Remedial Investigation Report –
Public Review DRAFT
Duwamish Marine Center Property
6365 First Avenue South
Seattle, WA 98018
Ecology Facility Site No.: 21945598
Agreed Order No.: DE 8072

Prepared for: Mr. Clint Harris
Duwamish Marine Center
16 South Michigan St.
Seattle, WA 98108

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September 30, 2020

G-Logics Project 01-0979-G

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Mr. Clint Harris
Duwamish Marine Center
16 South Michigan St.
Seattle, WA 98108

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Dear Mr. Harris:

This Remedial Investigation Report includes the results of the site-exploration efforts conducted at the above-referenced property (the "Property"). This report documents the purpose, approach, and results of these explorations as well as G-Logics conclusions and opinions. We trust the information presented in this report meets your needs at this time.

Should you require additional information or have any questions, please contact us at your convenience. Thank you again for this opportunity to be of service.

Sincerely,
G-Logics, Inc.

DRAFT

Rory L. Galloway, LG, LHG
Principal

DRAFT

Stuart Hyde
Project Geologist

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ACRONYMS AND ABBREVIATIONS

AET	Apparent Effects Threshold
BMP	Best Management Practices
CAP	Cleanup Action Plan
CB	Catch Basin
CDC	Center For Disease Control
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
CLARC	Cleanup Levels and Risk Calculations
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
COPC	Contaminant/Chemical of Potential Concern
CSM	Conceptual Site Model
CSO	Combined Sewer Outfall
CWA	Clean Water Act
DMC	Duwamish Marine Center
DRO	Diesel-Range Organics
ECOCHEM	ECOCHEM Data Quality
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FS	Feasibility Study
GRO	Gasoline-Range Organics
LDW	Lower Duwamish Waterway
MDL	Method Detection Limit
MHHW	Mean Higher High Water
MTCA	Model Toxics Control Act
NAVD 88	North American Vertical Datum of 1988
NFA	No Further Action
NTR	National Toxics Rule
ORO	Oil-Range Organics
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PQL	Practical Quantitation Limit
PVI	Petroleum Vapor Intrusion
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation

RM	River Mile
SCO	Sediment Cleanup Objective
SMS	Sediment Management Standards
STB	Samson Tug and Barge
SVOC	Semi-Volatile Organic Compound
SWPPP	Stormwater Pollution Prevention Plan
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TEE	Terrestrial Ecological Evaluation
TEQ	Toxicity Equivalency Quotient
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VCP	Voluntary Cleanup Program
VOC	Volatile Organic Compound
WAC	Washington State Administrative Code

ES 1.0 EXECUTIVE SUMMARY

This Remedial Investigation (RI) report presents the findings, conclusions, and recommendations regarding contamination that is present on the Property located at 16 South Michigan Street, Seattle, Washington (identified as Duwamish Marine Center). Environmental-investigation work has been ongoing on the Site since 2000. After conducting Phase I and Phase II investigations, an Interim Action was conducted in 2002 to excavate lead-contaminated soils. A 2004 Phase II investigation and an RI completed by Pacific Crest Environmental in 2008 both stated that data gaps remained at the Site.

In 2011, the Washington State Department of Ecology (Ecology) determined that additional investigation work was required in order to sufficiently define the vertical and lateral extent of contamination at the Site and develop a more comprehensive RI. Subsequently, the Property owners entered into an Agreed Order with Ecology in September 2011 with the objective of performing a remedial action at the Property. Based on the information collected up to year 2011, the Agreed Order required the preparation of a Remedial Investigation Report (this report), Feasibility Study (FS), and Draft Cleanup Action Plan (CAP) for the Site. A Final CAP will be issued by Ecology with consideration of the draft RI and FS.

Since 2011, several additional environmental explorations have been conducted by SoundEarth Strategies and G-Logics, Inc. (G-Logics) to address the existing data gaps identified for the Site. This work has been completed with the objectives to close the previously-identified data gaps, characterize the nature and extent of Site contaminants, and assess exposure risks and pathways for both human health and the environment. With the additional environmental explorations, sufficient data has been collected to refine the conceptual site model (CSM) and complete this RI report. This RI report includes both "historical" data (data collected prior to 2011) and "new" data (collected between 2011 and 2018), all from various explorations at the Site and the adjacent Lower Duwamish Waterway (LDW).

ES 1.1 Site Description and Physical Setting

The Property consists of six legal parcels located adjacent to the east shore of the LDW. The Property is located between Slips 2 and 3 and River Mile (RM) 1.7 and RM 2.0. Parcel 4565 extends into the LDW, with approximately 0.5 acres submerged during high tide. The remaining five parcels are located in the upland region and do not extend into the LDW. The Site includes areas of soil, groundwater, surface water, and/or sediment that have been impacted with contaminants associated with the Property (and may extend off Property).

The Property previously was located within a bend of a river meander, as seen in the *Geologic Map of Seattle* (Troost & Booth, 2008). The old river channel, the Property, and surrounding areas were filled and elevated, with fill materials consisting of dredge spoils from the LDW and potentially other offsite soils. The Property is generally flat at an elevation ranging between 13.5 and 17.5 feet (based on the North American Vertical Datum NAVD 88).

Geologic deposits beneath the Property include the following:

- A large portion of the Property is located on artificial fill and dredge material from the Duwamish River, generated during the creation of the LDW. The fill material generally consists of silty, gravelly sands with varying amounts of concrete, metal, lumber, wood, and other miscellaneous debris. The thickness of the fill varies across the Property to a maximum interpreted thickness/depth of 16 feet.
- The fill unit generally is underlain by silty sands and gravelly sands with thin silt lenses, interpreted as undisturbed alluvial deposits. These deposits are present in all borings to the maximum explored depths.
- In several borings, a well-defined silt unit was present within the alluvial deposit, with thicknesses ranging between one and eight feet.

Groundwater in the Duwamish Valley is present within a single, large unconfined aquifer system (WindWard, 2010). The maximum depth of this aquifer system is approximately 100 feet below the ground surface. The thickness of this aquifer generally decreases to the north, east, and west of the valley. Discontinuous silt units are present within the regional aquifer and can act as local aquitards within the aquifer. Where present, these units can effectively separate the aquifer into locally distinct shallow and deeper zones (WindWard, 2010).

Tidal fluctuations influence the near-shore groundwater elevations, which can affect groundwater flows and directions. Groundwater-elevation fluctuations (due to tidal influence) ranged from 3.89 to 7.33 feet across the Property. The magnitude of water-level changes in wells is greatest near the LDW and also in the northern portion of the Property.

Groundwater generally flows to the west toward the LDW during low tide. However, high tides in the river results in temporary groundwater-flow reversals to the east-southeast.

ES 1.2 Data Gaps Identified by Ecology

Ecology prepared an opinion letter dated August 11, 2009 in response to the RI report that was prepared by Pacific Crest Environmental (dated May 11, 2009). It was Ecology's opinion that the lateral and vertical extent of contamination in soil, groundwater, and sediment at the Site was not sufficiently delineated. Additionally, the RI was not sufficient to establish cleanup levels or develop cleanup actions alternatives. Ecology identified the following data gaps in their August 2009 letter:

- Natural conditions at the Site and surrounding areas, including geology, surface water, groundwater, and natural resources, were not presented in the RI report.
- "The lateral and vertical extent of contaminants in soil and groundwater is not presented in sufficient detail to understand distributions across the property". Ecology stated that there was a lack of data to support the contaminant boundaries, as presented in the RI report.
- The RI report did not address the potential for sediment contamination.
- The RI report did not incorporate all exposure pathways that were identified for the draft RI report prepared for the LDW Superfund Site (dated November 5, 2007).

The work performed by SoundEarth Strategies and G-Logics between 2012 and 2019 has been performed to address the data gaps identified above. This RI report presents the findings, opinions, and recommendations of the performed work, as summarized below.

