominant source of sediment loading, contributing approximately 99 percent of the total sediment load entering the LDW. The remaining 1 percent was contributed from local sources along the LDW (e.g., upland runoff and a variety of discharges). The study determined that the majority of the sediment input to the LDW occurred during peak flow events (i.e., sediment solids loading increased significantly during peak discharges).

As reported by Harper-Owes (1983), the LDW has been a net sink for sediments during all river flow conditions from 1960 to 1980. Sediments deposited within the LDW have either contributed to steady accretion of the bed or have been removed from the system (disposed of off-site) through routine channel maintenance and berth dredging operations (Windward, 2003). These results are consistent with the findings of the more recent sediment transport model (STM) developed for the LDW, described below.

A three-dimensional STM (QEA, 2008) was developed to simulate water flow and sediment erosion and deposition over a range of flow and tidal conditions for the LDW. The STM estimated that, on average, over 200,000 metric tons of sediment enters the LDW each year, and that approximately 25 percent of the incoming sediment remains in the LDW (as newly deposited material) after dredging. Based on the STM, approximately 99 percent of the sediment entering the LDW is from upstream, and approximately 1 percent is directly discharged into the LDW via storm drains, CSOs, and small streams. Although direct discharges to the LDW only account for approximately 1 percent of the sediment load to the LDW, the contaminant concentrations in these sediments are much higher than in the sediments coming in from upriver.

Erosion and sediment deposition rates predicted by the LDW STM are summarized in the LDW ROD (EPA, 2014). Results from the STM indicate that the LDW is a net depositional environment, with annual sedimentation rates typically greater than 1 cm per year in subtidal areas and less than 1 cm per year in intertidal areas of the LDW. Sediments adjacent to the Subject Property (i.e., at RM 2.8) have an annual net sedimentation rate of over 3 cm per year, with slightly lower sedimentation rates along the property's shoreline with Slip 4 (1 to 3 cm per year). According to the STM, routine vessel operations in shallow and berthing areas of the LDW (including those adjacent to the Subject Property) cause localized propeller-wash scour to depths of 22 to 60 cm; routine vessel operations in the LDW navigation channel are predicted to mix sediments to depths of 1 to 2 cm. The STM's predictions are corroborated by sediment data collected in the same LDW locations over time, which indicate that natural recovery is occurring in some areas of the LDW (EPA, 2014).

5. REMEDIAL INVESTIGATION ACTIVITIES

This section provides an overview of the RI activities that have been performed in multiple phases as part of implementation of the AO. The first phase of the RI (Phase 1) was conducted from May 2013 through February 2014 by SLR, and consisted of collecting the data necessary to assess potential contaminant source areas, to better understand contaminant fate and transport and associated potential receptors, and to further review the ARARs for the Site. A Final Data Gaps Report was prepared by SLR in October 2014 that described the field activities completed during Phase 1 of the RI and the results of Phase 1 sampling and testing, and included a preliminary CSM and RI data gaps to be addressed during implementation of the Phase 2 activities.

In July 2014, Anchor conducted soil sampling and chemical testing in coordination with Ecology and DeNovo to support implementation of planned Subject Property re-development activities (i.e., rail construction) that were required by Ecology to be completed under an Interim Action (IA) process in accordance with the AO. As part of that IA planning effort, soil samples were collected from borings located in the northeastern, central, and southern parts of the Subject Property, and groundwater samples were collected from three groundwater monitoring wells (EMW-5S, HC-19, and DMW6) that were subsequently decommissioned in anticipation of construction of the new rail line.

In November 2014, a draft SAP Addendum document addressing the second phase (Phase 2) of the RI was submitted to Ecology (Anchor, 2014), which identified potential remaining RI data gaps for the Site, and proposed additional data collection activities required to complete the RI. The Phase 2 RI sampling activities began (concurrent with Ecology review/comment to the SAP Addendum) in November 2014 and were completed in January 2015. The Phase 2 sampling included additional soil investigation, monitoring well installation, one groundwater monitoring event, a tidal study, and surface and subsurface sediment sampling in the LDW, at an area located near the southwest corner of the Subject Property.

Phase 1 and Phase 2 of the RI were conducted in accordance with the RI/FS Work Plan (Ecology, 2012), including modifications accepted by 8th Avenue and Ecology (Ecology, 2013). The Phase 1 fieldwork (including sampling methods) and analytical procedures were conducted in accordance with the RI/FS Work Plan's Sampling and Analysis Plan (SAP). The Phase 2 fieldwork and analytical procedures were conducted in accordance with the draft SAP Addendum (Anchor, 2014). The RI/FS Work Plan, including the SAP, the Ecology (2013) letter that presented the accepted modifications to the RI/FS Work Plan, and the draft SAP Addendum are presented in Appendix A. Sampling field data logs (including soil boring and sediment core logs) and tables that summarize the RI samples and analyses are presented in Appendix D. The available soil boring logs from all of the previous investigations at the Site are also included in Appendix D.

The upland RI sampling locations are shown on Figure 12, and the RI sampling locations in the LDW (including Slip 4) are shown on Figure 13. Table 3 summarizes the sequence of the RI investigation activities.

5.1 RI SOIL INVESTIGATION ACTIVITIES

Multiple phases of soil sampling have been conducted as part of the RI and IA process. Figure 12 shows the locations of the RI and IA soil borings, as well as the previous soil sampling locations. Details of each phase of RI soil sampling, as well as the IA soil sampling, are discussed in the following subsections.

5.1.1 PHASE 1 RI SOIL SAMPLING

Phase 1 of the RI included soil sampling from 31 soil borings (EB-5, EB-14, EB-16, EB-17, EB-24, EB-28, EB-32, EB-38, EB-40, EB-41, EB-45, EB-46, EB-47, EB-50, EB-51, EMW-1S, EMW-2S, EMW-3S, EMW-4D, EMW-5S, EMW-6S, EMW-7S, EMW-8S, EMW-9S, EMW-10D, EMW-11, EMW-12S, EMW-13S, EMW-14D, EMW-15D, and EMW-16D), completing 11 of the borings as shallow groundwater monitoring wells (EMW-1S, EMW-2S, EMW-3S, EMW-5S, EMW-6S, EMW-7S, EMW-8S, EMW-9S, EMW-11S, EMW-12S, and EMW-13S), and completing 5 of the borings as intermediate-depth groundwater monitoring wells (EMW-4D, EMW-10D, EMW-14D, EMW-15D, and EMW-16D). The locations of the Phase 1 RI soil borings and monitoring wells are shown on Figure 12. A minimum of three soil samples collected from each of the borings, at target depths of 1, 5, 10, and 15 (where applicable) feet bgs, were submitted for laboratory analysis. The soil samples collected at target depths of 2.5, 7.5, and 12.5 feet bgs were also submitted to the laboratory and archived. Soil samples from the five deeper borings were also collected and archived at target depths of 20, 25, 30, 40, 45, and 50 feet bgs.

The soil samples from the Phase 1 borings were analyzed for metals (including mercury), PCBs, PAHs, SVOCs, DRO, ORO, and VOCs. Soil samples from borings EB-5, EB-32, EMW-12S, EMW-13S, and EMW-16D were also analyzed for GRO based on previous property operations (e.g., proximity to former USTs, the former garage, and the equipment maintenance shop). Select samples from borings EB-14, EB-28, EB-46, EMW-5S, and EMW-9S were also analyzed for dioxins and furans (D/F) based on previous operations (e.g., proximity to the former chimney, former refuse burner, and former oven/incinerator building). Select samples from borings EB-45, EMW-3S, and EMW-6S were analyzed for D/F based on field observations (e.g., the presence of charred wood and/or ash). The two soil samples with the highest total chromium concentrations (EB-32-5.0 and EB-38-5.0) were analyzed for hexavalent chromium. The results of the Phase 1 RI soil sampling are discussed in Section 7.4.

5.1.2 IA SOIL SAMPLING

IA soil sampling was conducted by Anchor in July 2014 to support implementation of planned development activities (i.e., rail construction). The purpose of the investigation was to evaluate soil conditions throughout the proposed IA project area, and to develop the extents of planned soil removal activities associated with the IA. Ultimately, the IA soil removal activities were not completed.

The investigation activities included sampling soil from 42 soil borings (IAB-1 through IAB-42). The locations of the borings are shown on Figure 12. Soil samples from each boring were collected from the anticipated bottom depth(s) of the planned excavation, as well as from a 2-foot-deeper interval, for laboratory analysis. In addition, soil samples collected from the top of the saturated zone, and from approximately 15 and 20 feet bgs were submitted to a laboratory for archiving and possible analysis.

Soil samples from the IA investigation were analyzed for metals (including mercury), PCBs, PAHs, SVOCs, DRO, ORO, and VOCs. Deeper samples (9 to 11 feet bgs and 11 to 13 feet bgs) from select borings (IAB-20, IAB-22, IAB-25, IAB-39, and IAB-41) were submitted for a subset of the above analyses. Samples from select borings (IAB-13, IAB-14, IAB-15, IAB-16, IAB-17, IAB-21, IAB-22, IAB-23, IAB-24, IAB-25, IAB-26, IAB-32, and IAB-36) were also submitted for analysis of D/F. The results of the IA soil sampling are discussed in Section 7.4.

5.1.3 PHASE 2 RI SOIL SAMPLING

Phase 2 of the RI was performed to address the remaining investigation data gaps after completing Phase 1 of the RI. The RI/FS Work Plan (Ecology, 2012) proposed drilling and sampling 39 soil borings for the Phase 2 RI investigation. However, based on an evaluation of the updated CSM and the remaining data gaps after the Phase 1 RI and IA sampling, 13 of the proposed borings were eliminated, and 20 of the proposed borings were moved to more effectively address data gaps. The SAP Addendum (Anchor, 2014) provided additional details regarding these changes.

The Phase 2 soil investigation included soil sampling from 31 soil borings (EB-03, EB-06, EB-07, EB-11, EB-12, EB-13, EB-19, EB-20, EB-22, EB-23, EB-25, EB-27, EB-30, EB-31, EB-34, EB-35, EB-36, EB-42, EB-44, EB-49, EB-53, EB-55, EB-56, EMW-5SA, DMW-6A, EMW-17S, EMW-18S, EMW-19D, EMW-20D, EMW-21D, and EMW-22D). Four of the borings were completed as shallow groundwater monitoring wells (replacement wells DMW-6A and EMW-5SA, and new wells EMW-17S and EMW-18S), and four of the borings were completed as deep groundwater monitoring wells (EMW-19D, EMW-20D, EMW-21D, and EMW-22D). The Phase 2 soil boring and monitoring well locations are shown on Figure 12. Based on the evaluation of soil data gaps from Phase 1, soil samples collected during the installation of replacement well EMW-5SA were not submitted for laboratory analyses. A minimum of two soil samples from each boring, except EMW-5SA, and up to eight soil samples from select borings, based on previous analytical results and the data gaps, were submitted for laboratory analysis. Soil samples were collected for analysis or archive from shallow borings (less than 20 feet deep) at target depths of 2 to 4, 5 to 7, 8 to 10, 11 to 13, and 15 to 17 feet bgs. For the deep borings (greater than 20 feet deep), additional samples were collected for analysis or archive at target depths of 18 to 20, 28 to 30, 38 to 40, 48 to 50, 58 to 60, 68 to 70, and 78 to 80 feet bgs. The samples were collected as close as possible to the target depths; however, some samples were adjusted slightly as warranted by obstructions or observations in the field.

Based on the remaining investigation data gaps, the soil samples from the Phase 2 borings were selectively analyzed for metals (including mercury), PCBs, PAHs, SVOCs, DRO, ORO, GRO, VOCs, extractable petroleum hydrocarbons (EPH), volatile petroleum hydrocarbons (VPH), and D/F. The results of the Phase 2 RI soil sampling are discussed in Section 7.4.

5.2 RI GROUNDWATER INVESTIGATION ACTIVITIES

Multiple rounds of groundwater sampling were conducted during the RI. Figure 12 shows the locations of the groundwater monitoring wells at the Site. Details of each phase of the RI groundwater sampling are discussed in the following subsections.

5.2.1 PHASE 1 RI GROUNDWATER SAMPLING

As described above, a total of 16 groundwater monitoring wells were installed during Phase 1 of the RI, including 11 shallow wells (EMW-1S, EMW-2S, EMW-3S, EMW-5S, EMW-6S, EMW-7S, EMW-8S, EMW-9S, EMW-11S, EMW-12S, and EMW-13S) and 5 intermediate-depth wells (EMW-4D, EMW-10D, EMW-14D, EMW-15D, and EMW-16D). The shallow wells were screened from approximately 5 to 20 feet bgs, and the intermediate-depth wells were screened from approximately 40 to 50 feet bgs. Shallow monitoring wells FMW-2 and MW-3 were decommissioned in accordance with the requirements of WAC 173-160 in June and September 2013, respectively. In accordance with the RI/FS Work Plan (Ecology, 2012), the newly installed wells were developed by using surging and pumping methods after installation. The well depths and screened intervals of the monitoring wells at the Site are presented in Appendix D.

Three groundwater monitoring events were conducted during Phase 1 of the RI; two quarterly low-tide monitoring events were conducted in July and October 2013, and one supplemental high-tide monitoring event was conducted in September 2013. The high-tide monitoring event was conducted between the first two quarterly monitoring events to evaluate the surface water effects on the groundwater conditions. The first quarterly groundwater sampling event was performed at least seven days after monitoring well development. The depth to groundwater in each well at the Site was measured, and field parameters including temperature, pH, dissolved oxygen (DO), oxidation reduction potential (ORP), turbidity, and conductivity were allowed to stabilize before the samples were collected. The wells were purged and sampled by using low-flow methodology. The groundwater samples collected during the low-tide monitoring events were analyzed for chloride, total and dissolved metals, PCBs, PAHs, SVOCs, total dissolved solids (TDS), DRO, ORO, GRO, total suspended solids (TSS), and VOCs. The groundwater samples collected during the high-tide monitoring event were analyzed for chloride, total and dissolved metals, TDS, and TSS. The results of the Phase I groundwater sampling are discussed in Section 7.5.

5.2.2 PHASE 1 GROUNDWATER MONITORING

During the first phase of the RI, groundwater monitoring data were collected from shallow and intermediate-depth groundwater monitoring wells on July 10, 2013 (during seasonal low-low tide conditions in the LDW), September 23, 2013 (during seasonal high-high tide conditions), and October 2, 2013 (during seasonal low tide conditions) (SLR, 2014). During each groundwater monitoring event, the depth of the surface water in Slip 4 was measured at the stilling well. The groundwater and surface water monitoring data from the 2013 events are presented in Appendix D and are discussed in Section 5.2.6.

5.2.3 IA GROUNDWATER SAMPLING

During the IA investigation, three shallow groundwater monitoring wells (DMW-6, EMW-5S, and MW-2) were sampled for dissolved metals analyses, and then decommissioned in July 2014, in accordance with the requirements of WAC 173-160. Shallow well HC-19 was also decommissioned; however, it could not be sampled prior to decommissioning because it had been damaged (Anchor, 2014). HC-19 and MW-2 were not replaced due to their proximity to other monitoring wells that provide shallow groundwater data. DWM-6 and EMW-5S were replaced during Phase 2 of the RI (see Section 5.2.4). The results of the IA groundwater sampling are discussed in Section 7.5.

5.2.4 PHASE 2 RI GROUNDWATER SAMPLING

During Phase 2 of the RI, a total of eight groundwater monitoring wells were installed, including two new shallow wells (EMW-17S and EMW-18S), two replacement shallow wells (DMW-6A and EMW-5SA), and four deep wells (EMW-19D, EMW-20D, EMW-21D, and EMW-22D). The shallow wells were screened from approximately 5 to 20 feet bgs, and the deep wells were screened from approximately 75 to 80 feet bgs. In accordance with the RI/FS Work Plan (Ecology, 2012), the newly wells installed wells were developed by using surging and pumping methods.

In December 2014, a groundwater sampling event was conducted during Phase 2 of the RI. Groundwater samples were collected from each well at the Site during low tide conditions. The samples were collected at least 24 hours after development of newly installed wells, in accordance with the Draft Phase 2 SAP Addendum (Anchor, 2014). The depth to groundwater in each well at the Site was measured, and field parameters including temperature, pH, DO, ORP, turbidity, and conductivity were allowed to stabilize before the samples were collected. The groundwater samples were analyzed for chloride, total and dissolved metals, PCBs, PAHs, SVOCs, TDS, DRO, ORO, and VOCs. The results of the Phase 2 groundwater sampling are discussed in Section 7.5, and copies of the groundwater sampling data sheets are presented in Appendix D.