ES 1.3 Updated Conceptual Site Model

With the information presented in this report, an updated conceptual site model has been summarized below.

ES 1.3.1 Summary of Contaminants of Potential Concern

Several contaminants have been identified as contaminants of potential concern (COPC) based on screening levels, lateral and vertical distribution, frequency of screening-level exceedances, and relative magnitude of concentrations when compared to the identified screening levels. The following table presents the preliminary list of COPCs for each media based on the results of this RI.

Chemical	Media					
	Soil	Groundwater	Riverbank Sediment	Catch-Basin Sediment	Stormwater	Vapor Intrusion
Metals						
Arsenic	X	X			X	
Chromium (III)	X					
Copper	X	X	X		X	
Lead	X	X				
Mercury	X**	X	X		X	
Nickel	X**	X			X	
Zinc	X	X				
Polychlorinated Biphenyls (PCBs)						
Total PCBs	X	X	X		X	
Semivolatile Organic Compounds (SVOCs) and Polycyclic Aromatic Hydrocarbons (PAHs)						
Acenaphthene	X**	X				
Bis(2-ethylhexyl)phthalate	X**	X		X	X	
Fluoranthene				X		
Fluorene	X**	X				
Naphthalene						X
Pentachlorophenol	X	X			X	
Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)						
cPAH Toxicity Equivalency Quotient (TEQ)	X					
Benzo(a)anthracene		X			X	
Benzo(a)pyrene		X			X	
Benzo(b)fluoranthene		X			X	
Benzo(k)fluoranthene		X				
Chrysene		X			X	
Indeno(1,2,3-cd)pyrene		X			X	
Dibenzo(a,h)anthracene		X			X	
Petroleum Hydrocarbons						
Diesel range organics (DRO)	X**	X				
Oil range organics (ORO)	X	X				

Note: X indicates the contaminant is listed as a COPC for the selected media. Asterisks (**) indicate that contaminant was included as a soil COPC based on groundwater COPC evaluation. Selected soil-screening levels were not exceeded.

ES 1.3.2 Nature and Extent of Contamination

The nature and extent of contaminants for soil, groundwater, riverbank sediment, catch-basin sediment, stormwater, and soil gas are summarized below.

Soil Contaminants

Soil COPCs consist of metals, PCBs, cPAHs, PAHs, SVOCs, and petroleum hydrocarbons. Below is a summary of each category.

- **Metals:** Arsenic and lead were detected at concentrations exceeding soil screening levels at widespread locations across the Site and to depths of 20 feet below ground surface, suggesting a non-point source release. Elevated concentrations of chromium, copper, mercury, nickel, and zinc were more confined to specific areas of the Site, predominantly parcel 4565 and on the adjacent Port of Seattle property. Elevated concentrations of these contaminants were found to depths up to 20 feet below ground surface.
- **Total PCBs:** All screening-level exceedances of PCB concentrations occurred on the northern half of Parcel 4565 (near a former junk dealer) and within 10 feet of the ground surface.
- **SVOCs and PAHs:** Pentachlorophenol was detected in one soil sample (collected from well MW06) at a concentration exceeding the selected soil screening level. In addition, the nature and extent of acenaphthene, fluorene, and bis(2-ethylhexyl)phthalate in soil have been evaluated based on their presence in groundwater above applicable screening levels. Elevated concentrations of these contaminants were found predominantly on parcel 4565 and at depths between 5 and 15 feet below ground surface.
- **cPAHs:** cPAHs were found at concentrations exceeding soil screening levels at many locations across the Site, predominantly between the ground surface and depths up to 15 feet. The cPAH concentrations did not exceed screening levels in borings/wells located in the eastern portion of the Site.
- **Petroleum Hydrocarbons:** DRO and ORO were found at concentrations exceeding soil screening levels at locations on parcel 4565 near the former junk yard, parcel 3447 near the equipment wash, and on the adjacent Port of Seattle property. All screening-level exceedances were found between the ground surface and depths up to 15 feet.

Groundwater Contaminants

Groundwater COPCs also consist of metals, PCBs, cPAHs, PAHs, SVOCs, and petroleum hydrocarbons. Below is a summary of each category.

- **Metals:** Arsenic concentrations consistently exceeded groundwater screening levels at all well locations across the Site. Lead screening level exceedances were consistent along the southwest portion of the Property adjacent to the LDW. Concentrations and locations of copper, mercury, nickel, and zinc detections fluctuated greatly between sampling events.
- **Total PCBs:** Total PCB Aroclors were only detected during a 2002 sampling event in wells MW2 and MW4 (PCB Aroclors were not detected in recent groundwater-sampling events). Concentrations of total PCB congeners exceeded groundwater screening levels in all three wells recently sampled at locations across the Site.
- **SVOCs and PAHs:** Bis(2-ethylhexyl)phthalate concentrations exceeded groundwater screening levels in all sampled wells during one sampling event and is thought to be an artifact of sampling/laboratory-analysis procedures. Additionally, pentachlorophenol only was detected in groundwater collected from well MW06 at concentrations exceeding the groundwater screening level. Acenaphthene and fluorene concentrations consistently exceeded groundwater screening levels in well MW16 in the central-western portion of the Site.
- **cPAHs:** cPAHs were found at concentrations exceeding groundwater screening levels in wells located along the western and southwestern Property boundary (adjacent to the LDW).
- **Petroleum Hydrocarbons**: DRO and ORO were found at concentrations exceeding groundwater screening levels in wells located along the western and southwestern Property boundary (adjacent to the LDW).

Riverbank Sediment Contaminants

Riverbank Sediment COPCs consist of metals and PCBs. Below is a summary of each category.

- **Metals:** Copper and mercury concentrations exceeded riverbank sediment screening levels in several locations, predominantly in the southern half of the Property shoreline.
- **Total PCBs:** Total PCB Aroclor concentrations exceeded riverbank-sediment screening levels in a majority of riverbank samples collected on and adjacent to the Property (PCB Congeners were not analyzed as part of the riverbank-sediment explorations conducted for the Site). Additionally, several LDW-sediment samples collected adjacent to the Property (collected

by others) exceeded the applicable PCB-screening levels.

Catch-Basin Sediment Contaminants

Catch-basin Sediment COPCs consist of metals and PCBs. Below is a summary of each category.

- **SVOCs and PAHs:** Bis(2-ethylhexyl)phthalate concentrations exceeded screening levels in a majority of sampled catch basins during the sampling events and is thought to be an artifact of sampling/laboratory-analysis procedures. Fluoranthene screening level exceedances only occurred in catch basins CB08 and SWC1.

Stormwater Contaminants

Stormwater COPCs consist of metals, PCBs, cPAHs, PAHs, and SVOCs. Stormwater is conveyed across the Property through thirteen catch basins. With the exception of catch basin CB09, collected stormwater is directed into a common sump, which then is pumped into a treatment system. Treated stormwater is discharged to the LDW through outfall OUT1, where samples have been collected and analyzed to assess contaminant concentrations. Because stormwater samples only have been collected from this discharge point, the exact source and/or location of contaminants found in surface water/stormwater is not possible to interpret.

Soil Gas Contaminants and Potential Vapor Intrusion

Naphthalene is the only COPC present at the Site with concentrations exceeding groundwater screening levels for vapor intrusion concerns. Screening level exceedances occurred in several wells, all located on the western portion of parcel 4565.

ES 1.3.3 Contaminant Fate and Transport

The fate and transport of Site COPCs is summarized below.

Potential Sources and Transport Mechanisms

Potential sources for COPCs are presented below.

- **Metals:** LDW dredge spoils and other fill material used at the Site, industrial processes (i.e., welding and marine railway), material storage (i.e., shipping containers, building material, junk-yard items, paints, treated wood, etc.), stormwater discharge to the LDW, and/or upgradient sources.

- **PCBs:** LDW dredge spoils and other fill material used at the Site, material storage (i.e., junk yard items, paints, etc.), stormwater discharge to the LDW, and/or upgradient sources.
- **SVOCs and PAHs:** Treated wood/pilings, LDW dredge spoils and/or burn/trash debris used as fill material, sampling/laboratory artifact (for bis(2-ethylhexyl)phthalate), and/or a burning of fossil fuels/wood/debris.
- **cPAHs:** Treated wood/pilings, LDW dredge spoils and/or burn/trash debris used as fill material, motor-oil spills/leaks, and/or a burning of fossil fuels/wood/debris.
- **Petroleum Hydrocarbons:** Incidental surface spills/leaks from vehicles and equipment.

Many of the COPCs could have originated at the surface or near surface and first impacted shallow soil and/or surface water at the Site. Fill material has been found on the Property up to a depth of approximately 16 feet. If contaminants were present in the fill material when placed on the Property, COPCs could be present in the soil in certain areas of the Site to depths of 16 feet. Additionally, COPCs found in groundwater, deeper soils, and riverbank sediments located near the LDW shoreline could have originated from sources upstream in the LDW.

From the contaminant sources noted above, several transport/release mechanisms could contribute to migration of COPCs into other media. These mechanisms include the following:

- Soil leaching to groundwater,
- Soil leaching to catch-basin sediment,
- Surface soil/riverbank erosion to LDW surface water,
- Surface soil/riverbank erosion to sediment,
- Groundwater discharge to LDW surface water,
- Sheet flow into LDW surface water,
- Sheet flow into stormwater system,
- Catch-basin sediment to stormwater,
- Stormwater leaching to soil through cracks in piping,
- Stormwater into LDW surface water, and
- LDW Surface water to LDW sediment.

Groundwater-Plume Areas

Because the Property is mostly unpaved, surface/rain water infiltrating into the soil has the ability to mobilize COPCs through leaching. COPCs could then migrate to the water table, where they could be transported by groundwater in the direction of groundwater flow towards the LDW.

Based on environmental explorations conducted at the Site, groundwater COPCs are consistently present in four distinct areas: The northern portion of the Site (predominantly on parcel 4565), the western border of the Site (near the LDW shoreline and in the vicinity of wells MW14 to MW16), the central portion of the Site (near wells MW07, MW12, and MW13), and the southern portion of the Site (near well MW06). These areas and discovered contaminants are listed below.

- **Northern Plume:** Total PCB Congeners.
- **Western Plume:** Metals (lead and zinc), Total PCB Aroclors, SVOCs/PAHs (acenaphthene and fluorene), cPAHs, and petroleum hydrocarbon (DRO and ORO).
- **Central Plume:** Arsenic.
- **Southern Plume:** Pentachlorophenol.

Two groundwater COPCs, arsenic and bis(2-ethylhexyl)phthalate, were present in all wells at concentrations exceeding screening levels during one or more sampling events. The highest concentrations of arsenic in groundwater were located in the Central Plume (described above). Arsenic concentrations may be within background concentrations in other areas of the Site. Bis(2-ethylhexyl)phthalate was detected at similar concentrations during all sampling events and is thought to be an artifact of sampling/laboratory-analysis procedures.

While detected, concentrations of copper, nickel, and mercury were inconsistent in both magnitude of detected concentrations and locations found at the Site.

ES 1.3.4 Exposure Pathways and Potential Receptors

Given the COPCs, affected media, and transport/release mechanisms listed above, possible exposure pathways and potential receptors are listed below.

Exposure Medium	Exposure Pathway	Potential Receptors
Surface Soil	Direct Contact	On-Property Workers
Subsurface Soil	Direct Contact	On-Property Workers
Groundwater	Discharge to LDW Surface Water/Direct Contact	Subsistence Users Recreational Users Ecological Receptors Utility Workers
Catch-Basin Sediment	Direct Contact	On-Property Workers
Stormwater	Direct Contact with Stormwater, Discharge to LDW Surface Water	Subsistence Users Recreational Users Ecological Receptors
Indoor Air	Inhalation	None
Vapors/Particulate	Inhalation	On-Property Workers
LDW Surface Water	Direct Contact	Subsistence Users Recreational Users Ecological Receptors
LDW Sediment	Direct Contact	Subsistence Users Recreational Users Ecological Receptors
LDW Edible Biota	Plant Ingestion/ Aquatic Invertebrate Ingestion	Subsistence Users Recreational Users Ecological Receptors
LDW Edible Fish	Ingestion	Subsistence Users Recreational Users Ecological Receptors

ES 1.4 Recommendations and Opinions

Based on the evaluation of the current data set for this Site, G-Logics believes that the nature and extent of hazardous substances at the Site have been sufficiently characterized to initiate the Feasibility Study process for the Site. While preparing the Feasibility Study, G-Logics recommends performing the following additional actions at the Site.

- Check all onsite wells for damage. Replace/repair damaged wells as necessary.
- Install new wells near former MW-1D, MW2 and MW-2D well locations. Data previously collected from these wells indicate elevated concentrations of contaminants may be present. New groundwater data would be used to further assess the presence and delineate the extent of COPCs in these areas.
- Install a new well near boring GLB09. This location would bound the site to the northeast.
- Resample all wells for the identified COPCs.

1.0 INTRODUCTION

This Remedial Investigation Report (RI) has been completed for Duwamish Marine Center (DMC) Property (the "Property"), located at 6365 First Avenue South, Seattle, Washington (Figures 1-1, 1-2, 1-3, and 1-4). This RI is being prepared in accordance with the Agreed Order Number DE 8072 (the "Agreed Order") dated September 2, 2011 (attached as Appendix A), and in cooperation with the Washington State Department of Ecology (Ecology). The RI has been prepared in accordance with the Washington State Model Toxics Control Act (MTCA) as established in the Washington Administrative Code (173-340 WAC). G-Logics work also was conducted in accordance with the Ecology-approved workplans and technical memorandums prepared by SoundEarth Strategies in 2013 and 2014. This RI report is subject to the limitations presented in this RI report.

1.1 Purpose and Objective

This RI summarizes the environmental conditions of the Property, as well as sediments of the adjoining Lower Duwamish Waterway (LDW), with the intent of identifying the lateral and vertical distribution of contaminants of potential concern (COPC). The purpose of this RI report is to document the nature and extent of the contamination at the Site and to support a subsequent Feasibility Study (FS). The Feasibility Study will review potential cleanup alternatives such that one or more alternatives can be selected to implement a cleanup action at the Site.

1.2 Report Organization

This RI report is organized per Ecology's *Remedial Investigation Checklist*, guidance dated May 2016. The text and figures of this report present a summary of environmental conditions at the Site. Primary sections of this report are described below.

- **Section 1.0:** The first section of this report introduces and describes the purpose of the Remedial Investigation.
- **Section 2.0:** This section provides background information for the Site, including its history, location, description, land uses, and environmental actions in the area.
- **Section 3.0:** This section discusses the natural conditions of the Site including geology, hydrogeology, natural habitats, and terrestrial and ecological receptors.

- **Section 4.0:** This section describes the previous explorations and cleanup actions performed at the Site.
- **Section 5.0:** This section describes the recent explorations performed at the Site.
- **Section 6.0:** This section discusses the conceptual site model, screening levels, and preliminary contaminants of potential concern.
- **Section 7.0:** This section presents our conclusions and recommendations.
- **Section 8.0:** This section presents our limitations regarding this report.
- **Section 9.0:** This section presents references for the report.

2.0 PROPERTY AND SITE DESCRIPTION

This section includes the description, location, and current/past land use of the Property and the immediate surrounding area. For the purposes of this document, the "Property" refers to the six legal parcels owned by Filter Engineering/Duwamish Marine Center. The "Site" refers to the areas of soil, groundwater, surface water, soil gas, and/or sediment that have been impacted with COPCs associated with the Property, including the west-adjacent property owned by the Port of Seattle.