5.2.5 PHASE 2 TIDAL STUDY

During the Phase 2 tidal study, transducers were installed in 20 monitoring wells for a week (from December 29, 2014 to January 5, 2015), and set to record water level measurements at 10-minute intervals. Transducers were installed in 11 shallow wells (CMW-1, CMW-4, CMW-7, DMW-3, DMW-6A, EMW-1S, EMW-3S, EMW-5SA, EMW-7S, EMW-12S, and SLR-6) completed to depths of approximately 20 feet bgs, 4 intermediate-depth wells (EMW-4D, EMW-10D, EMW-15D, and EMW-16D) completed at depths of approximately 50 feet bgs, 4 deep wells (EMW-19D, EMW-20D, EMW-21D, and EMW-22D) completed at depths of approximately 80 feet bgs, and in the stilling well in Slip 4. The locations of the monitoring wells and the stilling well are shown on Figures 14 through 20. Four of the monitoring well locations are shallow/intermediate/deep well groupings spread across the Subject Property that were used to calculate horizontal and vertical hydraulic gradients (see Section 5.2.6).

Consecutive hourly water-level measurements were used from a 72-hour period of the tidal data (December 29, 2014 to January 1, 2015) to conduct Serfes analyses that provide a mean groundwater elevation at each well location (Serfes, 1991). The low and high tide groundwater elevations used to create groundwater elevation contour maps (see Figure 14 and Figures 16 through 20) were based on the lowest and highest tides observed in the stilling well during the 72-hour tidal study. In addition, groundwater elevations in the shallow monitoring wells during mean tide conditions were also used to create a groundwater elevation contour map (see Figure 15). The groundwater and surface water monitoring data from the Phase 2 tidal study are presented in Appendix E and are discussed in Section 5.2.6. The groundwater and surface water elevations during low, mean, and high tide conditions of the tidal study are presented in Table 4.

5.2.6 HYDROGEOLOGIC CONDITIONS BASED ON RI DATA

The hydrogeologic conditions beneath the Site were further interpreted based on the data collected during the high-high tide monitoring event on September 23, 2013, the low tide monitoring event on October 2, 2013, the low-low tide monitoring event on July 10, 2013, and during the Phase 2 tidal study. The groundwater elevations in shallow well CMW-1 were anomalous during the 2013 monitoring events and the Phase 2 tidal study, and were not used to evaluate the hydrogeologic conditions beneath the Subject Property. The groundwater and surface water monitoring data from the 2013 monitoring events and the Phase 2 tidal study are presented in Appendix D and Appendix E, respectively.

5.2.6.1 Shallow Groundwater Conditions

Horizontal hydraulic gradients were not calculated for the 2013 groundwater monitoring data because the data could not be corrected for tidal response time lags. Based on the Phase 2 tidal study data, horizontal gradients were calculated across the Subject Property by using tidally corrected data between shallow monitoring wells on Parcel F (EMW-1S/EMW-3S and EMW-1S/EMW-7S) and on Parcel D (DMW-3/CMW-4 and DMW-3/CMW-7). The locations of the wells are shown on Figure 14. The horizontal gradients, which ranged from 0.0033 to 0.0091 feet/foot during low tide conditions and from -0.0036 to 0.0016 feet/foot during high tide conditions, were calculated from the selected well pairs (see Table 5). A negative horizontal gradient represents inland flow and a positive gradient represents flow towards the waterway.

Shallow groundwater elevation contour maps for low, mean, and high tide conditions during the Phase 2 tidal study are presented on Figures 14, 15, and 16, respectively. Shallow groundwater flow during low tides is primarily to the southeast towards Slip 4. The contours indicate that most of the groundwater abuts against the seawall and then flows toward either end of the wall. The shallow groundwater flows into the waterway around the ends of the wall (through riprap areas), at steep hydraulic gradients. The horizontal hydraulic gradients from the well pairing DMW3/CMW4 are flatter in comparison to well pairings not located behind the seawall (i.e., EMW-1S/EMW-3S; see Figure 14). The shallow groundwater flow during low-low tide conditions on July 10, 2013 (SLR, 2014), during low tide conditions on October 2, 2013 (SLR, 2014), and during the low tide conditions of the Phase 2 tidal study indicated that the seawall retards groundwater flow during falling tides and diverts most of the flow to around the ends and beneath the seawall.

During mean tidal conditions, the shallow groundwater flows at a slower rate than during low tide conditions (see Figures 14 and 15), and the flow direction beneath Parcel F is primarily to the southeast towards Slip 4. Some of the groundwater drains into Slip 4, to the north of the seawall. The shallow groundwater flow direction beneath Parcel D is primarily to the southwest, which appears to be due to groundwater slightly mounding behind the seawall and diverting the flow. Most of the shallow groundwater flows into the LDW around the southwestern end of the seawall.

The shallow groundwater flow during high tides appears to primarily consist of surface water flowing inland around the ends of the seawall (through riprap areas) and recharging the groundwater beneath the Subject Property. The shallow groundwater appears to flow behind the seawall and then continue inland to the middle of the Subject Property where it meets shallow groundwater from Parcel F flowing towards Slip 4 (see Figure 16). However, it is important to note that during the high-high tide conditions on September 23, 2013, the shallow groundwater flowed inland across the entire Subject Property (SLR, 2014). During the high-high tide conditions on September 23, 2013 (SLR, 2014) and during the high tide conditions of the Phase 2 tidal study, the groundwater elevation data from the shallow monitoring wells indicate that the seawall retards surface water flow draining into the unconfined groundwater unit, which is consistent with 2008 high tide groundwater monitoring data (SLR, 2008).

In 2013, SLR inspected the upper part of the sheet pile seawall during low tide conditions to check for groundwater seeps along the wall and boulder riprap. Several seeps were identified during the inspection, and five of the seeps (through holes in the wall) had sufficient flow to allow for seep sample collection (SLR, 2014). These seeps were not subsequently repaired. Based on the presence of holes and cracks in the wall above the riprap, holes and cracks are also likely present in the wall beneath the riprap. These holes and cracks are allowing some groundwater to flow through the wall during low and mean tide conditions and some surface water to flow through the wall during high tide conditions. Based on the chloride concentrations in groundwater samples from shallow wells located near the seawall (see Table 18a), the salinity of the shallow groundwater near the wall is relatively inconsistent and some of the higher salinity concentrations are located behind the middle part of the wall. Based on the observed seeps and the chloride concentrations in shallow wells near the seawall, the wall is leaky, but the volume of water that is flowing through the wall is significantly less than the volume of water that is held back and diverted by the wall.

Figure 10 shows the inferred hydrogeologic conditions at cross section A-A' during high tide conditions and low tide conditions (the location of cross section A-A' is shown on Figure 12). This cross section depicts how the seawall effects the water levels and thus flow during both high and low tide conditions, as water levels in the stilling well (Slip 4 surface water) and shallow well CMW-5 (groundwater approximately 48 feet behind the seawall) are offset by several feet. The groundwater monitoring data from shallow well CMW-4, which is located approximately 17 feet behind the seawall, also shows that the wall affects the water levels and flow during low and high tide conditions (see Figures 14 through 16).

5.2.6.2 Intermediate-Depth Groundwater Conditions

Intermediate-depth groundwater elevation contour maps for low and high tide conditions during the Phase 2 tidal study are presented on Figures 17 and 18, respectively. The intermediate-depth groundwater monitoring wells are screened at depths of approximately 40 to 50 feet bgs, and the depth of the seawall is approximately 43 feet bgs. The intermediate-depth groundwater flow during low tides is primarily to the southeast towards Slip 4. The groundwater flows under the seawall and under the riprap areas into the waterway. During high tide conditions, the intermediate-depth groundwater flows under the seawall and the riprap areas, and inland at northwestern and northern directions.

5.2.6.3 Deep Groundwater Conditions

Deep groundwater elevation contour maps for low and high tide conditions during the Phase 2 tidal study are presented on Figures 19 and 20, respectively. During Phase 2 of the RI, the four deep wells (EMW-

19D, EMW-20D, EMW-21D, and EMW-22D) were used to assess deeper flow within the unconfined groundwater unit at depths of approximately to 75 to 80 feet bgs (over 30 feet below the seawall). The deep groundwater flow during low tides is primarily to the southeast towards Slip 4. The groundwater flows under the seawall and under the riprap areas into the waterway, which is similar to the intermediate-depth flow. During high tide conditions, the deep groundwater flows under the seawall and the riprap areas, and inland at northwestern and northern directions.

5.2.6.4 Vertical Hydraulic Gradients

Phase 1 Vertical Gradients

Vertical gradients were calculated by using the 2013 groundwater elevation data from the four nested shallow and intermediate-depth well pairs (CMW-4/EMW-15D, CMW-6/EMW-14D, CMW-7/EMW-16D, and DMW-3/EMW-10D). The gradients were calculated from data collected during the seasonal low-low tide event on July 10, 2013, and during the high-high tide event on September 23, 2013. The results indicated a net downward gradient adjacent to the seawall (ranging from -0.024 to -0.0004 feet per foot) during low tide conditions, and a net upward gradient adjacent to the seawall (ranging from 0.0046 to 0.010 feet per foot) during high tide conditions (SLR, 2014). The shallow wells exhibited a dampened tidal response relative to the intermediate-depth wells, which further supports the conclusion of the 2008 tidal study (SLR, 2008) that the seawall is retarding groundwater and surface water flow. The vertical gradient at an inland part of the Subject Property, as measured at well pair DMW-3/EMW-10D, was less pronounced, but indicated upward flow during both high and low tides (ranging from 0.0042 to 0.0057 feet per foot; SLR, 2014).

Phase 2 Vertical Gradients

Vertical gradients were calculated by using the groundwater elevation data from three of the four nested shallow and deep well pairs (CMW-7/EMW-21D, CMW-4/EMW-20D, and DMW-3/EMW-19D) during low tide conditions on December 31, 2014, and during high tide conditions on January 1, 2015. The groundwater elevations in the wells during low and high tide conditions, and the vertical gradients are presented on Table 5. The results indicate negative vertical gradients across the Subject Property during low tide conditions (ranging from -0.0071 to -0.021 feet per foot), indicating shallow to deep (downward) groundwater movement. Overall, the mean vertical gradients indicate that groundwater is moving downward, similar to the low tide conditions. High tide vertical gradients near the waterway ranged from -0.0015 feet per foot between CMW-14 and EMW-20D and -0.0037 feet per foot at CMW-7 and EMW-21D, which indicate downward groundwater movement. During high tide, there was a positive vertical gradient between DMW-3 and EMW-19D (the most inland well pair), indicating an upward groundwater movement (deep to shallow).

The vertical hydraulic gradients near the seawall during low and high tide conditions indicate that some of the groundwater is flowing downward and under the seawall. This shows that during low tide, the shallow groundwater is unable to drain completely underneath the seawall, and during high tide, it continues to drain, albeit at a reduced rate.

5.2.6.5 Groundwater Responses

In tidally influenced groundwater units, a time lag typically occurs between the surface water high and low tides and the corresponding high and low groundwater elevations. The time lag between the tide level and the corresponding groundwater elevation increases with increased distance from the shore. Additionally, the amplitude of the groundwater response to the tide level decreases with increased distance from the shore.

The shortest average time lags were in the shallow, intermediate-depth, and deep wells located within 72 feet of the shoreline (see Table 6). The time lags for the groundwater response to changes in tide conditions were higher in the wells located further away from the shore. The longest time lags (140 and 110 minutes) were observed in shallow groundwater well EMW-1S (located 519 feet from the shore) and intermediate-depth well EMW-10D (located 381 feet from the shore).

The greatest amplitude of the groundwater response, suggesting high tidal influence, occurred in the intermediate-depth and deep groundwater wells located within 72 feet of the shore, except in deep well EMW-22D (see Table 6). The maximum amplitude in the stilling well was 11.98 feet, and the maximum amplitudes in the wells located near the shore ranged from 6.03 to 7.46 feet. Shallow well CMW-7, located approximately 41 feet from the shore and approximately 75 feet from the southwestern end of the seawall, also exhibited an amplitude of over 6 feet (6.55 feet). The lowest amplitudes (0.54 to 4.00 feet) were typically located in wells located over 200 feet from the shore; however, the amplitude at shallow well SLR-6, located 125 feet from the shoreline, was 2.81 feet.

The on-site shallow, intermediate-depth, and deep groundwater responses (time lag and amplitude) to the tidal conditions provide supporting evidence that the seawall retards shallow groundwater flow. The shallow groundwater amplitudes are typically dampened in comparison to the intermediate-depth and deep groundwater amplitudes that are similar distances from the shoreline (see Table 6). The time lags are typically greater in the shallow groundwater wells than in the intermediate-depth and deep groundwater wells that are located at similar distances from the shoreline (see Table 6).

5.2.7 PHASE 1 RI GROUNDWATER SEEP SAMPLING

In accordance with the RI/FS Work Plan (Ecology, 2012), SLR performed a reconnaissance during low tide conditions to check for groundwater seeps along the seawall and boulder riprap that border the southern and southeastern edges of the upland portion of the Subject Property. Several seeps were identified during the inspection, and five of the seeps had sufficient flow to allow for sample collection (SLR, 2014). The seep samples (designated SEEP-1 through SEEP-5) were analyzed for chloride, total and dissolved metals, PCBs, PAHs, SVOCs, TOC, DRO, ORO, GRO, TSS, and VOCs. The locations of the seep samples are shown on Figure 12. The seep sample analytical results are discussed in Section 7.5.

5.3 STORMWATER AND CATCH BASIN SOLIDS SAMPLING

During Phase 1 of the RI, one catch basin solids sampling event and two stormwater sampling events were conducted. The locations of the current and former stormwater catch basins and outfalls are shown on

Figure 2. Details of the catch basin solids and stormwater sampling events are presented in the following subsections.

5.3.1 RI STORMWATER SAMPLING

SLR collected stormwater samples from the six stormwater outfalls (OF1 through OF6) that were active at the Subject Property during two qualifying storm events that occurred on June 26, 2013, and February 20, 2014. During both sampling events, SLR conducted a visual inspection of stormwater sheet flow at the Subject Property to further evaluate the potential for discharges to the LDW. The stormwater samples were grab samples collected directly from the outfalls during storm events with at least 0.1 inches of rainfall over a 24-hour period preceded by at least 24 hours of only trace precipitation (SLR, 2014). Stormwater was not sampled during Phase 2 of the RI because qualifying storm events were not identified that occurred during suitable tidal stages to access to the outfalls.

The stormwater samples were analyzed for chloride, total metals, PCBs, PAHs, SVOCs, TOC, DRO, ORO, GRO, TSS, and VOCs. The February 2014 stormwater samples were also analyzed for polybrominated diphenyl ethers (PBDEs). The RI stormwater sampling results are discussed in Section 7.7.1.

5.3.2 RI CATCH BASIN SOLIDS SAMPLING

Between June 6 and 11, 2013, SLR collected catch basin solids samples from two of the catch basins within each of the six stormwater conveyance lines on Parcel D that were active at that time (SLR, 2014). The solids samples were collected from catch basins DP1CB2, DP1CB3, DP2CB2, DP2CB5, DP3CB1, DP3CB3, DP4CB2, DP4CB4, DP5CB1, DP5CB4, DP6CB1, and DP6CB4. The locations of the catch basins and the underground stormwater conveyance lines are shown on Figure 2. The samples were collected from accumulated solids on filter inserts when applicable, and from the basins when filters were not present. The samples were analyzed for grain size (GS), metals, PCBs, PAHs, SVOCs, TOC, DRO, ORO, GRO, total solids (TS), and VOCs. The samples from DP4CB4 and DP6CB1, located near the former refuse burner and former chimney, respectively, were also analyzed for D/F. The results of the catch basin solids sampling are discussed in Section 7.7.2.