A map of the Property, prepared by PLS, Inc. professional surveyors, is attached as Figure 2. Figure 2 includes property boundaries (based on King County iMap), permanent site features (i.e., buildings and docks), utility locations, the approximate current shoreline location (based on aerial photographs), and sampling locations on and adjacent to the Property.

2.1 Property and Contact Information

General information regarding the Property is presented below.

- **Property Owner:** James D. and Jacqueline H. Gilmur Living Trust, c/o Filter Engineering Co.
- **Potentially Liable Person:** James D. and Jacqueline H. Gilmur Living Trust, c/o Filter Engineering Co.
- **Site Name:** Duwamish Marine Center
- **Site Address:** 6365 First Avenue South, Seattle, Washington, 98108
- **Facility/Site Nos.:**
    - 21945598 (Duwamish Marine Center)
    - 1020256 (Samson Tug and Barge)
    - 71371939 (Duwamish Marine Center, Inc.)
    - 65697348 (Burgess Enterprises)
- **EPA ID Nos.:**
    - WAH000029081
    - WAD988504999 (Duwamish Marine Center)
    - WAD988508305 (inactive, Burgess Enterprises)
- **UST/LUST ID No.:** 101434 (inactive, Burgess Enterprises)

- **Cleanup Site ID No.:** 4146
- **Ecology Voluntary Cleanup No.:** NW 1646 (inactive)
- **Agreed Order No.:** DE 8072 (active)

Contact information for the Property owner, environmental consultant, and Ecology site manager is presented below.

- **Property Owner**

  James D. Gilmur and Jacqueline H. Gilmur Revocable Living Trust (JRLT) and the S&LA Hale Family Limited Partnership (HFLP), c/o Filter Engineering Co.
  16 South Michigan Street, Seattle, WA 98108
  Telephone: (206) 762-8799
  Contact Person: Mr. Clint Harris

- **Environmental Consultant**

  G-Logics, Inc.
  40 2nd Avenue SE, Issaquah, WA 98027
  Telephone: (425) 391-6874
  Project Manager: Stuart Hyde, Project Geologist

- **Regulatory Project Manager**

  Washington State Department of Ecology
  3190 160th Avenue SE
  Telephone: (425) 649-7219
  Ecology Project Manager: Ms. Victoria Sutton

2.2 Regional Setting

The Property is located within the Georgetown neighborhood of Seattle, WA. The area immediately surrounding the Property historically has been zoned as industrial and currently remains industrial zoning. The neighborhood of Georgetown includes industrial, commercial, and residential zoning.

The Property also is situated on the east shoreline of the LDW, a U.S. Environmental Protection Agency (USEPA) Superfund site (USEPA, 2017). The Property is a part of the "Slip 2 to Slip 3 source control area" as defined by Ecology in their "Source Control Strategy" document (Ecology, 2016).

Further details regarding the regional setting are discussed below.

2.2.1 Lower Duwamish Waterway Superfund Site

The Property is located adjacent to the Lower Duwamish Waterway Superfund site. The LDW site was added to USEPA's National Priorities List in 2001, which consists of a five-mile stretch of the Duwamish River ending in Elliott Bay in Seattle, Washington. The LDW flows through the Seattle neighborhoods of South Park and Georgetown, used for industrial purposes for over 100 years. The industrial nature of the LDW has resulted in contamination from many sources including direct discharge from industries, stormwater discharge, runoff from upland properties, and street/road runoff. The primary contaminants of concern in the LDW include polychlorinated biphenyls (PCBs), dioxins/furans, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and arsenic.

Through a "Memorandum of Agreement" (USEPA, 2014b), the USEPA was designated the Lead Agency for the in-waterway portion of the LDW Site as defined in the "Record of Decision" for the LDW (USEPA, 2014a). According to the "Record of Decision", the cleanup strategy and selected remedial actions for the LDW site are focused to address contaminated sediments and surface water below the mean higher high water (MHHW) level. For the LDW, the MHHW elevation is 11.3 feet (based on the North American Vertical Datum NAVD 88). Above this elevation is considered "upland". Ecology is the Lead Agency for the source-control activities for upland properties, as defined in their "Source Control Strategy" (Ecology, 2004, updated 2016).

2.2.2 Regional and Community Features

The Property is located within the Georgetown neighborhood of Seattle, Washington. Downtown Seattle is located approximately five miles due north of the Property. Regional features of note include Boeing Field, a public airport currently owned and operated by King County. Several breweries also are located near the Property in the Georgetown neighborhood. Additionally, South Seattle College has two campuses located near the Property: the Georgetown Campus is located to the southeast and main campus is located west of the Property in West Seattle.

2.2.3 Regional Streams and Surface-Water Bodies

The Property is located on the eastern shoreline of the LDW and is approximately equidistant between the Puget Sound to the west and Lake Washington to the east.

2.2.4 South Michigan Street Combined Sewer Outfall

The South Michigan Street combined sewer outfalls (Michigan St CSO) is located just south of the Property. The drainage basin flowing to the Michigan St CSO covers approximately 1,900 acres along the east side of the LDW (shown in Attachment A). The CSO basin is comprised of industrial, residential, and commercial properties and includes the King County International Airport.

A regulator station (Michigan St Regulator located at South Michigan St and East Marginal Way) is located upgradient of the Michigan St Outfall, which directs wastewater under normal conditions to the Elliott Bay Interceptor (for treatment). When the capacity of the Elliott Bay Interceptor is exceeded, the Michigan St Regulator releases stormwater flows to the Michigan St CSO located near the Property. Between 2000 and 2007, an average of 11 combined wastewater and stormwater overflow events occurred per year at the Michigan St CSO (Ecology/SAIC, 2009).

From 2007 to 2009, the King County Department of Natural Resources and Parks, Water and Land Resources Division, conducted stormwater sampling at several CSO locations in the LDW basin (King County , 2009). As part of this study, five stormwater samples were collected from the Michigan St Regulator and analyzed for PCB congeners, total and dissolved metals, polycyclic aromatic hydrocarbons (PAHs), phthalates, Semivolatile Organic Compounds (SVOCs), and conventional contaminants. For comparison purposes, results from these analyses have been included in the stormwater tables included in this report (discussed in Section 5.0 below).

2.3 Property Location, Address, and Description

The Property consists of six legal parcels located adjacent to the east shore of the LDW. The Property is located between Slips 2 and 3 and River Mile (RM) 1.7 and RM 2.0. The Property is generally flat with an elevation ranging between 13.5 and 17.5 feet (NAVD 88). Parcel 4565 extends into the LDW, with approximately 0.5 acres submerged during high tide. The remaining five parcels are in the upland region and do not extend into the LDW.

Legal descriptions for the Property and parcels are presented below. Current King County tax-assessor records are attached as Appendix B.

- **Property Quadrant Coordinates:** Township 24N, Range 4E, Section-Quarter 30-NE
- **Property Zoning Designation:** Industrial General 1 – Unlimited 85 (IG1 U/85)

Parcel No.	Parcel Address	Parcel Size	Current Tenant, Use and Features
536720-4545	6351 1st Ave S	0.65 acres (28,525 sq ft)	**Samson Tug and Barge:** Shipping Container Storage; Truck-Wheel Wash
536720-4560	6361 1st Ave S	0.49 acres (21,439 sq ft)	**Samson Tug and Barge:** Office and Operational Uses; Maintenance and Storage Building; Small Maintenance Shed
536720-4565	6365 1st Ave S	2.80 acres (122,080 sq ft)	**Filter Engineering and Samson Tug and Barge:** Shipping Container Storage and Barge Offloading; North, Middle, and South Docks
536720-3415	6365 1st Ave S	0.49 acres (21,537 sq ft)	**Filter Engineering and Samson Tug and Barge:** Equipment/Material Storage and Truck Weighing; Temporary Storage Building, Truck Scale, and Small Operational Office
536720-3447	16 S Michigan Street	0.03 acres (1,225 sq ft)	**Filter Engineering:** Industrial General Purpose and Material Storage; Concrete Slab
536720-3635	16 S Michigan Street	0.29 acres (12,444 sq ft)	**Duwamish Metal Fabricators:** Metal Fabrication and Welding and Office Space; Large Shop Building with Office Space

DMC leases portions of the Property to other companies (as tabulated above). Samson Tug and Barge leases the northern portion of the Property. Burgess Enterprises formerly operated on the Property in the area now occupied by Samson Tug and Barge (SAIC, 2009). Duwamish Metal Fabricators currently leases Parcel 3635 in the southern portion of the Property.

2.3 Current Parcel Features, Land Use, and Operations

Current tax-parcel numbers, operations, land use, and features located on the Property are listed below and shown on Figures 3-1 and 3-2.

Operator	Current Land Use, Operations, and Features
Samson Tug and Barge: 536720-4545, 4560, 4565, 3415	Samson Tug and Barge (STB) performs barge and cargo-hauling services between Seattle, Washington and Alaska. Shipping containers and crates are generally used during shipment. STB uses Parcels 4545, 4560, 4565, and 3415 for their operations. Parcel 3415 contains a truck scale and a small building (Scale House) used by STB for weighing incoming shipping containers. Parcel 4560 consists of the office/maintenance building and a small maintenance/storage building used by STB. There is a drive lane that runs between the two buildings. Parcel 4565 is predominantly used for shipping-container storage by STB. A small dispatch office is located on the parcel for STB field operations. The North, Middle, and South docks also are present on this parcel. The North dock is used for loading/unloading barges by STB. A truck-wheel wash is located on Parcel 4545 for exiting trucks. The remainder of the Parcel is used by STB for shipping-container storage.
Filter Engineering: 536720-4565, 3415, 3635	Filter Engineering is a business entity used for the transfer of bulk materials from barges to truck containers. Filter Engineering uses the South dock adjacent to Parcel 4565 for offloading bulk materials from barges, generally consisting of demolition debris and permitted hazardous waste (retained in original shipping containers). These materials are offloaded using a mobile crane and are placed directly into lined truck containers. Parcel 3415 consists of a temporary building made of stacked shipping containers and a roof, used by Filter Engineering for equipment and machinery storage. Filter Engineering also runs a stormwater-treatment system for the entire Property, which is located near the west border of Parcel 3415. Filter Engineering also uses office and storage space in the building on Parcel 3635.
Duwamish Metal Fabricators: 536720-3635, 3447	Duwamish Metal Fabricators, Inc. leases shop and office space in the building located on Parcel 3635. Duwamish Metal Fabricators is a contract metal fabricator and completes cutting, bending, drilling, and welding projects on the premises. Sandblasting and painting services are not conducted on the Property. Duwamish Metal Fabricators also uses Parcel 3447, which is a small area covered by concrete paving, used for drive access and metal storage.

2.4 Historical Property Land Use and Operations

The Duwamish River was redirected and developed into the LDW in 1913. By 1969, it is understood that the parcels along Slip 2 were filled, now extending into the water. The following information was obtained from reviewed sources of historical information, aerial photographs, and interviews (included on CD as Appendix C). Historical operations, land use, and features located on the Property are listed below by parcel, with locations of historical features/businesses shown on Figure 4.

Parcel 536720-4545

Parcel 4545 currently is located along Slip 2 off the east side of the LDW (a former meander of the Duwamish River). It appeared to be developed by 1936 for residential use along the water (historical tax records). It is understood that after the area was converted to industrial use, subsequent permanent buildings have not been built on the parcel. In addition, no reviewed information indicates that hazardous materials historically were located on the parcel (e.g., fuel storage tanks).

Parcel 536720-4560

Parcel 4560 currently lies along Slip 2 off the east side of the LDW. The Parcel appeared to be developed by 1936 for residential use along the water (historical tax records). Tax records understood to be for 1959 and 1967 state that a large building with the words "Seattle Machinery Co." was built on the parcel, followed by a small garage in 1967. These appear to be the same structures currently located on the parcel. An underground storage tank (UST) was reportedly installed on the parcel in 1964 with no reported closure date (EDR Radius Map). No evidence of this UST has been found on the Property. As stated in the EDR Radius Map, since at least 1972 the parcel has been and currently is operated by STB.

Parcel 536720-4565

Parcel 4565 currently lies along the bend of Slip 2 and the LDW. The parcel appeared to have been developed by 1936 with multiple residential and/or industrial buildings located along the water (Aerial Photo Package). It is understood that a marine railway was located on the parcel from the 1940s until the mid-1970s. A marine railway is a structure used to haul boats onto shore for maintenance and storage. The structure generally extends into the water from the shoreline and uses an engine, pulleys, and chains/cables to pull the boats onto shore. The marine railway was reportedly 120 feet by 40 feet and included two small stove-heated buildings (Pacific Crest Environmental, 2009). The approximate location of the former marine railway is shown on Figure 4.

A junk dealer (Junk House Co.) reportedly operated in the north end of the Parcel in the 1960s and 1970s. Aerial photographs indicated that in the late 1970s a dock was developed on the northwest corner of the parcel (the "North Dock"). The "Middle Dock" also was built on the parcel sometime between 1980 and 1985. No reviewed information indicates that USTs or large volumes of hazardous materials have been located on the parcel.

Parcel 536720-3415

Parcel 3415 currently lies along the east side of the LDW. As shown in a 1953 aerial photograph, the parcel was used as general storage until the 1970s, when it was acquired by Larsen Construction Company. Aerial photographs suggest that the parcel continued to be used as general storage from the 1970s to present day. No reviewed information indicates that USTs or large volumes of hazardous materials have been located on the parcel.

Parcel 536720-3447

Based on historical aerial photographs, parcel 3447 appears to have always been used for storage and/or a drive-through lane for that portion of the Property. Permanent structures do not appear in any of the historical photographs.

Parcel 536720-3635

Parcel 3635 is understood to have been developed by 1936 with three small buildings along the southwest corner. The parcel was the developed in 1945 for industrial use when it was purchased by Truax Machine and Tool Co (historical tax records). It appeared that a machine shop and dock were built on the parcel following the purchase. Historic tax records indicate the building was heated by oil, but no additional information was discovered. As shown in a 1965 aerial photograph, the dock was modified into a boat shed. The machine shop and "South Dock" are still currently located on the parcel and are operated by Duwamish Metal Fabricators.

2.5 Property Infrastructure

The Property is served by several public utilities including water, natural gas, electrical power, and sanitary sewer. The Property is mostly unpaved and contains several buildings and structures to support the business operations. Concrete paving exists between the buildings located on adjacent parcels 536720-3635 and -3415. This concrete paving extends, and covers, the entire area of parcel 536720-3447. Also, asphalt paving extends from 1st Avenue South onto the Property, on Parcel 536720-4560, used as a small parking area for the STB office.

An in-ground truck scale is located on Parcel 536720-3415 and is used to weigh incoming truck loads prior to shipment/container drop off. In addition, a truck-wheel wash is located on the north end of the Property, on Parcel 536720-4545. The wheel wash includes a water-catchment basin located underneath the wheel wash. Water from this wheel wash is periodically removed and disposed offsite at an appropriate facility and replaced with fresh water.

2.5.1 Property Drainage, Stormwater Management, Treatment, and Discharge

The primary stormwater-management system on the Property consists of 13 catch basins (CB01 through CB13) that direct stormwater into a treatment system prior to discharge to the Duwamish. These catch basins collect surface-water runoff from most of the Property (approximately 4.7 acres), which is then transferred to a common sump (labeled CB SWC1 on Figure 2). Stormwater is then transferred to the treatment system for treatment and subsequent discharge (as described below). Each on-Property catch basin is equipped with a sediment trap purposed to prevent high volumes of sediment from entering the stormwater-treatment system. Accumulated catch-basin sediment is removed periodically a vacuum-extraction company (i.e., LineScape of Washington) and disposed at an appropriate offsite facility.