After the catch basin solids sampling event, the catch basins in Parcel D were inspected and cleaned in accordance with the RI/FS Work Plan (Ecology, 2012). The stormwater conveyance lines were cleaned and video inspected for cracks or offsets. The elevation of the base of each catch basin and the invert elevation of each outfall pipe were surveyed to determine if any part of the stormwater drainage system was below the groundwater table (SLR, 2014).

5.4 RI SEDIMENT INVESTIGATION ACTIVITIES

Multiple phases of sediment sampling were performed during the RI. Figure 13 shows the locations of the RI sediment samples. Details of each phase of RI sediment sampling are discussed in the following subsections.

5.4.1 PHASE 1 RI SEDIMENT INVESTIGATION

In accordance with the RI/FS Work Plan (Ecology 2012), SLR collected intertidal sediment samples (designated IS-1 through IS-5) from within the bank riprap on July 23 and 24, 2013. The samples were collected at each end of the existing pier (designated IS-1 and IS-5) and in proximity to stormwater drainage system outfalls OF2, OF3, and OF4 (designated IS-2, IS-3, and IS-4), which were active at that time. The locations of the intertidal sediment samples are shown on Figure 13. A sample could not be collected near outfall OF5 because there was no exposed sediment within the riprap in that area (SLR, 2014). The samples were analyzed for D/F, GS, metals, PCBs, PAHs, SVOCs, TPH-Dx, TOC, and TS. The results of the intertidal sediment sampling are discussed in Section 7.6.1.

5.4.2 PHASE 2 RI SEDIMENT INVESTIGATION

During Phase 2 of the RI, Anchor conducted surface and subsurface sediment sampling within the LDW to address sediment data gaps. During the Phase 2 sediment investigation, several sampling stations that were targeting a possible historical sand blast grit dump area near the Subject Property were moved due to the presence of underwater utilities and safety concerns (see Figure 13).

5.4.2.1 Surface Sediment Sampling

In December 2014, a total of 18 surface sediment samples (designated SSED-01 through SSED-12 and SSED-13A, SSED-14, SSED-15A, SSED-16A, SSED-17A, and SSED-18A) were collected from within the berth areas on and near the Subject Property. The locations of the surface sediment samples are shown on Figure 13. The surface sediment samples were collected by using Van Veen methodology in accordance with the procedures described in the Draft Phase 2 SAP Addendum (Anchor, 2014). The samples were collected from the 0- to 10-cm biologically active zone, and were analyzed for D/F, GS, metals, PCBs, PAHs, SVOCs, TOC, TS, and VOCs. The results of the surface sediment sampling are discussed in Section 7.6.1.

5.4.2.2 Subsurface Sediment Sampling

In December 2014, a total of six subsurface sediment cores (SSED-SB-12A, SSED-SB-13A, SSED-SB-14A, SSED-SB-16A, SSED-SB-19, and SSED-SB-20) were completed in the LDW, at locations near the Subject Property. Cores SSED-SB-12A, SSED-SB-13A, SSED-SB-14A, and SSED-SB-16A were co-located with surface sediment samples SSED-12, SSED-13A, SSED-14, and SSED-16A, respectively, in the vicinity of a possible historical sand blast grit dump area adjacent to the Subject Property. Two additional subsurface core locations (SSED-SB-19 and SSED-SB-20) were added at Ecology's request during the sampling effort to aid in delineating the extents of potential impacts. The subsurface sediment core locations are shown in Figure 13. The subsurface sediment sampling was performed by using a vibratory core sampler (vibracore) consistent with the procedures described in the Draft SAP Addendum (Anchor, 2014). Chemical testing of the samples included GS, metals, PCBs, PAHs, SVOCs, TOC, TS, VOCs, and selective testing for D/F. Logs of the subsurface core logs are included in Appendix D. The results of the subsurface sediment sampling are discussed in Section 7.6.2.

5.5 PHASE 1 RI GEOPHYSICAL SURVEYS

During Phase 1 of the RI, geophysical surveys were conducted on August 21, 2013, to determine if the former fuel oil UST at the northwestern part of Parcel F was still present, and to identify the locations of any remaining buried pipes and catch basins associated with historical stormwater drainage system on Parcel F (SLR, 2014). The geophysical surveys were conducted at eight locations; at the former fuel oil UST, the two inactive sumps, the abandoned sump, the three potentially buried catch basins that were shown on a 1946 drawing or a 1990 drawing in Crowley's files, and at the two buried partial catch basins that were discovered in 2010. The results of the geophysical surveys indicated that the former UST and the former drainage system catch basins and lines are no longer present. The surveys did not identify any underground pipes or catch basins connected to the inactive or former wash water sumps (Id.).

6. SITE SCREENING LEVELS

This section presents the derivation of screening levels for soil, groundwater, and sediment that were used to define the nature and extent of chemicals at the Site that may pose a potential risk to human health or the environment. Consistent with the process outlined in Ecology's memorandum, *Groundwater Cleanup Levels for Upland Sites Along the Lower Duwamish Waterway*, updated March 1, 2016 (Ecology, 2016a), Site screening levels were developed to be conservative and address the full range of potentially applicable exposure pathways and receptors under current and foreseeable future uses of the Site. RI screening levels were not set below natural background concentrations or below the practical quantitation limits (PQLs) for the analyses, in accordance with MTCA. An exceedance of a screening level does not indicate that cleanup is required (nor that the cleanup level will be determined), but may indicate that additional assessment is warranted. Additional information may be collected in subsequent steps of the MTCA cleanup process to support Ecology's determination of cleanup levels (CULs) and/or remediation levels for the Site, in accordance with MTCA.

The LDW Superfund Site Record of Decision (ROD; EPA, 2014) identified the sediment remedial action levels (RALs) necessary to achieve protection of human health and the environment. A detailed summary of the EPA-approved RALs for intertidal- and subtidal-elevation sediments is provided in the ROD. The RALs were developed to achieve the necessary reductions in the spatially-weighted average concentrations (SWACs) in sediment and the long-term sediment CULs identified in the ROD. The targeted SWAC reductions account for system-wide risk reduction to both human health and ecological receptors applied at the appropriate exposure scale (e.g., point-based versus waterway-wide) for each receptor and each chemical of concern (COC) shown to cause unacceptable risks in the baseline risk assessments. Further, RALs directly account for waterway-wide specific conditions that influence risk reduction to the various receptors and implementation of a successful sediment remedy, such as upstream source control, sediment elevations, potential for sediment bed scour, and the appropriate vertical depth of compliance. The long-term sediment CULs identified in the ROD are goals and are subject to the evaluation of risk reduction efforts over time. Based on this information, and to ensure consistency with the ROD, the RALs are the most site-specific and applicable sediment screening levels for use in the LDW. Therefore, the Site screening levels for sediments are the RALs presented in the LDW ROD (EPA, 2014). The future determination of CULs for the Site will be developed in accordance with MTCA (Chapter 173-340 WAC), though 8th Avenue anticipates that the sediment CULs will be based on the ROD RALs.

The following subsections identify the range of groundwater, soil, and sediment exposure pathways and receptors considered, and outline the associated RI screening levels and their derivation.

6.1 OVERVIEW OF EXPOSURE PATHWAYS AND RECEPTORS

An exposure pathway describes the mechanisms by which human or ecological exposure to site contaminants can occur under current (baseline) conditions, assuming no remedial action or protective control is in place. To be considered complete, an exposure pathway must include the following:

- An identified source of contaminant(s)

- A mechanism for contaminant release and transport from the source
- A point of exposure where contact with the contaminant can occur
- An exposure route through which contact with the contaminant can occur
- A receptor that can be exposed to the contaminant

An exposure pathway is considered potentially complete if a human or ecological receptor can be exposed to a contaminant via that pathway.

6.1.1 GROUNDWATER EXPOSURE PATHWAYS

Assuming industrial future land uses, current and future potentially complete exposure pathways for groundwater include the following:

- **Human direct contact:** Workers contacting contaminated groundwater during excavation or other construction-related activities if no worker protection controls are in place
- **Ecological:** Direct exposure for benthic and aquatic organisms in the LDW if groundwater contaminants migrate and discharge to marine sediment and surface water
- **Human consumption:** Humans consuming fish or other organisms contaminated by discharges of contaminated groundwater to marine sediment and surface water
- **Inhalation:** Workers and visitors in buildings inhaling indoor air contaminated by vapor intrusion (i.e., by the volatilization of contaminants from shallow groundwater) if slab on grade buildings are constructed in the future near locations where volatile contaminants are present in the subsurface

Groundwater at the Site is not a practicable source of potable water under current and foreseeable future conditions. Both groundwater and surface water at the Site are non-potable based on MTCA criteria (WAC 173-340-720[2]); see Section 6.2.1.1 for the non-potability determination. As such, the human use of groundwater at the Site for drinking water purposes is not considered a current or future potentially complete pathway.

6.1.2 SOIL EXPOSURE PATHWAYS

Assuming industrial future land uses, current and future potentially complete exposure pathways for soil include the following:

- **Human direct contact/inhalation:** Workers or visitors contacting contaminated soils (skin contact and incidental ingestion) and/or inhaling contaminated dust or vapors during soil excavation or other industrial activities at the Site if no protection controls are in place
- **Soil-to-groundwater**: Leaching of soil contaminants to Site groundwater
- **Soil-to-sediment:** Erosion and runoff of surficial/bank soils to LDW sediments if no controls (i.e., capping, shoreline bulkhead, or catch basin improvements) are in place

6.1.2.1 Terrestrial Ecological Evaluation

This section presents the results of the terrestrial ecological evaluation (TEE) at the Site. Documentation of the TEE process is provided in Appendix G. The Site does not qualify for a primary exclusion due to the presence of hazardous substances of concern and the fact there are areas of contiguous habitat greater than 0.25 acres adjacent to and within 500 feet of the Site. The largest of these is estimated to be approximately 1 acre (see Appendix G). All habitat areas are considered to be of low quality because they are isolated from other habitats by surrounding industrial land uses. With the exception of one limited area in the northern portion of Parcel F, the Site is paved with asphalt or concrete. The unpaved area in Parcel F is a developed stormwater infiltration system consisting of gravel fill that is stabilized with a topsoil and vegetation cover. The unpaved infiltration area contains some grass and invasive volunteer vegetation species. However, it should be noted that WMNS plans to pave the infiltration area with asphalt in 2019.

As noted above, the Site does not qualify for a primary exclusion. Therefore, the next step is to determine whether a simplified or site-specific TEE is needed. This decision is documented in the attached "Terrestrial Ecological Evaluation Process - Simplified or Site-Specific Evaluation?" form in Appendix G, which documents that a simplified TEE is appropriate. To determine if the Site is located directly adjacent to an area where management or land use plans maintain or restore native vegetation, Ms. Rachel Kane of SLR contacted Mr. Rodney Nealer of the City of Seattle Parks Department on February 9, 2018 (Kane, 2018). Mr. Nealer informed Ms. Kane that the neighboring Georgetown Pump Station Park is currently undeveloped and that there are not any plans for development at this time. As there are not any management or land use plans in place to maintain or restore native vegetation in the park, a site-specific TEE is not required on this basis.

The first step of the simplified TEE process is completing the initial exposure analysis (Table 749-1; see Appendix G), which determines if a site-specific TEE is needed. The simplified TEE includes an estimation of the area of contiguous undeveloped land on or within 500 feet of the Site. A 3.8-acre park is located across Slip 4 from the Site, and industrial facilities (Emerald Services facility and Boeing Plant 2 facility) are present across Slip 4, between the Site and the park. Over 500 feet of riprap along Slip 4 with some limited bushes and other vegetation occurs between the Site and the industrial facilities and park across Slip 4, and it is not considered terrestrial habitat; therefore, the park across Slip 4 from the Site was not included in our estimation of the area of contiguous undeveloped land on or within 500 feet of the Site. The Georgetown Pump Station Park located adjacent to the southwest corner of the Subject Property was therefore identified as the largest area of contiguous undeveloped land within 500 feet of the Site. Furthermore, after WMNS paves the stormwater infiltration area on Parcel F in 2019, there will not be any unpaved areas on the Subject Property and the low quality habitat that is currently present on the property will be eliminated. Based on the simplified TEE exposure analysis form, the industrial site use and lack of significant habitat acreage will significantly limit potential chemical exposure to the extent that the TEE can be ended.

Terrestrial wildlife exposure to soil is not considered a complete exposure pathway for the Site. Current conditions and the planned additional paving of the Subject Property limit terrestrial wildlife exposures. If contaminated soil is left in place as part of the FS evaluation and the development of the Draft Cleanup

Action Plan (DCAP), legally binding institutional controls (environmental covenant[s]) can be put in place that require maintenance of the Subject Property pavement to limit wildlife exposure to the underlying contaminated soil after the cleanup action is implemented.

6.1.3 SEDIMENT EXPOSURE PATHWAYS

As described in the LDW ROD (EPA, 2014), contaminated sediments will be remediated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process for the LDW by dredging and engineered capping. Assuming industrial future land uses, current and future potentially complete exposure pathways for sediment include the following:

- **Benthic organisms:** Direct exposure for benthic and aquatic organisms present in the biologically active zone (0 to 10 cm below the mudline).
- **Higher trophic level organisms:** Food chain effects associated with the potential bioaccumulation of contaminants.
- **Human consumption of seafood:** Humans consuming organisms contaminated by marine sediment.
- **Human direct contact**: Humans contacting contaminated surficial/intertidal sediment (skin contact and incidental ingestion) through clamming or beach play/public access in intertidal beach areas accessible at the terminus of 8th Avenue South. In addition, this exposure pathway includes direct contact of sediment by net fishermen in the LDW and Slip 4.

6.2 DERIVATION OF SCREENING LEVELS BY MEDIA

The basis for establishing RI screening levels for groundwater, soil, and sediments is described in the following subsections. General assumptions used in the derivation of screening levels include the following:

- **Current/future use of Site as industrial:** Industrial operations and activities have been conducted at the Site and adjacent properties since approximately the 1920s. The Site is currently zoned for general industrial use by the City of Seattle and is anticipated to remain industrial for the foreseeable future. On this basis, the upland portion of the Site meets the criteria of an industrial property under WAC 173-340-200, which defines industrial properties as follows:
  - Properties that are or have been characterized by, or are to be committed to, traditional industrial uses such as processing or manufacturing of materials, marine terminal and transportation areas and facilities, fabrication, assembly, treatment, or distribution of manufactured products, or storage of bulk materials, that are either:
    - › Zoned for industrial use by a city or county conducting land use planning under chapter 36.70A Revised Code of Washington (RCW) (Growth Management Act [GMA]); or
    - › For counties not planning under chapter 36.70A RCW (GMA) and the cities within them, zoned for industrial use and adjacent to properties currently used or designated for industrial purposes.

- Land use planning conducted under the GMA by the City of Seattle and KC considers any property zoned for industrial use as an industrial property.
- To be considered an industrial property, the Site also meets the following characteristics per WAC 173-340-745(1)(a)(i):
  - People do not live on the property, and the primary potential exposure route is to adult employees of businesses located on the property
  - Access to the property by the general public is generally not allowed or is highly limited and controlled
  - Food is not normally grown or raised on the property
  - Operations are often, but not always, characterized by the use and storage of chemicals, noise, odors, and truck traffic
  - Land surface of the property is mostly paved to minimize potential exposure to soil
  - Support facilities such as offices, restaurants, and other facilities may be present on site, but are primarily devoted to administrative functions necessary for the industrial use
- As described in Sections 2 and 3, WMNS currently is leasing the Subject Property for use as a materials reload and transfer facility. People do not live on the Site, and workers or visitors are the primary receptors contacting contaminated soils or groundwater during industrial activities at the Site. Food is not grown or raised on the upland portion of the Site, and operations at the Site are characterized by bulk material offloading (i.e., from barges onto rail cars) and truck traffic. Facilities at the Site are designated for administrative operations and industrial uses, and there are no residential or recreational areas on the Site. The land surface at the Site is currently covered by paving or gravel fill, limiting potential exposures to vegetation and native soils. The Site is a secured facility, surrounded by a fence, with strict employee-only access, and the aquatic portion of the Site is also private property with limited access by the general public.

- **Groundwater and surface water are not potable:** The Site groundwater is non-potable and is hydraulically connected to the LDW, which is also not potable. Therefore, the highest beneficial use of Site groundwater is discharge to surface water, and neither the groundwater nor surface water is potable (see Section 6.2.1.1 for the non-potability determination).

6.2.1 GROUNDWATER SCREENING LEVELS

For constituents analyzed at the Site (RI data), Table 7 presents the range of criteria from which groundwater screening levels are derived, along with the most stringent of those criteria, which are applied as the screening levels for this RI. In cases where the most stringent groundwater value was below the laboratory PQL for a given chemical, the PQL was selected as the screening level. The derivation of the Site-specific RI groundwater screening levels is described in the following subsections.

6.2.1.1 Highest Beneficial Use of Site Groundwater

The most beneficial current or potential use of Site groundwater is the discharge to marine surface water in the LDW. Site groundwater is classified as non-potable in accordance with WAC 173-340-720(2), based on the following:

- (**2)(a): The groundwater does not serve as a current source of drinking water**. Drinking water at the Site is currently supplied by the City. Drinking water supply wells are not known to exist at this Site or in the Site vicinity. In addition, the West Seattle Reservoir is the nearest reservoir, and it is located hydraulically upgradient of the Site. Based on the KC Well Log Viewer, uses of groundwater for drinking water purposes (WAC 173-201A-602) have only been reported north of RM 4.9 (Turning Basin).
- **(2)(b): The groundwater is not a potential future source of drinking water**. Due to the LDW estuarine environment (sourced in Elliott Bay), the Site groundwater contains elevated concentrations of salinity and TDS, making it impractical for use as drinking water. For example, at least one of the RI groundwater samples from shallow wells CMW-1, CMW-3, CMW-4, CMW-6, EMW-3S, and EMW-13S, from intermediate-depth well EMW-16D, and from all of the deep wells (EMW-19D, EMW-20D, EMW-21D, and EMW-22D) contained TDS concentrations greater than the MTCA potability threshold (10,000 milligrams per liter [mg/L]), per WAC 173-340-720(2)(b)(ii).
- ***(2)(c): The department determines it is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water, as defined in (a) and (b) of this subsection, at concentration which exceed groundwater quality criteria published in Chapter 173-200 WAC.***

  and
- ***(2)(d): Even if groundwater is classified as a potential future source of drinking water under (b) of this subsection, the department recognizes that there may be sites where there is an extremely low probability that the groundwater will be used for that purpose because of the site's proximity to surface water that is not suitable as a domestic water supply. Per 173-201A WAC, use designations prohibit the use of the water from the LDW for domestic water supply.***
- The LDW (including Slip 4), which is adjacent to the Site, consists of saline water and qualifies as a marine waterbody. Based on RI work at the Site, the unconfined groundwater unit beneath the property is hydraulically interconnected with the LDW (WAC 173- 340-720[2][d][iv]), as described in Section 5.2.6. There are known points of entry of the groundwater into the surface water (WAC 173- 340-720[2][d][ii]), as groundwater discharges into the surface water during low tide conditions. During high tide conditions, saltwater from the LDW intrudes the unconfined groundwater unit, and withdrawal of Site groundwater would potentially draw more saline water into the groundwater unit beneath the Subject Property (saltwater intrusion). As a result, groundwater from the unconfined groundwater unit is classified as nonpotable and cannot practicably serve as a current source of drinking water (WAC 173-340-720[2][d][iii]).
- Based on Site-specific conditions, anticipated future industrial use of the Site and surrounding areas, and applicable state regulations that restrict the installation of groundwater supply wells, drinking water is not a practicable future use for Site groundwater. Therefore, groundwater

screening levels applied in this RI are the most stringent values based on protection of the adjacent marine environment (water and sediment) and vapor intrusion. The derivation of groundwater screening levels is described in the following subsections.

6.2.1.2 Protection of Marine Water Quality (Water Column)

Considering the factors presented above, RI groundwater quality data are compared against groundwater screening levels that are the most stringent criterion based on protection of marine surface water. In accordance with MTCA (WAC 173-340-720[1][c]), groundwater screening levels protective of surface water incorporate MTCA surface water cleanup levels, including criteria from applicable state and federal laws (e.g., WAC 173-340-730; see Table 7).

For protection of marine water quality, screening levels are the most stringent of aquatic life criteria (marine chronic) and human health criteria for consumption of aquatic organisms under state and federal laws, including the following:

- **Washington State Water Quality Standards** (WAC 173-201A-240). In August 2016, Ecology proposed new state water quality standards for toxic chemicals (rulemaking on Chapter 173-201A WAC). Those water quality standards affected by the rulemaking include the state's proposed fish consumption rule, also known as the human health criteria rule. Although these criteria have not been finalized by Ecology, the proposed revisions to the human health surface water criteria (i.e., for human health consumption of organisms only) are used along with values protective of marine aquatic life to develop groundwater screening levels.
- **Federal National Recommended Water Quality Criteria** pursuant to Section 304(a) of the Clean Water Act. The human health ambient water criteria are periodically updated by EPA and were updated most recently for some analytes in 2015; the "human health for the consumption of organism only" criteria are used to develop groundwater screening levels. Criteria for protection of marine aquatic life are also included.
- **Federal National Toxics Rule** (40 Code of Federal Regulations 131.36 and 131.45) because Washington State does not fully comply with Section 303(c)(2)(B) of the Clean Water Act.
- **MTCA Standard Method B surface water cleanup levels** (173-340-730 WAC) use a MTCA default fish consumption rate of 54 grams/day (g/d) and a 0.5 fish diet fraction (i.e., half of the fish consumed are from the Site).
- **MTCA Modified Method B surface water cleanup levels** have been developed by assuming a higher fish consumption rate than the 54 g/d default MTCA value and the 0.5 fish diet fraction. The specific seafood consumption rate for the LDW, which was determined at 97.5 g/d based on the adult tribal reasonable maximum exposure (Tulalip data; Windward, 2007b) of 7.5 g/d of benthic fish, 43.4 g/d of crab, 38.5 g/d of other shellfish, and 8.1 g/d pelagic fish (e.g., salmon), was applied for the Site. Additionally, a fish diet fraction of 1.0 (all from the Site), is assumed for calculating site-specific MTCA Method B surface water screening levels for screening level derivation, and those levels are 3.3 times more stringent than MTCA default values. However, Method B cleanup levels are developed only if sufficiently protective human health-based surface water criteria or standards (ARARs) have not been established under applicable state and federal

laws, in accordance with WAC 173-340-730(3)(b)(iii). If a sufficiently protective ARAR exists for a compound, "ARAR" is displayed for that compound in the MTCA Method B surface water cleanup level comparison column of Table 7. If a sufficiently protective ARAR is not available, the MTCA Method B surface water cleanup level is applied and adjusted downward for the assumed higher fish consumption rate.

6.2.1.3 Protection of Marine Sediment

The RI groundwater screening levels must protect against recontamination of marine sediment quality, assuming that groundwater contaminants transported from the Site (upland) would partition from groundwater to sediment within the bioactive zone, which is defined for the adjacent LDW site as the uppermost 10 cm of sediment below the mudline. Sediments within the LDW are already contaminated, but this is not considered in the derivation of RI groundwater screening levels.

For long-term protectiveness of marine sediment quality (to ensure that chemicals will not accumulate above protective levels), groundwater screening levels are calculated based on steady state (long-term) equilibrium (partitioning between sediment and groundwater) with the marine benthic SCO (WAC 173-204-320). For organic chemicals that partition to sediment organic carbon, a fractional organic carbon of 1.9% (i.e., based on findings of the LDW RI Report) is assumed, and is used to adjust the soil/water distribution coefficient for sediment by using the organic carbon/water partition coefficient combined with the fraction organic carbon. Groundwater concentrations protective of marine sediment are calculated as the SCO divided by a combination of the adjusted sediment/water distribution coefficient, a dilution factor, and two other sediment parameters (dry bulk density and water-filled porosity). For inorganics, the calculation uses the dry weight SCO and a sediment/water distribution coefficient adjusted for a pH of 8. Distribution and partition coefficients are taken from Ecology's Lower Duwamish Waterway Preliminary Cleanup Levels Workbook Supplemental Information, dated December 2017 (Ecology, 2017). Table 7 summarizes the groundwater criteria that are protective of marine sediment.

The following considerations were applied for the protection of marine sediment:

- **Benthic organisms:** There is potential for direct exposure of benthic and aquatic organisms present in the biologically active zone (0 to 10 cm) of sediment adjacent to the Site to deep groundwater; therefore, groundwater levels were derived to be protective of this exposure pathway.
- **Human consumption of benthic organisms:** Standard and Modified MTCA Method B surface water levels, as well as surface water ARARs, that account for fish consumption are used in the Site groundwater screening level development and are consistent with human health assumptions protective of this exposure pathway (i.e., in accordance with WAC-173-340-730 [Ecology, 2017] and WAC 173-201A).
- **Higher trophic level organism consuming benthic organisms:** The potential risks associated with food web/ecological exposure are incorporated into sediment screening levels (e.g., consistent with the LDW ROD), and are discussed in Section 6.2.3.

- **Human direct contact:** The potential risks associated with dermal contact and/or incidental ingestion of sediment are incorporated into sediment screening levels (e.g., consistent with the LDW ROD), and are discussed in Section 6.2.3.

6.2.1.4 Protection from Vapor Intrusion

Volatilization of contaminants in shallow groundwater can represent a potential issue for vapor intrusion (VI) to future structures (indoor air) or outdoor ambient air on the Site. For the purposes of the RI, conservative ("Tier 1") groundwater VI screening levels are obtained from the Lower Duwamish Waterway Preliminary Cleanup Levels Workbook dated December 2017 (Ecology, 2017). Air concentrations protective of indoor air are more stringent than those for outdoor air; therefore, Ecology's guidance includes groundwater screening levels based on indoor air only. Both Method B (unrestricted land use) and Method C (industrial land use) values are used to derive groundwater screening levels for the Site (see Table 7).

6.2.1.5 Specific Considerations

Specific considerations apply for TPH compounds. Currently, TPH screening levels for groundwater protective of surface water do not exist. In addition, marine SCO values are not available for the lighter end compounds in gasoline, but are available for individual compounds such as PAHs found in heavier petroleum fractions (i.e., DRO and ORO) to calculate groundwater concentrations of individual compounds protective of marine sediments. Therefore, MTCA Method A groundwater cleanup levels will be used as the groundwater screening levels, protective of marine surface water and sediment at 800 micrograms per liter (µg/L; based on presence of benzene) for GRO, and 500 µg/L for DRO, ORO, and for total semi-volatile petroleum hydrocarbons (the sum of DRO and ORO; see Table 7).

6.2.2 SOIL SCREENING LEVELS

Soil screening levels depend on current and planned use of the Site, which in accordance with MTCA, can be divided into industrial use and everything else (unrestricted, which includes residential). The current and planned future use of the Site is industrial and meets the requirement of a "traditional industrial use" under MTCA (WAC 173-340-745). In addition to direct contact exposure to soil, the soil screening levels also need to address soil leaching to groundwater discharging to marine water and sediment, soil leaching to groundwater, and soil runoff to marine sediment.

For the chemicals that have been included in soil sample analyses at the Site, Table 8 presents the range of criteria (i.e., ARARs) from which soil screening levels could have been derived. However, to identify the soil screening levels for the Site, SLR only used the direct contact, TEE, and natural background values. To address the soil leaching to groundwater and the soil leaching to groundwater discharging to marine water and sediment pathways, it was assumed that all groundwater chemicals of concern (COCs; based on the most stringent groundwater criteria) were also identified as soil COCs. Ecology required that Method B residential levels for direct contact be conservatively applied instead of industrial levels, and the most stringent of the direct contact values, the TEE values, and the natural background levels for the Puget Sound region (metals) (Ecology, 1994) and for the State of Washington (dioxins/furans) (Ecology, 2010) were applied as the screening levels for this RI (see Table 9). As with groundwater, in cases where the most stringent soil value was below the laboratory PQL for a given chemical, the PQL was selected as the screening level. The analytical data for Site soil were compared against the soil screening levels developed in this RI. The derivation of the Site-specific soil screening levels is described in the following subsections.

6.2.2.1 Direct Contact Pathway

Even though the Site meets the industrial site requirements of WAC 173-340-706, Ecology required that soil concentrations protective of human direct contact (ingestion only) under residential land use (i.e., MTCA Method B and select Method A soil cleanup levels) be conservatively included as an ARAR for the Site based on current and planned Site use. The most conservative of the MTCA Method B carcinogenic and noncarcinogenic residential values for ingestion are included in Table 9. For comparative purposes, the Method C soil cleanup levels for industrial land use are included in Table 8.

6.2.2.2 TEE Pathway

As described in Section 6.1.2.1, terrestrial wildlife exposure to soil is not considered to be a complete exposure pathway for the Site based on the TEE. However, the simplified TEE screening levels for commercial and industrial land use from Table 749-2 of WAC 173-340 were conservatively included in the development of screening levels for soil to ensure that the screening evaluation is protective of both human and ecological receptors.

6.2.3 SEDIMENT SCREENING LEVELS

Baseline human health risk assessments (HHRAs) and ecological risk assessments (ERAs) were conducted as part of the LDW RI (Windward, 2010) to determine the potential pathways by which human and ecological receptors could be exposed to LDW contaminants (e.g., through sediment direct contact and consumption of aquatic organisms or marine surface water) and the associated long-term risks to these receptors. Using the results of the LDW HHRA and ERA, the EPA developed contaminant-specific RALs (EPA, 2014), which are contaminant thresholds that will be used to identify specific sediment areas that require active remediation (e.g., dredging, capping, enhanced natural recovery [ENR], or a combination thereof), and to evaluate different remedial alternatives for the LDW. For the purposes of this RI, and to maintain consistency with the CERCLA process underway for the LDW site, EPA's RALs are used as screening levels for the Site sediments.

The risk-based RALs, as presented in the LDW ROD (EPA, 2014), were established by EPA for surface and subsurface sediments, intertidal and subtidal sediments, and Recovery Category areas. Human-health-based RALs were developed to address human health COCs (as determined in the HHRA) and include total PCBs, arsenic, total cPAHs TEQ, and total D/F TEQ. Benthic protection RALs were developed to address the 39 COCs that affect benthic species, as determined in the ERA. Sediment screening levels for all SMS parameters and LDW COCs evaluated as part of this RI are applied to both surface and subsurface sediments at the Site (see Table 10).

7. NATURE AND EXTENT OF CONTAMINATION

7.1 DATA EVALUATION

For the purposes of this RI, the previous soil and catch basin solids sample analytical results for the Site were compared to the soil and sediment screening levels, respectively. The RI groundwater and sediment sample analytical results were compared to the groundwater and sediment screening levels, respectively. The RI stormwater sample analytical results were compared to the groundwater screening levels, which are primarily based on protection of surface water or sediment. The pre-RI groundwater sample analytical results were not compared to the screening levels because the recent RI data present a more accurate depiction of the current conditions. Furthermore, there were not any areas where previously high groundwater concentrations were not subsequently sampled.

SLR evaluated the previous investigation methods and the technical quality of the previous soil sample analytical data, and determined that the sampling methods were appropriate and that all of the analytical data can be used to characterize the soil conditions. SLR and Friedman & Bruya, Inc., evaluated the analytical data from Phase 1 of the RI, and the analytical data are acceptable, with the assigned qualifiers, to characterize the Site conditions (SLR, 2014). Laboratory Data Consultants, Inc. (LDC) evaluated the analytical data from Phase 2 of the RI, and the analytical data are acceptable, with the assigned qualifiers, to characterize the Site conditions. All of the data qualifiers are included in the attached data tables. Copies of the laboratory analytical reports for the Phase 2 RI samples are presented in Appendix H, and copies of the LDC data validation reports for the Phase 2 analytical data are presented in Appendix I.

7.2 CHEMICALS OF CONCERN

RI data were compared to the Site-specific screening levels for soil, groundwater, and sediments. The pre-RI soil and catch basin solids data were also compared to the soil and sediment screening levels, respectively. Chemicals that were present at concentrations exceeding media-specific screening levels with detected results or undetected results (MRL exceeded the screening level) in one or more samples were identified as chemicals of potential concern (COPCs). Based on the large list of COPCs, SLR conducted statistical analyses for each Site medium to identify the Site COCs. Tables 11 through 16 present the Site COPCs and COCs by medium. The statistical analysis of the data that was used in the multi-tier screening process to derive the COPCs and COCs is presented in Appendix J.