Catch Basin CB09, located in the parking area adjacent to the STB office, is the only catch basin that flows offsite and into the sanitary-sewer system, located along 1st Avenue South. The interpreted sheet-flow direction of surface water across the Property has been presented in the *Stormwater Engineering Report* prepared by Lean Environment (2016), and is shown on Figure 5-1 of this report. The locations of catch basins and the stormwater-treatment system also are presented on Figures 5-1 and 5-2.

Catch basin CB14 (shown on Figures 2 and 5) is located on the north-adjoining property (6335 1st Avenue South). This catch basin collects stormwater from the adjacent property, but discharges to the LDW through outfall OUT2 located on the DMC Property. The *Stormwater Engineering Report* prepared by Lean Environment (2016) reports that outfall OUT2 is “locked-out, no connection to waterway”. However, during G-Logics assessment work at the Site, it was found that this understanding was not correct. Rather, OUT2 was found to be connected to catch basin CB14 and discharging effluent to the LDW. Because of this, OUT2 was sampled by G-Logics during stormwater-sampling events, with results included in this report (see Sections 5.5 and 6.5). It is G-Logics understanding that catch basin CB14 collects surface-water runoff from a paved parking lot located on the north-adjoining property.

In general, all stormwater piping and catch basins located on the Property are located at elevations above the water table. The elevation of groundwater during high tide is approximately eight feet (NAVD 88). The lowest recorded invert elevation of stormwater piping between catch basins on the Property is 9.2 feet, found at catch basin CB05.

2.5.1.1 Stormwater Pollution Prevention Plans

Stormwater Pollution Prevention Plans (SWPPPs) have been prepared for Samson Tug and Barge and Duwamish Metal Fabricators by Blue Environmental (attached in Appendix D). The SWPPPS outline the procedures used to develop and implement Best Management Practices (BMPs) when managing stormwater on each portion of the Property. The SWPPPs contain guidelines on the physical, structural, operational, and administrative means of preventing the pollution of stormwater that is managed on the Property.

2.5.1.2 Stormwater-Treatment System

A stormwater-treatment system has been installed on the Property to collect and treat surface-water runoff prior to discharge into the LDW (through outfall OUT1). The stormwater is treated in the system through the following general processes:

- Electrocoagulation
- Gravity sedimentation
- Polishing through sand filtration
- Recirculation through filters

Additional details regarding the treatment system can be found in *Stormwater Engineering Report* prepared by Lean Environment (2016), Appendix D.

2.5.1.3 Discharge Permits

STB and Duwamish Metal Fabricators manage and discharge stormwater on the Property under two separate Ecology Industrial Stormwater General Permits, WAR011484 and WAR125423 (attached in Appendix D). Further details regarding the system, discharge requirements, discharge volumes, and stormwater analytical results can be found in the *Stormwater Engineering Report* prepared by Lean Environment (2016) and the *Stormwater Pollution Prevention Plans* prepared for the Property (Blue Environmental, 2015 and 2016). These documents also are attached in Appendix D.

Currently, Blue Environmental samples stormwater on the Property, as needed per the requirements of the discharge permits for STB and Duwamish Metal Fabricators. In addition, stormwater samples were analyzed for COPCs associated with the Property during several sampling events in 2015, 2016, and 2017. The stormwater analytical results collected by Blue Environmental are included in this report and further discussed in Section 5.5 below.

2.6 Waste Management

Other than general office waste (e.g., paper, washroom waste), permitted solid waste or waste water is not routinely generated at any facility located on the Property. According to the SoundEarth Strategies *Remedial Investigation/Feasibility Study Work Plan* (dated May 13, 2013), Resource Conservation and Recovery Act (RCRA) identification numbers have been assigned to DMC (WAD988504999) and STB (WAH000029081) because of previous hazardous-waste generation. In addition, STB was identified as a hazardous-waste transfer facility under RCRA identification WAH000029081.

2.7 Future Land Use

At this time, we understand that the Property eventually will be paved with asphalt or concrete, with intent to control airborne dust and soil/sediment runoff caused by onsite equipment. G-Logics does not know of other planned or proposed changes to the current land uses.

2.8 Adjacent Contaminant Sources to the Lower Duwamish Water

The DMC Property is located within the River Mile 1.7 to 2.0 East (Slip 2 to Slip 3) “Source Control Areas”, one of several areas identified by Ecology as part of the cleanup of the LDW (SAIC, 2009). The Slip 2 to Slip 3 source-control area generally is defined by stormwater-drainage basins discharging to the same area of the LDW. Based on the *Data Gaps Report* (SAIC, 2009), as well as the *Lower Duwamish Waterway Source Control Strategy* (Ecology, 2004, updated 2016), Ecology published the *Source Control Action Plan* (Ecology/SAIC, 2009). This document describes the potential sources of sediment contamination along the LDW from Slip 2 to Slip 3. The document also identified actions necessary for the prevention of recontamination of LDW sediment once cleanup of the waterway is completed. These reports specifically discuss the Michigan Street CSO (discussed in Section 2.2.4 above), identified as a significant source of contaminants to the LDW, directly adjacent to the Property.

In general, the primary sources/pathways for possible recontamination of the LDW sediment include the following.

- Direct discharges from private and public outfalls, including the Michigan St CSO
- Surface runoff (sheet flow) from adjacent properties
- Groundwater discharges

- Bank erosion
- Direct spills to the LDW
- Atmospheric deposition

In addition, the following adjacent properties have been assessed by Ecology/SAIC in their 2009 *Data Gaps Report* as potential upland sources of contamination relating to the LDW (shown on Figure 4 of the 2009 report and included as Attachment B).

- Port of Seattle property, located along the southwest Property boundary
- Seattle Biodiesel, located adjacent to the Property to the north
- Seattle Department of Transportation, located to the south of the Property
- Washington State Department of Transportation, located to the east of the Property
- Seattle Truck Repair/Evergreen Tractor, located to the east of the Property,
- Former Frank's Used Cars, located to the northeast of the Property

Details regarding potential sources and contaminant pathways of sediment recontamination to the LDW are presented in the *Data Gaps Report* and *Source Control Action Plan* (mentioned above).

3.0 NATURAL CONDITIONS

Prior to industrialization, the Duwamish valley contained a well-stratified estuary with the meandering Duwamish River and associated floodplains, wetlands, and tidal marshes. Native American communities used the valley for fishing, hunting, gathering, and limited farming. During the late 1800s, white settlers moved into the area and subsequently began clearing, logging, and farming the Duwamish Valley. Industrial activities in the Duwamish valley and along the Duwamish River began in the early 1900s. Dredging and straightening of the Duwamish River and the creation of the LDW occurred concurrently with the industrialization of the area (WindWard, 2010).

The Property is located between Slips 2 and 3, which are remnants of former river meanders. Prior to the reconfiguration of the LDW, the course of the Duwamish River meandered to the east of Property, flowing downstream through the area of Slip 3 to the east with a horseshoe bend bringing the river through the area of Slip 2 and continuing downstream. The historical river channel can be seen in the "Geological Map of Seattle" produced by Troost and Booth (2008), as shown on Figures 6-1 and 6-2.

In addition, the LDW shoreline adjacent to the Property has changed over the years as the Property was increasingly filled and extended into the waterway. Figure 6-3 shows the approximate shoreline locations over time since the LDW was formed. Additional details regarding the natural conditions of the Site and Property are described below.

3.1 Physiography/Topography

The Property is located on the east shoreline of the LDW between Slips 2 and 3 (approximately 1.9 miles upstream from the river mouth). The Property and surrounding areas are located within a north-south trending valley created by glacial and fluvial processes. The channel and depth of the Duwamish River was extensively modified with the creation of the LDW starting in the early 1900s. The LDW flows to the north and ultimately into Elliott Bay in the Puget Sound.