7.3 INDICATOR HAZARDOUS SUBSTANCES

Indicator hazardous substances (IHSs) are defined by MTCA as a subset of hazardous substances present at a site that are selected per WAC 173-340-708 for monitoring and analysis during any phase of remedial action, for the purpose of characterizing the site or establishing cleanup requirements for that site (WAC-173-340-200). For the 8th Avenue Terminals Site, IHSs, which are a subset of the soil and groundwater COCs, were selected to aid in characterizing the nature and extent of soil and groundwater contamination at the Site. In accordance with WAC 173-340-703, the factors used to select the IHSs (and eliminate COCs from consideration as an IHS) included the following:

- The toxicological characteristics of the hazardous substance that influence its ability to adversely affect human health or the environment
- The chemical and physical characteristics that govern the hazardous substance's persistence and mobility
- Natural background concentrations, thoroughness of testing, frequency of detection, and degradation by-products

In addition, the selected IHSs represented each major analytical group of the COCs and had the largest contaminant distributions for each major analytical group.

IHSs were only selected for soil and groundwater. Based on the above criteria, the selected Site IHSs are as follows:

- Soil: metals (arsenic, copper, lead, and selenium), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), total PCBs, total D/F TEQ, and petroleum hydrocarbons (total sem-volatile petroleum hydrocarbons [sum of DRO and ORO] and GRO).
- Groundwater: metals (dissolved arsenic and dissolved copper), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), and total PCBs.

Tables 11 and 12 present the selected IHSs for soil and groundwater, respectively. A description of the selection process to identify the IHSs is presented in Appendix J.

7.4 SOIL

The soil data for the Site were used to evaluate the lateral and vertical extents of the selected IHSs in soil. The soil sample analytical results are presented in Tables 17a through 17e.

Arsenic concentrations greater than the screening level of 7.3 milligrams per kilogram (mg/kg) are present in shallow soil (less than 6 feet bgs) throughout most of Parcel D and at localized areas in Parcel F (see Figure 21). The arsenic concentrations typically decrease with depth and from 6 to 12 feet deep, the arsenic-impacted soil is not as widespread in Parcel D and there is only one exceedance on Parcel F (see Figure 22). Below 12 feet bgs, there are soil samples from several locations on Parcel D that contain arsenic concentrations greater than the screening level (see Figure 23). The lateral extents of the arsenic concentrations that exceed the screening level have been delineated, except to the west of boring HC-1A (near the western border of the Subject Property), at a depth of greater than 12 feet bgs. The vertical extents of the arsenic concentrations greater than the screening level have been not delineated at borings HC-1A, EB-12, EB-53, EMW-15D, and EMW-21D (see Figure 23). The area with the greatest arsenic concentrations occurs in the former pipe and chain manufacturing area (including the sandblast area along the property's southern shoreline), the former pole dipping area, the former treated pole storage area, the former sawmill area, and the dredge fill areas. The maximum arsenic concentration (6,000 mg/kg) is at boring IAB-20, at the 5- to 7-foot depth interval. IAB-20 is located in the middle of Parcel D, just outside the footprint of the former treated pole storage area (see Figures 21 and 22). Soil samples from IAB-20 also contain the maximum copper and lead concentrations.

At depths from ground surface to 6 feet bgs, the copper concentrations greater than the screening level (550 mg/kg) occur in a large southwest to northeast trending area within the central part of Parcel D (see Figure 24). The lateral extents of the copper concentrations that exceed the screening level have been delineated. The copper concentrations typically decrease with depth and there are no exceedances of the screening level at a depth below 12 feet bgs (see Figures 25 and 26). Since copper is only retained as a soil COC because it is a groundwater COC, SLR also evaluated the copper concentrations below the screening level. Copper concentrations greater than 36 mg/kg (the natural background concentration) are typically located in the vicinity of the area that contains concentrations greater than 550 mg/kg; however, there are localized areas containing copper concentrations greater than 36 mg/kg near the seawall. The greatest copper concentrations occur near the former pipe and chain manufacturing building, the former sawmill area, the former pole dipping area, the former treated pole storage area, and the dredge fill areas.

At depths from ground surface to 6 feet bgs, the lead concentrations greater than the soil screening level (220 mg/kg) occur in a large southwest to northeast trending area, similar to copper, within the central part of Parcel D (see Figure 27). The lateral extents of the lead concentrations that exceed the screening level have been delineated. The lead concentrations typically decrease with depth and there are only two locations (EMW-21D and EB-31) that exceed the screening level at a depth below 12 feet bgs (see Figures 28 and 29). The vertical extents of the lead concentrations greater than the screening level have been delineated at EB-31 (at 18 feet bgs), but not at EMW-21D. The greatest lead concentrations occur in the vicinity of the former pipe and chain manufacturing building, the former sawmill area, the former pole dipping area, the former treated pole storage area, and the dredge fill areas. The lead, arsenic, and copper exceedances occur in similar areas near the former pipe and chain manufacturing building, the former sawmill area, the former pole dipping area, the former treated pole storage area, and the dredge fill areas, which may indicate co-located sources.

At depths from ground surface to 6 feet bgs, selenium concentrations greater than the screening level (0.8 mg/kg) occur at several localized areas across the Subject Property; however, several of the areas are based on non-detect results (see Figure 30). The maximum selenium concentration detected in the shallow soil is 17 mg/kg at SB-11 (0 to 1 foot bgs), which is located in the former concrete products manufacturing area on Parcel F. In addition to the former concrete products manufacturing area, the detected selenium concentrations greater than the screening level occur at the former excelsior factory/press area and the former pipe and chain manufacturing area. The lateral extents of the selenium concentrations at the Site that exceed the screening level have been delineated. The selenium concentrations typically decrease with depth and there are only a few locations in the center of Parcel D that contain selenium concentrations greater than the screening level at depths between 6 and 12 feet bgs (see Figure 31). There are only two soil samples at a depth below 12 feet bgs (at EMW-21D and EB-31, near the seawall) that contain selenium concentrations greater than the screening level (see Figure 32). The vertical extents of the selenium concentrations greater than the screening level at EMW-21D and EB-31 have not been delineated. However, the selenium screening level is based on protection of terrestrial ecological organisms, which will not apply during the future development of cleanup levels for the Site.

At depths from ground surface to 6 feet bgs, the vinyl chloride concentrations greater than the screening level (0.67 mg/kg) occur at three localized areas on Parcel D; however, these areas are based on non-detect results (see Figure 33). There were no detected vinyl chloride concentrations greater than the screening level (see Figures 34 and 35). Since vinyl chloride is only retained as a soil COC because it is a groundwater COC, SLR also evaluated the concentrations below the screening level. There are no detected vinyl chloride concentrations greater than 0.1 mg/kg at the Subject Property. There are only localized areas of vinyl chloride in the groundwater at concentrations greater than the screening level, and there are no detected soil concentrations in those areas.

Total cPAH TEQ concentrations greater than the screening level (0.19 mg/kg) occur in the shallow soil throughout most of Parcel D and at localized areas on Parcel F (see Figure 36). The lateral extents of the total cPAH TEQ concentrations greater than the screening level have been delineated. The concentrations typically decrease with depth; however, there are several localized areas on Parcel D that exceed the screening level at depths below 12 feet bgs (see Figures 37 and 38). At boring EMW-10D, the total cPAH TEQ concentration is 111.84 mg/kg at a depth of approximately 35 feet bgs. The total cPAH TEQ concentrations at EMW-10D decrease to below the screening level at a depth between 35 and 49 feet bgs. EMW-10D is located in the vicinity of the former pole dipping tank, treated pole storage area, former creosote tanks, and former tanks/pump house. The vertical extent of the total cPAH TEQ concentrations greater than the screening level is delineated at the Site, except at boring EMW-21D. Total cPAH TEQ concentrations that are over 10 times greater than the screening level are present in the former wood treating operations area, the former sawmill area, the former pipe and chain manufacturing building, and the former dredge fill areas.

The total D/F TEQ concentrations greater than the screening level (13 nanograms per kilogram [ng/kg]) occur in the shallow soil at the western and central parts of Parcel D, and at one localized area (at boring EMW-6S) on Parcel F, near the property border (see Figure 39). The lateral extents of the total D/F TEQ concentrations greater than the screening level have been delineated, except to the west of borings EB-34 and EB-42 (near the western border of the Subject Property) and to the southwest of EB-42. The concentrations decrease with depth and there are no exceedances of the screening level at depths below 7 feet bgs (see Figures 40 and 41). The greatest total D/F TEQ concentrations occur near the former wood treating area, near the former refuse burner at the sawmill, and near the dredge fill areas.

Total PCB concentrations greater than the screening level (0.5 mg/kg) were detected in shallow soils at localized areas in Parcel D and at one localized area in Parcel F (see Figure 42). The lateral extents of the total PCB concentrations greater than the screening level have been delineated, except at boring DB12 (near the western border of the Subject Property) at a depth below 6 feet bgs (see Figure 43). Below 6 feet bgs, there are only two exceedances of the screening level (at DB12 at 11.5 feet bgs and EMW-21D at 14.7 feet bgs) that are based on detected concentrations (see Figures 43 and 44). There are several other localized areas of total PCB concentrations greater than the screening level that are based on non-detect values. The vertical extent of the total PCB concentrations greater than the screening level have been delineated at the Site. Since total PCBs is only retained as a soil COC because it is a groundwater COC, SLR also evaluated the concentrations below the screening level. There are very few detected total PCB concentrations below 0.5 mg/kg and they do not appear to be at the areas of PCB-impacted groundwater. The maximum detected total PCB concentration in shallow soil is 4 mg /kg (at approximately 4.5 feet bgs) at DMW-6, which is located in the footprint of the former pipe and chain manufacturing building. The greatest detected total PCB concentration on Parcel F is 1.05 mg/kg (at approximately 1 foot bgs) at SS-5, which is located at the former concrete products manufacturing and storage area.

Total semi-volatile petroleum hydrocarbon (sum of DRO and ORO) concentrations greater than the screening level (2,000 mg/kg) are present in the shallow soil at localized areas on Parcel D and Parcel F (see Figure 45). The greatest concentrations in the shallow soil are located near the former pole dipping operations area, the former pipe and chain manufacturing operations area (including the area formerly used for sandblasting and equipment maintenance), and the former concrete products manufacturing area. The lateral extents of the total semi-volatile petroleum hydrocarbon concentrations greater than the screening level have been delineated. The concentrations typically decrease with depth (see Figures 46 and 47); however, there are elevated concentrations near the former aluminum window manufacturing area on Parcel F (31,000 mg/kg at TP100810 at 9.5 feet bgs) and the former pole dipping area (21,000 mg/kg at EMW-10D at approximately 35 feet bgs). At EMW-10D, the semi-volatile petroleum hydrocarbon concentrations greater than the screening level do not extend to a depth of 49 feet bgs. Except at TP100810, the vertical extents of the total semi-volatile petroleum hydrocarbon concentrations greater than the screening level have been delineated at the Site.

GRO concentrations greater than the the screening level (30 mg/kg) only occur at two sample locations (EB-51 and CMW-7) at the southern end of Parcel D (see Figures 48, 49, and 50). The maximum GRO concentrations from EB-51 and CMW-7 (1,400 and 110 mg/kg, respectively) were from the samples collected at depths of approximately 7.5 and 7 feet bgs, respectively). The lateral and vertical extents of the GRO concentrations greater than the screening level have been delineated at the Site.

7.5 GROUNDWATER AND SHORELINE SEEPS

The RI groundwater and seep data for the Site were used to evaluate the lateral and vertical extents of the selected IHSs in groundwater. The groundwater sample analytical results are presented in Tables 18a through 18e.

The maximum dissolved arsenic concentrations (up to 283 µg/L) exceed the screening level (5 µg/L) in the shallow groundwater located throughout most of Parcel D and in parts of Parcel F (see Figure 51). The highest concentrations are located behind the seawall, co-located with and hydraulically downgradient of arsenic-impacted soil (see Figure 21). The maximum dissolved arsenic concentrations at all of the intermediate-depth wells exceed the screening level (see Figure 52); however, the concentrations (up to 35.4 µg/L) are much lower than the concentrations in the shallow monitoring wells. Furthermore, arsenic analytical results by EPA Method 200.8 can be affected by matrix interferences from brackish groundwater conditions. To evaluate the potential effects of the brackish groundwater beneath the Subject Property, the September and October 2013 groundwater samples were analyzed for dissolved arsenic by EPA Method 1638 ICP-DRC-MS (ICP-DRC-MS; SLR, 2014). When comparing the analytical results by EPA Method 200.8 and ICP-DRS-MS, the dissolved arsenic concentrations were typically lower when using ICP-DRC-MS (Id.). Figures 53 and 54 show the dissolved arsenic concentrations by ICP-DRC-MS in the shallow and intermediate-depth groundwater monitoring wells, respectively. The areas of dissolved arsenic concentrations greater than the screening level in the shallow groundwater are similar when analyzing by EPA Method 200.8 or ICP-DRC-MS; however, the dissolved arsenic concentrations by ICP-DRC-MS are below the screening level in all of the samples from the intermediate-depth wells. The highest dissolved arsenic concentrations by EPA Method 200.8 are primarily in shallow wells located near the shoreline that contain salinity concentrations greater than 4 parts per thousand (ppt; SLR, 2014). The intermediate-depth groundwater consistently contained salinity concentrations greater than 3 ppt during the 2013 sampling events (id.), and it is likely that the arsenic exceedances in the intermediate-depth wells are due to matrix interferences from brackish groundwater conditions. The dissolved arsenic concentrations in the deep wells do not exceed the screening level (see Figure 55), therefore, the vertical extent has been delineated. The lateral extents of the dissolved arsenic concentrations greater than the screening level, after analysis by ICP-DRC-MS, have been delineated at the Site, except to the west of well HC-20 (near the western border of the Subject Property; see Figure 53).

The maximum dissolved copper concentrations exceed the screening level (2.4 µg/L) in the shallow groundwater located behind the seawall and at the eastern end of Parcel F (near the Slip 4 shoreline; see Figure 56); however, similar to arsenic, copper concentrations by EPA Method 200.8 can be affected by matrix interferences from brackish groundwater conditions. To evaluate the potential effects of the brackish groundwater, the September and October 2013 groundwater samples were analyzed for dissolved copper by ICP-DRC-MS. When comparing the dissolved copper concentrations by the two analytical methods, the ICP-DRS-MS concentrations are typically much lower (SLR, 2014). Figure 57 shows the dissolved copper concentrations by ICP-DRC-MS in the shallow groundwater monitoring wells, and there are only four localized areas where the dissolved copper concentrations are greater than the screening level. The highest dissolved copper concentrations by EPA Method 200.8 are in shallow wells located near the shoreline that have salinity concentrations greater than 4 ppt (SLR, 2014). Figures 58 and 59 show the maximum dissolved copper concentrations by EPA Method 200.8 and the dissolved concentrations by ICP-DRC-MS, respectively, in the intermediate-depth wells. The maximum dissolved copper concentrations by EPA Method 200.8 exceed the screening level in all of the samples. However, the dissolved copper concentrations by ICP-DRC-MS do not contain any exceedances of the screening level. As described above, the groundwater in the intermediate-depth wells consistently contained salinity concentrations greater than 3 ppt during the 2013 sampling events (SLR, 2014), and it is likely that the copper concentrations greater than the screening level in the intermediate-depth wells are due to matrix interferences from brackish groundwater conditions. The maximum dissolved copper concentrations in the deep monitoring wells are low, ranging from non-detect to approximately two times the screening level (see Figure 60). The samples in the deep wells were analyzed by EPA Method 200.8, and it is likely that the copper concentrations above the screening level in the deep wells are due to matrix interferences from brackish groundwater conditions. The lateral and vertical extents of the dissolved copper concentrations by ICP-DRC-MS that exceed the screening level have been delineated at the Site.

The vinyl chloride concentrations in the RI groundwater and seep samples are typically non-detect and below the screening level (0.18 µg/L; see Figures 61, 62, and 63). The maximum vinyl chloride concentrations exceed the screening level at shallow well EMW-2S (1.5 µg/L), located at the northeastern part of Parcel F, and at shallow well CMW-5 (0.57 µg/L), located behind the seawall. In addition, the maximum vinyl chloride concentration at intermediate-depth well EMW-4D (0.26 µg/L) exceeds the screening level. EMW-4D is located at the southeastern corner of Parcel F, near the shoreline (see Figure

62). The lateral extents of the vinyl chloride concentrations greater than the screening level have been delineated, except to the east of EMW-2S. None of the samples from the deep wells contain detectable vinyl chloride concentrations, and the vertical extent has been defined at the Site.

The maximum total cPAH TEQ concentrations in the shallow groundwater exceed the screening level (0.01 µg/L) at the central and western parts of Parcel D and at the central part of Parcel F (see Figure 64). The maximum total cPAH TEQ concentration (0.75 µg/L) is at shallow well SLR-3, which is located in Parcel F near the former excelsior factory and press facility. Elevated total cPAH TEQ concentrations in groundwater also occur in areas with co-located cPAH impacts in soil, including at the former pole dipping operations area, the former sawmill, the former pipe manufacturing building, and the dredge fill areas. There are two areas of total cPAH TEQ screening level exceedances in Parcel D and Parcel F that are mostly driven by non-detect values with reporting limits above the screening level. In addition, the maximum total cPAH TEQ concentration (0.11 µg/L) at off-property background well EMW-17S exceeds the screening level, indicating an off-property source of cPAHs. The total cPAH TEQ concentrations in all of the seep samples are below the screening level. The groundwater samples from the intermediate-depth wells show that the maximum total cPAH TEQ concentration (0.11 µg/L) at EMW-15D exceeds the screening level. EMW-15D is located at the southeastern part of Parcel D, along the shoreline (see Figure 65). The lateral extents of the total cPAH TEQ concentrations greater than the screening level have been delineated at the Site. The samples from all four of the deep wells contain total cPAH TEQ concentrations greater than the screening level (see Figure 66); however, the concentrations at two of the wells are non-detect values (none of the cPAH analytes are detected in the samples). The vertical extents of the total cPAH TEQ concentrations greater than the screening level have been delineated, except at wells EMW-19D and EMW-20D.

The maximum total PCB concentrations (up to 0.17 µg/L) in the shallow groundwater exceed the screening level (0.01 µg/L) at the southern and western parts of Parcel D (see Figure 67), and the highest concentration (0.17 µg/L) occurs in a localized area behind the seawall. There is also an area at the northern part of Parcel F that exceeds the screening level; however, it is based on a non-detect value (none of the PCB analytes were detected in the sample). The lateral extents of the total PCB concentrations greater than the screening level have been delineated at the Site. PCBs are not detected in any of the groundwater samples from the intermediate-depth and deep monitoring wells (see Figures 68 and 69, respectively); therefore, the vertical extent has been delineated.

7.6 SEDIMENT

The surface sediment data evaluated as part of the RI consist of Phase 1 intertidal sample (0 to 3 inches deep) and Phase 2 surface sediment sample (0 to 10 cm deep) results. The surface sediment COCs for the Site are SVOCs (benzyl alcohol), PAHs [benzo(a)anthracene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, total benzofluoranthenes(b,j,k), and total HPAH], and total PCBs. Subsurface sediment data evaluated as part of the RI consist of the Phase 2 subsurface sediment core sample (0 to 14 feet deep) results. The subsurface sediment COCs for the Site are benzyl alcohol, PAHs [anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, total benzofluoranthenes(b,j,k), total HPAH, total LPAH, and total cPAHs TEQ], total D/F TEQ, and total PCBs.

Tables 13 and 14 present the selected surface and subsurface sediment COCs, respectively, and a description of the selection process to identify the COCs is presented in Appendix J. The RI surface sediment data are presented in Tables 19a through 19d for LDW stations and Tables 20a through 20d for intertidal locations. The RI subsurface sediment data are presented in Tables 21a through 21d.

Due to the complexities associated with the LDW Superfund Site, such as numerous contaminant sources and sediment mobility, the RI sediment data for the 8th Avenue Site were not evaluated for lateral and vertical extents of the COCs. To depict the distribution of several COCs in the RI surface sediment samples (including intertidal sediment samples), the concentrations of benzyl alcohol, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, total benzofluoranthenes(b,j,k), and total PCBs are shown on Figures 70, 71, 72, 73, and 74, respectively. To show the distribution of several COCs in the RI subsurface sediment samples, the concentrations of total cPAHs TEQ, total D/F TEQ, and total PCBs are presented on Figures 75, 76, and 77, respectively.

7.6.1 SURFACE SEDIMENT

Benzyl alcohol concentrations exceed the screening level (57 micrograms per kilogram [µg/kg]) at 16 of the 23 sampling stations, including both intertidal and LDW surface sediment locations (see Figure 70). The greatest benzyl alcohol concentrations are from LDW stations SSED-09 (570 µg/kg) and SSED-03 (540 µg/kg). In general, the benzyl alcohol concentrations increase with distance away from the Subject Property shoreline. The benzyl alcohol concentrations at four of the five intertidal sediment locations are below the screening level, and the only exceedance is a non-detect value where the MRL exceeds the screening level.

Of the PAH COCs, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and total benzofluoranthenes (b,j,k) concentrations exceed their screening levels (12, 34, and 230 mg/kg organic carbon normalized [mg/kg-OC], respectively) at 2 of the 23 sampling stations (SSED-16A and SSED-14), both located over 160 feet downriver of the Subject Property (see Figures 71, 72, and 73, respectively). The maximum dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and total benzofluoranthenes(b,j,k) concentrations in surface sediment are 85.47, 242, and 1,524 mg/kg-OC, respectively (at station SSED-16A). Benzo(a)anthracene, fluoranthene, phenanthrene, and total HPAH concentrations exceeded their screening levels (110, 160, 100, and 900 mg/kg-OC, respectively), at 1 of the 23 stations (SSED-16A), which is located over 160 feet downriver of the Subject Property. The maximum benzo(a)anthracene, fluoranthene, phenanthrene, and total HPAH concentrations in surface sediment are 1,164, 2,849, 1,140, and 10,043 mg/kg-OC, respectively.

Total PCBs concentrations exceed the screening level (12 mg/kg-OC) at 13 of the 23 sampling stations (see Figure 74). The greatest total PCB concentration is at SSED-16A (67.8 mg/kg-OC), which is located over 160 feet downriver of the Subject Property. The other impacted stations are located in the LDW and in Slip 4, including at intertidal sediment sampling station IS-4.

7.6.2 SUBSURFACE SEDIMENT

The benzyl alcohol results were rejected by the laboratory for all of the samples from the sediment cores, except from core SSED-DB-12A. Three of the samples from core SSED-SB-12A were analyzed for benzyl alcohol, and the concentrations in the samples were above the screening level (57 µg/kg). The maximum concentration (260 µg/kg) is at the 4- to 6-foot depth interval. Station SSED-SB-12A is located approximately 100 feet offshore of the southwest corner of the Subject Property (see Figure 13).

Samples from all six of the sediment cores were analyzed for PAHs. Total cPAH TEQ, total LPAH, total HPAH, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, pyrene, and total benzofluoranthenes(b,j,k) concentrations greater than their respective screening levels occur at three of the six subsurface sediment core locations (SSED-SB-12A, SSED-SB-14A, and SSED-SB-16A). SSED-SB-14A and SSED-SB-16A are located over 160 feet downriver of the Subject Property and SSED-SB-12A is located approximately 100 feet south of the Subject Property shoreline (the maximum total cPAH TEQ concentrations in the subsurface sediment samples are shown on Figure 75). Anthracene and phenanthrene concentrations greater than their screening levels occur at two of the six subsurface sediment core locations (SSED-SB-12A and SSED-SB-14A). The samples from cores SSED-SB-12A, SSED-SB-14A, and SSED-SB-16A that contained the PAH concentrations greater than the screening levels were collected at depths of approximately 8 to 10 feet, 0.5 to 2 feet, and 1 to 2.7 feet below the mudline, respectively.

Total D/F TEQ concentrations greater than the screening level (25 ng/kg) are present in samples from two of the four analyzed sediment cores (see Figure 76). The maximum detected concentration is 66.6 ng/kg at station SSED-SB-13A (0.5 to 2 feet below the mudline), and the other exceedance is at SSED-B-14A (47.5 ng/kg at 0.5 to 2 feet below the mudline). SSED-SB-13A and SSED-SB-14A are located over 160 feet downriver of the southwestern corner of the Subject Property.

Samples from all six of the sediment cores were analyzed for total PCBs. Samples from four of the six cores (SSED-SB-12A, SSED-SB-13A, SSED-SB-14A, and SSED-SB-16A) contained total PCB concentrations that exceed the screening level (12 mg/kg-OC; see Figure 77). The maximum concentration is 109.9 mg/kg-OC at SSED-SB-14A (0.5 to 2 feet below the mudline), located over 160 feet downriver of the Subject Property and near two other stations (SSED-SB-13A and SSED-SB-16A) with PCB exceedances at similar depths (i.e., less than 2.5 feet below mudline). At station SSED-SB-12A, located approximately 100 feet south of the Subject Property and upriver of the other core locations that contain PCB exceedances, the PCB concentrations greater than the screening level are present at depths of approximately 2 to 4 feet, 6 to 8 feet and 8 to 10 feet. The maximum total PCB concentration (67.32 mg/kg-OC) at SSED-SB-12A is at the 8- to 10-foot depth interval.

7.7 STORMWATER AND CATCH BASIN SOLIDS

The RI stormwater sample analytical data are provided in Tables 22a through 22d, and the RI and pre-RI catch basin solids sample analytical data are presented in Tables 23a through 23f. The groundwater screening levels were used to evaluate the stormwater data, and sediment screening levels were used to evaluate the catch basin solids data. The stormwater COCs are metals (total arsenic, copper, nickel, and zinc), VOCs (chloroform), SVOCs (BEHP), and PAHs (chrysene). The catch basin solids COCs include zinc, SVOCs (BEHP, butylbenzyl phthalate, m&p-cresol, benzoic acid, and benzyl alcohol), and total D/F TEQ.

7.7.1 STORMWATER

Stormwater samples were collected at the facility's six stormwater outfalls (OF1 to OF6) during two storm events that occurred on June 26, 2013, and February 20, 2014. The 2013 and 2014 samples from the outfalls, except the 2014 sample from outfall OF2, contained total copper concentrations (up to 43.6 µg/L) greater than the screening level (2.4 µg/L). The 2013 and 2014 samples, except the 2013 sample from outfall 0F1 and the 2014 sample from OF2, contained total zinc concentrations (up to 255 µg/L) that exceeded the screening level (81 µg/L). The 2014 samples from outfalls OF3 and OF4 contained total arsenic and nickel concentrations (up to 11.5 and 30 µg/L, respectively) that exceeded the screening levels (5 and 81 µg/L, respectively).

The 2014 stormwater sample from outfall OF2 was the only sample that contained a chloroform concentration (13 µg/L) that exceeded the screening level (1.19 µg/L). The 2013 samples from OF2 and OF4 and the 2014 sample from OF3 were the only samples that contained BEHP concentrations (up to 8.3 µg/L) greater than the screening level (3 µg/L). The 2013 sample from OF2 and the 2014 samples from OF3 and OF4 were the only samples that contained chrysene concentrations (up to 0.049 µg/L) that exceeded the screening level (0.02 µg/L). Chrysene is a COC for subsurface sediment.

7.7.2 CATCH BASIN SOLIDS

During the RI and the pre-RI investigations, a total of 21 catch basin solids samples were collected from 15 selected catch basins on Parcel D. In addition, a solids sample was collected from a former stormwater drainage pipe on Parcel F. A total 17 of the 21 samples contained total zinc concentrations (up to 3,450 mg/kg) that exceeded the screening level (410 mg/kg). The maximum total zinc concentration was from the pipe solids sample that was collected in 2012 from a former conveyance line on Parcel F that has since been filled will concrete (and the former outfall plugged; SLR, 2012). Zinc is not a COC in surface and/or subsurface sediment.

BEHP was detected at concentrations (up to 756 mg/kg-OC) greater than the screening level (47 mg/kg-OC) in 10 of the 15 samples that were analyzed for BEHP. Two of the other analyzed samples did not contain detectable BEHP concentrations, but the MRLs exceeded the screening level. Butylbenzyl phthalate was detected at concentrations (up to 96.2 mg/kg-OC) greater than the screening level (4.9 mg/kg-OC) in 4 of the 14 samples that were analyzed for butylbenzyl phthalate. The other 10 analyzed samples did not contain detectable butylbenzyl phthalate concentrations; however, the MRLs exceeded the screening level. A total of three, two, and two of the samples that were analyzed for m&p-cresol, benzoic acid, and benzyl alcohol, respectively, contained concentrations (up to 21,000, 3,100, and 2,000 µg/kg, respectively) that exceeded the screening levels (63, 650, and 57 µg/kg, respectively). All of the other 13, 16, and 15 analyzed samples for m&p-cresol, benzoic acid, and benzyl alcohol, respectively, did not contain detectable concentrations, but the MRLs exceeded the screening levels. BEHP, butylbenzyl phthalate, m&p-cresol, and benzoic acid are not COCs in surface and/or subsurface sediment. Benzyl alcohol is a COC for surface and subsurface sediment; however, it is not present in the Site soil at concentrations above the screening level, and it is not present in the Site groundwater at concentrations greater than the MRLs.

Two of the three catch basin solids samples that were analyzed for D/F contained total D/F TEQ concentrations (57.57 and 236 ng/kg) that exceeded the screening level (25 ng/kg). The 2013 samples from catch basins DP4CB4 and DP6CB1 contained the screening level exceedances. Catch basin DP4CB4 was resampled in 2014, and the total D/F TEQ concentration was below the screening level. Total D/F TEQ is a subsurface sediment COC for the Site.

8. CONCEPTUAL SITE MODEL

This section summarizes the conceptual site model (CSM) for the Site. The CSM is based on data presented in this RI Report and incorporates the following:

- The hydrogeologic and aquatic setting
- Current and planned future Site uses
- The nature and extent of COCs in Site media based on data collected to date
- The fate and transport of COCs and the potential impacts to environmental receptors

With this framework, the CSM will guide the development of the FS, including the selection of cleanup levels and cleanup alternatives appropriate for the Site.

8.1 INDICATOR HAZARDOUS SUBSTANCES

IHSs, a subset of Site COCs, were used to focus the RI and aid in characterizing the nature and extent of the soil and groundwater contamination of the Site. As described in Section 7.3, IHSs were selected in accordance with WAC 173-340-708.

As discussed in Section 7, the Site IHSs are as follows:

- Soil: metals (arsenic, copper, lead, and selenium), VOCs (vinyl chloride), PAHs (total cPAHs TEQ), total PCBs, total D/F TEQ, and petroleum hydrocarbons (total semi-volatile petroleum hydrocarbons [sum of DRO and ORO] and GRO).
- Groundwater: metals (dissolved arsenic and copper), VOCs (vinyl chloride), PAHs (total cPAHs TEQ), and total PCBs.
- There are no IHSs for surface sediment. The COCs for surface sediment are SVOCs (benzyl alcohol), PAHs [benzo(a)anthracene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, total benzofluoranthenes(b,j,k), and total HPAH], and total PCBs.
- There are no IHSs for subsurface sediment. The COCs for subsurface sediment are SVOCs (benzyl alcohol), PAHs [anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, total benzofluoranthenes(b,j,k), total HPAH, total LPAH, and total cPAH TEQ], total PCBs, and total D/F TEQ.
- There are no IHSs for stormwater. The COCs for stormwater are metals (total arsenic, copper, nickel, and zinc), VOCs (chloroform), SVOCs (BEHP), and PAHs (chrysene).
- There are no IHSs for catch basin solids. The COCs for catch basin solids are metals (zinc), SVOCs (BEHP, benzyl alcohol, m&p-cresol, butylbenzyl phthalate, and benzoic acid), and total D/F TEQ.

8.2 ON-SITE SOURCES OF CONTAMINATION

Since May 2014, the Subject Property has undergone redevelopment by WMNS [e.g., paving, demolition of structures, repairs/updates to the stormwater system, and installation of a rail spur (with three rail lines), new operational structures, and water treatment systems] for use as a materials reload and transfer facility. In this timeframe, SLR is unaware of any releases of hazardous substances at the Subject Property, and current Facility best management practices (BMPs) limit the potential of any future hazardous substance releases. Prior to the WMNS operations, dating back to the early 1980s, the Subject Property was used by previous tenants for cargo storage and distribution, for grinding and storage of wood, and for school bus parking (SLR, 2014). There are no records of hazardous substance releases at the Subject Property during that time.