The Property previously was located within a bend of a river meander, as seen in the *Geologic Map of Seattle* (Troost & Booth, 2008). The old river channel, the Property, and surrounding areas were filled and elevated, with fill materials consisting of dredge spoils from the LDW and likely other offsite soils. The Property currently is relatively flat and is located at an elevation approximately 13.5 to 17.5 feet (NAVD 88).

3.2 Regional and Property Geology

The Puget Sound region was shaped by several glacial episodes, the last of which occurring approximately 15,000 years ago. As glaciers advanced and retreated, the region was sculpted by the ice, creating the current glacial deposits and bedrock conditions. The regional sediments are primarily composed of alluvial clays, silts, and sands deposited by the White, Green, and Black Rivers. These alluvial sediments overly glacial-till deposits of interbedded silty sands to sandy silts with gravel (Pacific Crest Environmental, 2009).

The Duwamish Valley has also been significantly impacted by volcanic mudflows, specifically the Osceola mudflow that descended from Mount Rainier and deposited a massive layer of sediment into the White River and Puyallup River Valleys approximately 5,600 years ago. This mudflow led to the diversion of the historical course of the White River to the present day Green River, creating the current boundaries of Elliott Bay (WindWard, 2010).

Based on drilling work conducted on the Property and a review of the Geologic Map of Seattle (Troost & Booth, 2008), a large portion of the Property is located on artificial fill that was placed on upland properties when the Duwamish River was redirected and straightened in the early 1900s. The fill material generally consists of silty, gravelly sands with varying amounts of concrete, metal, lumber, wood, and other miscellaneous debris. The thickness of the fill varies across the Property to a maximum interpreted thickness/depth of 16 feet (based on exploration borings).

The fill unit is generally underlain by silty sands and gravelly sands with thin silt lenses, interpreted as undisturbed alluvial deposits. These deposits are present in all borings to the maximum explored depths. In several borings, a well-defined silt unit was present within the alluvial deposit, with thicknesses ranging between one and eight feet. Boring/well logs for the conducted Site explorations are attached as Appendix E. Cross sections have been prepared to show the surface topography and interpreted subsurface geology for the Site. Cross sections locations are shown on Figure 7-1, with cross sections presented on Figures 7-2 through 7-6.

3.3 Hydrogeology and Surface Waters

Groundwater in the Duwamish Valley is present within a single, large unconfined aquifer system (WindWard, 2010). The maximum depth of this aquifer system is approximately 100 feet below the ground surface. The thickness of this aquifer generally decreases to the north, east, and west of the valley. Discontinuous silt units are present within the regional aquifer and can act as local aquitards within the aquifer. Where present, these units can effectively separate the aquifer into locally distinct shallow and deeper zones (WindWard, 2010). Further information regarding the hydrogeology and surface-water conditions present on and adjacent to the Property is described below.

3.3.1 Groundwater Conditions

Groundwater conditions have been assessed using 15 groundwater-monitoring wells located across the Property (well locations shown on Figure 8-1). Based on information previously gathered for the Property, two potential groundwater zones, “shallow” and “deep”, were believed to exist, based on the presence of a silt unit. However, during G-Logics drilling and well installation in the fall of 2015, the silt unit was found to be discontinuous. As such, a distinct shallow groundwater zone (above the silt unit) generally was not encountered. Therefore, shallow-zone wells installed at the Property (wells MW05 through MW16) were screened across the water table.

Three deeper wells were installed in pairs with three shallow wells and are denoted with a “D” (wells MW09D, MW10D, and MW12D). These wells were screened between approximately 15 and 30 feet below the ground surface and are used to assess groundwater conditions at greater depths.

3.3.2 Tidal-Influence Study

Tidal fluctuations in the adjacent LDW can influence near-shore groundwater elevations, which in turn may affect the movement of groundwater and contaminants on and from the Property. A tidal-influence study was conducted on the Property between August 25 and August 31, 2016, performed to evaluate the tidal fluctuations and effects on groundwater flows on the Property (attached as Appendix F). Continuous groundwater-elevation data was collected in multiple wells located throughout the Property in order to calculate mean groundwater elevations and hydraulic gradients (vertical and lateral). Wells used for the tidal study are shown on Figure 9-1.

With this information, measured groundwater elevations were used to assess the mean groundwater elevations and net groundwater-flow directions (Figure 9-2), as well as groundwater flow directions during observed low and high-tide events (Figures 9-3 and 9-4, respectively). Hydrographs for the shallow-zone wells and deep-zone wells are presented in Appendix F.

The tidal-influence study was started on August 25, 2016. In order to continuously collect data across the Site, a transducer was submerged into the following wells.

- Shallow-Zone Wells: MW05, MW06, MW07, MW08, MW10, MW11, MW12, MW13, MW16
- Deep-Zone Wells: MW-9D, MW-10D, MW-12D.
- Temporary Stilling Well: SW-01

Based on the results of the tidal-influence study, the following conclusions regarding mean-groundwater elevations, tidal fluctuations, hydraulic gradients, and tidal influence of the LDW on the Property are presented below.

- Mean groundwater elevations were calculated using the Serfes Method over a 72-hour period. Mean groundwater elevations on the Property ranged from 5.34 to 6.14 feet. Mean groundwater-flow directions in shallow-zone wells were to the south, southwest, and west (Figure 9-2).
- All monitoring wells at the Site are tidally influenced, with elevation fluctuations ranging from 3.89 to 7.33 feet. The magnitude of elevation changes is greatest near the shoreline and decreases with distance inland (groundwater-elevations fluctuations and isocontours presented on Figure 9-5).
- The lag time of water-level changes is shortest near the LDW and increases with distance inland. Water-level elevations closely follow tide stages. Average lag times range from 18 minutes to 117 minutes.
- Mean vertical-hydraulic gradients were calculated for two well pairs: a mean downward gradient of 0.021 ft/ft in MW10/10D and a mean upward gradient of 0.032 ft/ft in MW12/12D.Although, as shown on Graph 3-1, wells MW10/10D appear to shift from a downward gradient at low tide towards no vertical gradient at high tide. In contrast, the vertical-hydraulic gradient in wells MW12/12D appears to maintain an upward vertical gradient, regardless of tide conditions (Graph 3-2).
- Lateral-hydraulic gradients were calculated across the Property for three well sets. Lateral gradients ranged from 0.0016 to 0.0049 ft/ft, generally in the

direction of the LDW (south, southwest, and west). The calculated gradients and flow directions are presented on Figure 9-6.

- Chloride concentrations measured in groundwater on the Property ranged from 1.11 to 4,870 mg/L (Figure 9-7). Chloride concentrations indicate that tidal intrusion of river water occurs on the Property and affects upland groundwater quality to distances between 120 and 200 feet inland of the LDW shoreline.

Although groundwater elevations in wells distant from the LDW shoreline showed a response to tidal fluctuations, the groundwater-elevation fluctuations in distant wells likely are due to mounding of groundwater as it encounters saltwater from the LDW. This mounding causes temporary groundwater-flow reversals in the "upgradient" direction. However, mean groundwater elevations indicate that net flow is to the west towards the LDW.

Based on measured groundwater-elevation fluctuations, hydraulic gradients, tidal-lag times, and chloride concentrations, all areas on the Property within approximately 120 feet of the LDW shoreline appear to be strongly hydraulically connected to the LDW river water. These areas also coincide with locations that have been filled with dredged and/or imported material. Additionally, based on the data, the central and southern portion of the Property (south of well MW12) appear to be impacted by river-water infiltration further inland (to distances of approximately 200 feet) than the northern portion of the Property.

3.3.3 Surface Water Hydrology

Surface-water hydrology of the LDW has been described in the Remedial Investigation report prepared by WindWard (2010). Currently, the Green River (located to the South of the LDW) contributes the majority of freshwater to the LDW. Average flow through the LDW in 2003 and 2004 was approximately 1,500 cubic feet per second (cfs). Flow volumes decrease during the dry summer months and peaks during the winter-rainy season. Surface water runoff from areas around the LDW (i.e., storm drains, CSOs, tributary creeks, etc.) contributes generally less than 1 % of the total flow (WindWard, 2010).