Based on the historical industrial operations at the Subject Property since approximately the early 1920s and the pre-RI and RI investigation results, the following potential contaminant source areas exist at the Site (see Figure 78):

- The area associated with the former wood treating operations, including a former treated pole storage area, former pole dipping and creosote tanks, former pump house, and former boiler, located in the northwestern portion of Parcel D appears to be a source of metals (arsenic, copper, and lead), PCBs, PAHs, D/F, GRO, and total semi-volatile petroleum hydrocarbons in soil, and arsenic, copper, PCBs, and PAHs in groundwater.
- The area associated with historical dredge fill materials, located along the nearshore and shoreline areas of Parcel D and the southeastern corner of Parcel F, appears to be a source of metals (arsenic, copper, lead, and selenium), PCBs, and PAHs in soil, and arsenic, copper, and PAHs in groundwater.
- The area associated with the former sawmill and excelsior factory and press operations, in the northern half of Parcel D and southeastern corner of Parcel F, appears to be a source of metals (arsenic, copper, lead, and selenium), PCBs, PAHs, D/F, and total semi-volatile petroleum hydrocarbons in soil, and arsenic, copper, and PAHs in groundwater.
- The area associated with the former aluminum window manufacturing plant in Parcel F appears to be a source of metals (arsenic, copper and selenium) and PAHs in soil, and arsenic, copper, and vinyl chloride in groundwater.
- The area associated with the former pipe and chain manufacturing operations, including the former sandblast area, former incinerator building, and former oil tank vault, located in the southern part of Parcel D, appears to be a source of metals (arsenic, copper, and selenium), PCBs, PAHs, GRO, and total semi-volatile petroleum hydrocarbons in soil, and arsenic, copper, vinyl chloride, PCBs, and PAHs in groundwater.
- The area associated with former concrete products manufacturing and storage operations in Parcel F appears to be a source of metals (arsenic and selenium), PCBs, PAHs, and total semi-volatile petroleum hydrocarbons in soil, and PCBs in groundwater.
- A possible historical sand blast grit dump area in the LDW, located immediately west of the Subject Property, may be a source of subsurface sediment impacts by PAHs, PCBs, and D/F;

however, these chemicals are also COCs for the LDW site and are present in sediments located upriver of the Site.

8.3 OFF-SITE SOURCES OF CONTAMINATION

This section discusses potential off-site sources of upland impacts on the Subject Property, and potential off-site sources of sediment impacts on and near the in-water portion of the property. The Subject Property is located in an industrial area, and the neighboring industrial properties located hydraulically upgradient (north and northwest) of the property, such as the Markey Machinery facility and the Drywall Recycling Services facility, appear to be the sources of the known contaminated groundwater (arsenic and total cPAHs TEQ) at background wells EMW-1S and/or EMW-17S that is migrating onto the property.

COCs detected in sediments at concentrations exceeding the screening levels are present in areas beyond the boundaries of the Site. Sediments outside the Site are part of the LDW Superfund site and are subject to sediment cleanup requirements defined by the ROD (EPA, 2014) for the LDW. PCBs, PAHs, and D/F have been detected broadly in surface and subsurface sediments within the LDW. These contaminants are known to have numerous confirmed and suspected sources within the LDW.

As described in Section 3, previous sediment sample analytical results from Slip 4 showed that the elevated PAH, PCB, lead, mercury, zinc, BEHP, and D/F TEQ concentrations at the head of the slip were due to the five public stormwater outfalls that discharged at that location. The contaminant concentrations decreased with distance away from the head of the slip; however, concentrations greater than the RALs have migrated onto the Subject Property. It is also likely that other off-site sources contributed (and still contribute) to the sediment contamination on and near the Subject Property. Today, many sources of historical origin in the LDW basin, including direct discharges of municipal and industrial wastewater and spills, have been identified and controlled to some extent by enhanced regulatory requirements, improved housekeeping practices, and technological advances. The reduction of some contaminants, such as PCBs, is due in part to banned production and use in the United States; however, significant contamination of historical origin is still present in the environment, and releases are likely ongoing.

PCB legacies include older paints, caulks, and building materials still on or in existing structures, as well as soil and groundwater that were contaminated while PCBs were still actively used and produced in the United States. Historical off-site sources of PCBs to the LDW include dielectric fluids, waste oils, hydraulic oils, paints, and sealants. PCBs were also historically released with cement kiln emissions, along with D/F. PCBs also come from industrial, commercial, and residential properties (e.g., hydraulic fluid in historical equipment). Historical sources likely contributed much of the sediment contamination in the LDW, and historically impacted media/materials remain in the drainage basin and continue to be transported to the LDW.

PAHs are generated from the burning of organic matter, fossil fuels, and charcoal (pyrogenic) and are present in refined petroleum products (petrogenic). Therefore, PAHs are continually generated and released to the LDW drainage basin and airshed through petroleum use and combustion. In addition, PAHs were historically released from brick manufacturing operations, hydraulic equipment manufacturing, machine shops, and from repair and fueling of vehicles, airplanes, trains, and watercraft. They can continue to be released by most of these sources, but BMPs controlling spills and leaks have reduced input from these sources. In addition, timber piles and dolphins (groups of closely driven piles used as a fender for a dock, a mooring, or a guide for boats) in the LDW, and utility poles and railroad ties in the watershed, were treated with creosote, which can deposit PAHs directly into the LDW as these structures degrade.

D/F are not used in manufacturing operations but are unintentionally formed as byproducts of incineration when chlorine and organic material are present. They were historically (and are currently) released from the burning of waste and from paper mills, cement kilns, and drum recycling. Historically, D/F were byproducts of pentachlorophenol (used in wood treating) and pesticide production; neither activity is present in the LDW drainage basin today.

Benzyl alcohol concentrations greater than the screening level are present in surface and subsurface sediments on and near the Subject Property, though no known current or historical source exists on the Subject Property. According to a recent study by the USACE, elevated benzyl alcohol concentrations (including those from the LDW basin) may be directly attributable to the presence of decaying organic matter in sediments (USACE, 2016).

8.4 FATE AND TRANSPORT OF UPLAND CONTAMINANTS

Figure 79 is a graphical representation of the fate and transport of the contaminants at the Site. After any upland releases at the Subject Property, contaminants would initially have been located in surface soils (surface spills or impacted ash accumulation) or subsurface soils (UST releases, placement of impacted dredge fill, or burial of impacted ash or partially burned debris). Metals, PAHs, semi-volatile petroleum hydrocarbons, PCBs, and D/F in soil exist primarily in two phases: adsorbed to soil particles and dissolved in soil porewater. Where present, volatile petroleum hydrocarbons and VOCs also exist in the vapor phase.

As rain falls on the ground surface and infiltrates the subsurface, contaminants in surface soils and subsurface soils can dissolve in the rainwater and percolate through the subsurface soils. Some of the contaminant mass remains in the subsurface soils, in the phases listed previously, and some of the contaminant mass eventually reaches the groundwater. After the early 1980s, pavement has minimized rainwater infiltration across most of the Subject Property, limiting the leaching of contaminants from soil to groundwater. The northern portion of Parcel F is an unpaved stormwater infiltration area, and the leaching of contaminants from soil to groundwater is likely to be greater in that portion of the property. Groundwater levels are tidally influenced, and contaminants may move between subsurface soils and groundwater as the water levels rise and fall.

Riprap located along the southwestern bank of the upland portion of the Subject Property was inspected in July 2013 to determine if exposed soil was present that could potentially erode during major rainfall events, or by contact with surface water of the LDW (including Slip 4) during certain tidal events, and migrate to the surface water. During the inspection of the riprap, SLR personnel observed that the sheet pile seawall extended to the western property line, and the wall would prevent soil from eroding into the riprap. SLR did not observe any exposed soil between the riprap boulders (SLR, 2014), and transport of soil in the river bank via erosion to surface water and sediment in the LDW and Slip 4 is not considered a complete transport mechanism.

Stormwater sheet flow from Parcels D and F into Slip 4 is limited to the sloped concrete surfaces beneath the two loading ramps on Parcel D (SLR, 2014). Therefore, contaminants in surface soil are not transported directly to surface water through stormwater sheet flow. Prior to the installation of the stormwater treatment system at the Subject Property in 2018, stormwater on the upland portion of the property was directed into catch basins that discharged to Slip 4 and the LDW. Based on the previous stormwater conveyance system at the Subject Property, contaminants on paved surfaces (such as from surface spills) or on unpaved surfaces (such as contaminants in surface soil) may have been picked up and transported by stormwater to surface water and to sediment in Slip 4 and the LDW. The stormwater drainage system on Parcel D was thoroughly inspected in August 2013 (SLR, 2014). The results of the inspection showed that a pipe joint was separated and offset at one location on D Line #1, and stormwater could have drained into the subsurface soil and groundwater at that location. Except at the one separated pipe joint, which was subsequently repaired in 2017, no leaks were identified in the catch basins or drain lines, and it is unlikely that contaminants in the drainage system were released to subsurface soil and groundwater. After the 2018 installation of the stormwater treatment system and the re-routing of the conveyance system to the treatment system, any contaminants that are picked up and transported by stormwater to the treatment system should be captured by the system prior to discharge from outfall OF1.

The IHSs below the groundwater table exist primarily in two phases: a dissolved phase or sorbed to the soil particles in the water-bearing zone. Groundwater beneath the Subject Property is hydraulically connected to the LDW (including Slip 4). The sheet pile seawall retards most of the direct flow between shallow groundwater beneath Parcel D and surface water in Slip 4, but direct and re-directed flow occurs through the riprap near the ends of the seawall, and relatively minor flow occurs through holes and cracks in the wall. In addition, the deeper groundwater within the unconfined groundwater unit, at depths below 43 feet, likely flows under the seawall. Therefore, depending on their location beneath the property, contaminants in groundwater could discharge to surface water and sediment in the LDW and Slip 4. Under such conditions, migration to sediment could theoretically occur either directly through groundwater flow to sediment, or indirectly through sediment-surface water interactions following groundwater discharge to surface water.

Volatile contaminants in surface and subsurface soil are present in the vapor phase, and volatile contaminants in groundwater can also volatilize to the overlying soil. After volatilization, these contaminants can be transported to the surface to outdoor air and to indoor air. However, the resulting outdoor air concentrations are expected to be minimal due to instantaneous dispersion and mixing that occurs at the soil-air interface. Vapors may enter indoor air (i.e., through vapor intrusion) where volatile contaminants are present in the subsurface beneath or near a slab-on-grade building. At the Site, the identified volatile IHSs for soil (vinyl chloride and GRO) and groundwater (vinyl chloride) were only present at a few localized areas. Currently, there are no enclosed, slab-on-grade buildings located at the Subject Property; however, future redevelopment by WMNS may include new, slab-on-grade buildings in areas with vinyl chloride and/or GRO in the subsurface. Vapor intrusion is therefore not identified as a current transport mechanism, but the construction of future enclosed slab-on-grade buildings could complete this transport pathway.

Non-volatile IHSs present in surface soil may be transported to ambient air in the form of suspended particulates (i.e., dust). However, due to the use of the unpaved portion of the Subject Property for stormwater infiltration and the typically wet climate of the region, dust generation is expected to be minimal.

Given the industrial nature of the Site, only potential exposures to wildlife (i.e., not plants or soil biota) need be considered, and uptake of soil IHSs to plants or soil biota is not identified as a substantial transport pathway. The simplified TEE was ended as described in Section 6.1.2.1, and potential uptake of IHSs from soil to terrestrial wildlife is not further considered in this CSM. Also, humans are unlikely to hunt and consume terrestrial biota, and terrestrial biota do not represent a relevant exposure medium for humans. Aquatic plants can take up contaminants from the sediments and surface water through their roots and leaves. Aquatic biota can also accumulate chemicals in surface water and sediment through ingestion, dermal contact, and respiration. Aquatic biota can therefore potentially act as additional contaminated media.

8.5 FATE AND TRANSPORT OF SEDIMENT CONTAMINANTS

Contaminants in sediment exist primarily in two phases: adsorbed to sediment particles and dissolved in sediment porewater. In the LDW, the transport and fate of particle-associated chemicals (e.g., PCBs and other organics) are affected by a range of physical and chemical processes. Generally, physical sediment transport processes (e.g., net sedimentation, erosion, bed stability) have a significant effect on the transport and fate of these types of chemicals. The LDW sediment transport model (STM; QEA, 2008) evaluated the following three physical sediment transport processes as part of the LDW FS: 1) bed stability related to scour potential from high-flow events and passing ship traffic; 2) net sedimentation rates; and 3) solids loading into and out of each model grid cell in the LDW.

According to the results of the STM, scour of bed sediment materials in the LDW can be caused on a reach-wide scale by river discharge during high-flow events (i.e., high-flow-induced scour) and minimally by vessel traffic moving along the navigation channel. On localized scales, scour can occur as a result of vessel maneuvers in berthing areas such as those adjacent to the Subject Property. Ship-induced bed scour is typically an impulsive erosion/deposition process that tends to behave like an ongoing, small-scale, shallow mixing process for surficial bed sediment (i.e., within the top 10 cm).

Net sedimentation rates were determined in the STM (QEA, 2008) and validated using empirical evidence from the LDW RI and historical cores. Net sedimentation rates in the intertidal and subtidal bench areas throughout the LDW were estimated to range from 0.2 cm/year to greater than 2.0 cm/year, with those in the intertidal areas being on the order of 0.5 cm/year.

8.6 POTENTIAL EXPOSURE MEDIA

The following environmental media have or may have become contaminated and could be acting as sources of exposure for humans or aquatic biota:

- Surface soil
- Subsurface soil
- Ambient air
- Groundwater
- Surface water
- Surface sediment
- Subsurface sediment

8.7 POTENTIAL RECEPTORS

8.7.1 HUMAN RECEPTORS

The Subject Property is used as a materials reload and transfer facility by WMNS. As part of facility operations, WMNS performs offloading, loading, transloading, and storage of clean and/or non-hazardous contaminated materials (e.g., containerized bulk soils, sands, gravels, and liquids) from barges onto trucks and/or railcars, and stages/operates marine cargo and equipment, vehicles (including refueling), and railcars on the Subject Property, including at areas along the Parcel D shoreline. Throughout the Subject Property, industrial workers are present and are primarily outdoor workers. These workers may spend a portion of their time in the office trailers and scale house. Subject Property visitors, such as truck drivers and train operators, will also be routinely present (i.e., typically for short periods of time) as part of facility operations. It is possible that property redevelopment or construction of additional buildings may occur in the future; therefore, construction workers are identified as potential future receptors.

Trespassers are unlikely to enter the Subject Property due to the presence of a fence and locking gates that prevent access along the north and west sides, and the presence of Slip 4 and the LDW along the east and south sides. Fishermen in boats are occasionally present in Slip 4. A small beach area is located adjacent to the Subject Property at the terminus of 8th Avenue South; this beach is accessible to the public for recreational uses. Therefore, fishermen and recreational visitors are identified as off-site receptors.

8.7.2 ECOLOGICAL RECEPTORS

Except for the northern part of Parcel F, the entire Subject Property is capped with asphalt or concrete. The unpaved portion of Parcel F has been covered with gravel, topsoil and limited grass. The industrial activities at the Subject Property, and the industrial operations at surrounding properties, present a constant human disturbance. At present, the Subject Property offers limited, disturbed terrestrial habitat. Based on the results of the TEE for the Subject Property (see Section 6), terrestrial ecological receptors are not included in this CSM. The eastern and southeastern parts of the Subject Property are located adjacent to Slip 4 of the LDW, and the southern part of the property is adjacent to the main channel of the LDW. The LDW is tidally influenced, with water levels in Slip 4 varying more than 13 feet in response to Puget Sound tides. In 2011, Boeing conducted a salinity study of Slip 4, and the salinity measurements during three sampling events indicated that the water in Slip 4 is brackish (AMEC Geomatrix, 2011). Aquatic species are present in the LDW, including benthic invertebrates, shellfish, and resident and migratory fish (Striplin Environmental Associates, 2004).

8.8 POTENTIAL EXPOSURES

8.8.1 EXPOSURES TO HUMAN RECEPTORS

8.8.1.1 Currently Known Exposures

The human receptors currently present at the Subject Property include industrial workers that are assumed to be on the property during times of facility operation. Visitors (e.g., truck drivers, train and barge operators) are also on the Subject Property for short periods of time and on an irregular basis. Fishermen in boats are occasionally present in Slip 4. The public can access a small beach area adjacent to the property at the terminus of 8th Avenue South.

The Subject Property is almost entirely covered with asphalt or concrete, and the portion that is not paved is used for stormwater infiltration. Therefore, human receptors currently present on the property may be exposed to soils through direct contact (i.e., dermal contact and/or incidental ingestion), although the exposure would likely be minimal. Exposure through inhalation of windblown dust, although limited, is also potentially relevant for the Subject Property if exposed soils are disturbed and create dust. However, construction activities and heavy vehicle activity are not presently occurring within the unpaved portion of the property and dust generation under current conditions is expected to be minimal. Direct soil contact and inhalation of particulates therefore represent potentially complete exposure pathways for current human receptors at the Subject Property, although exposures are not expected to be significant.

Volatile contaminants were identified in the soil at the Subject Property; however, since there are no enclosed slab-on-grade buildings at the property, vapor intrusion from the subsurface to indoor air is considered an incomplete transport mechanism under current conditions. Outdoor air concentrations are expected to be minimal due to instantaneous dispersion and mixing that occur at the soil-air interface. Inhalation of vapors in outdoor air is considered a potentially complete but insignificant pathway for current industrial workers.

Contaminants in groundwater and in stormwater can migrate to surface water and sediment in the adjacent Slip 4 and LDW. Contaminants may then be taken up by aquatic and sediment-dwelling organisms such as fish and shellfish, which may be consumed by people fishing or harvesting shellfish in the area. Fishermen in boats have been observed in Slip 4 and shellfish harvesting (clamming) may occur at the small beach area at the terminus of 8th Avenue South; therefore, fish and shellfish consumption is currently considered to be a potentially complete exposure pathway for off-site receptors. The small beach area adjacent to the Subject Property, at the terminus of 8th Avenue South, may be used by the public; therefore, dermal contact with and incidental ingestion of sediments are also potentially complete exposure pathway for off-site receptors. Direct contact with sediments by net fishermen in Slip 4 and the LDW is also a potentially complete exposure pathway.

Due to the industrial nature of the area and the industrial use of the waterway, swimming is not expected, but due to public accessibility of a nearby beach, swimming may occur in the vicinity of the Site. Therefore, dermal contact with and incidental ingestion of surface water (i.e., by swimmers and/or net fishermen in Slip 4 and the LDW) are considered potentially complete pathways for off-site receptors, though these pathways are considered insignificant relative to other potential exposures associated with the Site.

Based on salinity measurements in July 2008 (SLR, 2008) and in groundwater samples collected during the RI, shallow groundwater within 50 feet of the LDW or Slip 4 is brackish in nature (salinity concentrations of 1.5 to 20 ppt). Deeper groundwater within the unconfined water-bearing unit (at approximately 40 to 80 feet) is also brackish (salinity concentrations of 3.5 to 4.9 parts per thousand) within at least 450 feet of the LDW or Slip 4. The brackish conditions in the unconfined water-bearing unit throughout most, if not all, of the Subject Property make the groundwater unsuitable for human consumption. No drinking water wells are present on the Subject Property, and drinking water is supplied by the City of Seattle. Based on existing data, consumption of groundwater is therefore an incomplete pathway for human receptors at the Subject Property.

8.8.1.2 Potential Future Exposures

Since April 2014, the upland portion of the Subject Property has been used by WMNS (under a property lease agreement) for redevelopment and operation as a materials reload and transfer facility. WMNS plans to continue operation of the facility in the future, and to continue redevelopment activities to improve the property infrastructure. Potential future receptors are likely to include industrial workers with similar exposures as current workers, except that the potential for soil contact and inhalation exposures could increase during future construction activities. Construction workers could also be present during future development activities. Fishermen accessing Slip 4 from the water will likely continue to be intermittently present in the future. If slab-on-grade buildings are constructed in the future over locations where VOCs are present at elevated concentrations in the subsurface, vapor intrusion into future buildings may become a complete exposure pathway.

Future construction workers could be exposed to contaminants in surface and subsurface soil, and in shallow groundwater through dermal contact or incidental ingestion during excavation activities. In the case of significant redevelopment and/or removal of pavement, inhalation of windblown dust may also occur. These exposure pathways are therefore considered potentially complete for the future construction worker receptor.

Since surface and/or subsurface soils could become exposed if construction activities occur on the Subject Property in the future, direct surface and subsurface soil contact pathways (including ingestion and dermal contact) and inhalation of windblown particulates in ambient air generated from surface or subsurface soil are also potentially complete for future industrial worker and Subject Property visitor receptors.

Future exposure pathways for off-site fisherman and public receptors (i.e., through consumption of aquatic organisms, direct contact with and/or incidental ingestion of surface water and/or sediment [through net fishing and recreation]) are the same as the current exposure pathways.

8.8.2 EXPOSURES TO ECOLOGICAL RECEPTORS

8.8.2.1 Currently Known Exposures

There is currently limited habitat at the Subject Property to encourage visits by terrestrial wildlife. Due to the limited terrestrial habitat and ongoing human disturbance at the Subject Property, terrestrial receptors are not expected to spend significant amounts of time or conduct nesting or breeding activities on the property. Based on these factors and the results of the simplified TEE, terrestrial ecological receptors and pathways were not included in this CSM.

Aquatic receptors in Slip 4 and the LDW could be exposed to contaminants through ingestion of and direct contact with surface water and sediment, through respiration, and through ingestion of plants and prey that may have accumulated contaminants from the environment. These exposure pathways are therefore considered potentially complete for aquatic receptors.

8.8.2.2 Potential Future Exposures

Future exposure pathways for aquatic ecological receptors are the same as the current exposure pathways. Current and future potential human and ecological receptors and exposure pathways are illustrated on Figure 80.

9. REMAINING RI DATA GAPS

The purpose of the RI is to determine the nature and extent of the contamination at the Subject Property, and to assess the potential risks to human health and the environment. Based on the existing data, there are some remaining investigation data gaps that may need to be addressed prior to completing the FS for the Site. These data gaps are described below.

Soil Data Gaps

- The lateral extents of the arsenic concentrations greater than the screening level, at a depth greater than 12 feet bgs, have not been delineated to the west of boring HC-1A (near the western border of the Subject Property).

- The lateral extents of the total PCB concentrations greater than the screening level, at a depth below 6 feet bgs, have not been delineated to the west of boring DB12 (near the western border of the Subject Property).

- The lateral extents of the total D/F TEQ concentrations greater than the screening level have not delineated to the west of borings EB-34 and EB-42 (near the western border of the Subject Property).

- The vertical extents of total cPAH TEQ and total PCB concentrations greater than their screening levels have not been delineated at boring EMW-21D.

- The vertical extents of the arsenic concentrations greater than the screening level have not been delineated at borings HC-1A, EB-12, EB-53, EMW-15D, and EMW-21D.

- The vertical extent of the lead concentration greater than the screening level at boring EMW-21D has not been delineated.

- The vertical extent of the total semi-volatile petroleum hydrocarbon concentration greater than the screening level at test pit TP100810 has not been defined.

- The depth of the shallowest fine-grained confining unit beneath the Subject Property has not been assessed, and the lateral continuity and thickness of that unit have not been determined.

Groundwater Data Gaps

- The lateral extents of the vinyl chloride concentrations greater than the screening level have not been delineated to the east of shallow well EMW-2S (near the eastern border of Parcel F).

- The vertical extents of the total cPAH TEQ concentrations greater than the screening level have not been delineated at the western part of Parcel D (at deep well EMW-19D) and near the sheet pile seawall (at deep well EMW-20D).

10. CONCLUSIONS

In compliance with the AO, an RI was conducted at the Site to characterize the nature and extent of the Site-related chemicals in both upland and aquatic areas, and to evaluate the risks that these chemicals may pose to human health and the environment. The RI was conducted in two phases; SLR completed Phase 1 from May 2013 through February 2014 and Anchor completed Phase 2 from November 2014 through January 2015. In addition, prior to completing Phase 2 of the RI, Anchor conducted IA sampling activities to support implementation of planned Facility development actions.

The work associated with both phases of the RI, as well as the IA sampling, included the following:

- Drilled 104 soil borings and collected soil samples from each boring
- Completed 15 of the borings as shallow groundwater monitoring wells, 5 of the borings as intermediate-depth groundwater monitoring wells, and 4 of the borings as deep groundwater monitoring wells
- Measured depths to groundwater and collected groundwater samples from the active monitoring wells at the Site during three low-tide events and one high-tide event in the LDW
- Conducted a tidal study at 20 monitoring wells, as well as at a stilling well in the LDW, for a period of one week
- Collected stormwater samples from the Subject Property outfalls during two qualifying storm events
- Collected two catch basin solids samples from each of the six stormwater conveyance lines on Parcel D
- Inspected the seawall and riprap for groundwater seeps and collected samples from five seeps that had sufficient flow
- Collected five intertidal sediment samples near each end of the Subject Property pier and near stormwater outfalls OF2, OF3, and OF4.
- Collected 18 surface sediment samples in the LDW at locations on and near the Subject Property
- Advanced and sampled 6 subsurface sediment cores in the LDW at locations near the Subject Property.

The results of the groundwater monitoring and tidal study data collected during the RI indicate that the shallow groundwater flow during low tides is primarily to the southeast towards Slip 4. The relatively flat horizontal gradients behind the seawall and the mean downward vertical gradients along the sheet pile seawall indicate that the seawall is retarding shallow groundwater flow as the groundwater abuts against the seawall and then the majority of the water flows to either end or under the wall. During high tides, waterway surface water flows inland primarily around the ends of the seawall and recharges the groundwater beneath the Subject Property. Holes and cracks in the seawall allow some groundwater and surface water to flow through the wall. During low tide conditions, the unconfined groundwater at depths below 43 feet bgs (the bottom of the seawall) flows to the southeast towards Slip 4, and then under the seawall and riprap areas into the waterway. During high tide conditions, the deeper groundwater flows under the seawall and riprap areas, and inland at northwestern and northern directions.

To evaluate the nature and extent of chemicals at the Site that may pose a potential risk to human health and the environment, SLR developed conservative Site screening levels for soil, groundwater, and sediment that addressed the full range of potentially applicable exposure pathways and receptors under current and foreseeable future uses of the Site. The RI and pre-RI soil and catch basin solids sample analytical results were compared to the soil and sediment screening levels, respectively. The RI groundwater and sediment sample analytical results were compared to the groundwater and sediment screening levels, respectively. The RI stormwater sample analytical results were compared to the groundwater screening levels, which are primarily based on protection of surface water or sediment.

Chemicals that were present at concentrations exceeding media-specific screening levels with detected results or undetected results (MRL exceeded the screening level) in one or more samples were identified as COPCs. Based on the large list of COPCs, SLR conducted statistical analyses for each Site medium to identify the Site COCs. Consistent with MTCA, IHSs were used as selected COCs for soil and groundwater to focus the characterization of the nature and extent of contamination of the Site. The identified IHSs for the Site include the following:

- Soil: metals (arsenic, copper, lead, and selenium), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), total PCBs, total D/F TEQ, and petroleum hydrocarbons (total sem-volatile petroleum hydrocarbons [sum of DRO and ORO] and GRO).
- Groundwater: metals (dissolved arsenic and dissolved copper), PAHs (total cPAHs TEQ), VOCs (vinyl chloride), and total PCBs.

All soil data were used to evaluate the lateral and vertical extents of the soil IHSs at the Site. Most of the soil IHSs occur at concentrations greater than the screening levels in the shallow soil beneath large areas of Parcel D and localized areas of Parcel F (if present). The IHS concentrations typically decrease with depth. The lateral and vertical extents of each of the soil IHSs have been delineated, except for the western extents of arsenic, total PCBs, and total D/F TEQ at the western part of Parcel D (at locations near the western border of the Subject Property), and the vertical extents of arsenic, lead, total cPAH TEQ, total PCBs, and semi-volatile petroleum hydrocarbons at localized areas of the Subject Property.

The RI groundwater data were used to evaluate the lateral and vertical extents of the groundwater IHSs at the Site. Most of the groundwater IHSs are present in the shallow groundwater beneath large areas of Parcel D and localized areas of Parcel F. The IHS concentrations typically decrease with depth. The lateral and vertical extents of each of the groundwater IHSs have been delineated, except for the lateral (eastern) extent of vinyl chloride near the eastern border of Parcel F (east of shallow well EMW-2S) and the vertical extents of total cPAH TEQ at the western part of Parcel D (at deep well EMW-19D) and near the sheet pile seawall (at deep well EMW-20D).

The Site COCs for surface sediment are SVOCs (benzyl alcohol), PAHs [benzo(a)anthracene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, total benzofluoranthenes(b,j,k), and total HPAH], and total PCBs. Benzyl alcohol and total PCB concentrations exceeded their screening levels at 16 and 13, respectively, of the 23 surface sediment sampling stations. PAH COC concentrations greater than their screening levels occurred at 1 or 2 of the 23 sampling stations. The Site COCs for subsurface sediment are benzyl alcohol, PAHs [anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, total benzofluoranthenes(b,j,k), total HPAH, total LPAH, and total cPAHs TEQ], total D/F TEQ, and total PCBs. The greatest sediment COC concentrations typically occurred at sampling stations located over 160 feet downriver of the Subject Property or approximately 100 feet south of the Subject Property shoreline. Due to the complexities associated with the LDW Superfund Site, such as numerous contaminant sources and sediment mobility, the RI sediment data from the 8^{th} Avenue Site were not evaluated for lateral and vertical extents of the COCs. Based on the RI sediment sample analytical results, the previous sediment dredging on the Subject Property, the extensive sediment sampling that has been conducted in the LDW and Slip 4, including on the Subject Property, and the EPA's planned remedial action for the LDW Superfund Site, the surface and subsurface sediments have been adequately characterized for the RI.

At least one of the stormwater samples contained metals (total arsenic, copper, nickel, and zinc), chloroform, BEHP, and/or chrysene concentrations greater than the groundwater screening levels. At least one of the catch basin solids samples contained zinc, SVOCs (BEHP, butylbenzyl phthalate, m&p-cresol, benzoic acid, and benzyl alcohol), and/or total D/F TEQ concentrations greater than the sediment screening levels. Of the stormwater and catch basin solids COCs, only benzyl alcohol, chrysene, and total D/F TEQ are sediment COCs for the Site. For the purposes of the RI, the catch basin solids and stormwater at the Site have been adequately characterized.

Based on the results of the RI, the Site data (a combination of historical data and RI data) are of sufficient quantity and quality to characterize the nature and extent of the Site-related chemicals, and to understand the potential risks that these chemicals may pose to human health and the environment. The Site data can be effectively used to develop Site CULs and the cleanup action alternatives that will be evaluated in the FS. Although there are some remaining investigation data gaps that may need to be addressed prior to completing the FS, these data gaps are not critical to the understanding of the overall Site conditions. Based on the data presented in this Report, the RI has met the requirements of WAC 173-340-350 and WAC 173-204-560, as defined in the AO.

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The purpose of an environmental assessment is to reasonably evaluate the potential for, or actual impact of, past practices on a given site area. In performing an environmental assessment, it is understood that a balance must be struck between a reasonable inquiry into the environmental issues and an appropriate level of analysis for each conceivable issue of potential concern. The following paragraphs discuss the assumptions and parameters under which such an opinion is rendered.

No investigation can be thorough enough to exclude the presence of hazardous materials at a given site. If hazardous conditions have not been identified during the assessment, such a finding should not therefore be construed as a guarantee of the absence of such materials on the site, but rather as the result of the services performed within the scope, practical limitations, and cost of the work performed.

Environmental conditions that are not apparent may exist at the site. Our professional opinions are based in part on interpretation of data from a limited number of discrete sampling locations and therefore may not be representative of the actual overall site environmental conditions.

The passage of time, manifestation of latent conditions, or occurrence of future events may require further study at the site, analysis of the data, and/or reevaluation of the findings, observations, and conclusions in the work product.

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