Being a well-stratified estuary (or salt-wedge estuary), the fresh-water stream flow determines the overall water circulation of the LDW. Fresh water overlies salt water entering from the Puget Sound and creates a sharp salt water/freshwater interface. Mixing does occur, but it is slight. According to the *Record of Decision* (USEPA, 2014a), the tidally-influenced water (salt-water "wedge") is present from Harbor Island to RM 2.2, regardless of tide height or stream flow.

3.3.4 Groundwater-Surface Water Interface and Seeps

Along the shoreline of the Property, groundwater generally enters the LDW surface/river water through diffusion and seeps. Depending on tidal cycles and seasonal fluctuations in groundwater flow, groundwater will discharge when the tide height is lower than the groundwater table. During sampling by SoundEarth Strategies in 2015, one seep (Seep 82 shown on Figure 8-1) was discovered on the northern end of the Property. Other obvious seeps have not been discovered on the Property.

3.4 Natural Habitat and Ecological Receptors

Due to the industrialization of the Duwamish valley and the creation of the LDW, the ecological habitat of the area has been extensively altered and greatly reduced. Approximately 98% of the intertidal mudflats, tidal marshes, and subtidal areas historically present along the river have either been filled or dredged (WindWard, 2010). A summary of the ecological habitats and biological communities present along the LDW has been described in great detail in the *Remedial Investigation Report* produced by WindWard Environmental, LLC (July 9, 2010). A summary of their findings is presented below.

3.4.1 Natural Habitat

As stated above, 98% of the natural habitat historically present along the Duwamish River has been significantly altered. Of the tidal marshes currently present along the LDW, none are near the Property or Site. Intertidal mudflats and subtidal sediments also are present in a very limited extent adjacent to the Property. The Property shoreline predominantly consists of armoring and riprap with varying amounts of concrete and metal debris. According to the 2010 WindWard report, these hard surfaces can support populations of “encrusting organisms, such as barnacles, and burrowing organisms, such as shipworms.” However, the already limited natural habitat present adjacent to the Property is further degraded due to overwater structures (i.e., docks) and the reduced nutrient, sediment, and organic matter replenishment due to shoreline armoring.

In addition, the upland portions of the Property have been extensively filled to the current elevation of approximately 13.5 to 17.5 feet (NAVD 88). Starting in the early 1900s, the Property has been completely altered from its original state. A majority of the Property is unpaved and consists of imported surfacing fill consisting of sand, gravel, and cobbles. Several buildings also are located on the Property. No vegetation or natural habitat currently exists on the Property.

3.4.2 Fish, Birds, and Mammals

Although fish, bird, and mammal species do not inhabit the Property, these ecological receptors are variably present in and along the shoreline of the LDW. Therefore, they should be considered in the development of cleanup standards for soil and sediment at the Site.

3.4.3 Benthic Invertebrates

Numerous studies have been conducted regarding the benthic invertebrate communities present in the LDW. Again, the *Remedial Investigation Report* produced by WindWard (2010) details these studies and their findings. In summary, the report assumes that the biologically active zone in the LDW is within the top 10 centimeters of the sediment surface. For this document, it is assumed that there are biologically active zones located adjacent to the Property. Because of this, benthic invertebrates should be considered when developing cleanup standards for groundwater, surface water, and sediment media on and adjacent to the Property.

3.4.4 Threatened and Endangered Species

Fifteen species, including nine fish and six bird species, have been identified in the LDW study area as candidate species, threatened species, or species of concern (WindWard, 2010). Of the threatened/endangered species, Chinook salmon, Coho salmon, Puget Sound steelhead, Pacific herring, bald eagle, western grebe, and peregrine falcon regularly inhabit the LDW. The other eight species rarely/incidentally inhabit the LDW.

According to the LDW RI report (Appendix A of the WindWard 2010 report), salmonid species (including Chinook and Coho) spend limited time in the LDW. Generally, salmonids spawn in the middle reaches of the Green River (and tributaries) and do not feed to a significant degree in the LDW. Puget Sound steelhead also reportedly spawn in the Green River and tributaries and spend little time in the LDW. Pacific herring are seasonally abundant in the LDW and predominantly feed on pelagic invertebrates and epibenthic invertebrates to a lesser extent. Because the herring mainly feed on pelagic prey, they are less exposed to LDW COPCs than benthic-feeding fish.

According to the LDW RI report, five bald eagle nests were reported within five miles of the LDW, the closest located in West Seattle (1.6 miles from the LDW). Bald eagles primarily ingest fish, with birds and mammals making up the remainder of their diet. Although bald eagles have been found in the vicinity of the LDW, the extent of prey taken from the LDW is unclear. Western grebe are found in substantial numbers in the LDW area and predominantly feed on fish (specifically Pacific herring, pilchard, stickleback, sculpin, sea perch, and smelt) in areas of mudflats and shallow-water habitats. Western grebes inhabit the area from approximately October to early May. Small numbers of peregrine falcons are present in the LDW area. These birds generally feed on rock pigeons and European starlings but may also ingest waterfowl on occasion. Limited information is presented about the peregrine falcon in the LDW RI report.

Further information regarding the Environmental Risk Assessment prepared for the LDW can be found Appendix A of the 2010 WindWard report.

3.5 Terrestrial and Ecological Evaluation and Screening Criteria

MTCA requires consideration of ecological receptors, achieved by completing a Terrestrial Ecological Evaluation (TEE). The purpose of this evaluation is to protect land-based plants and animals from exposure to contaminated media. The procedures, as put forth by WAC 173-340-7491, require applicants to first review primary exclusions. Certain circumstances provide exclusion from further ecological evaluation at the Site because the contaminants either have no pathway to harm the plants and animals or there is no habitat where plants or animals live or forage near the contamination. If one or more primary exclusions apply, the Site is exempt from further terrestrial ecological evaluation, and the TEE process ends. Document support for the TEE performed at the Site is included as Appendix G. In addition, Ecology performed a TEE assessment for the Site (dated November 7, 2017) and also is included in Appendix G.

3.5.1 TEE Process

The exemptions for conducting a TEE are as follows:

- Contamination is below 15 feet without institutional controls, or below 6 feet with institutional controls.
- Contamination is (or will be) covered by buildings or pavement.
- Concentrations are below natural background levels.
- Insufficient contiguous undeveloped land (for petroleum contamination, at least 1.5 acres existing on the property, or within 500 feet of the property).

If no exemption exists, a TEE (either a Site-specific TEE or a Simplified TEE) is conducted. A Site-specific TEE must be performed under the following conditions:

- The contamination is located on or directly adjacent to an area where management or land use plans maintain native or semi-native vegetation.
- The area of contamination is used by threatened or endangered species.
- The property contains 10 acres of native vegetation within 500 feet of contamination.

If none of the conditions for a Site-specific TEE apply, a Simplified TEE can be conducted. The Simplified TEE process is intended to identify those sites which do not have a substantial potential for posing a threat of significant adverse effects to terrestrial ecological receptors, and therefore may be removed from further ecological consideration during cleanup. The TEE may be ended at a site where conditions include any of the following:

- Land use at the site and surrounding area makes substantial wildlife exposure unlikely (Table 749-1 in WAC 173-340 is used to make this evaluation).
- If the contaminant concentrations are below those given in Table 749-2 (WAC 173-340) within the point of compliance (15 feet with no institutional controls, 6 feet with controls).
- Potential exposure pathways from soil contamination to ecological receptors are not present.
- Area of soil contamination is less than 350 square feet.

3.5.2 Site TEE Review

In the case of the Site, the following primary exclusions apply.

- Soil contamination is or will be completely covered by buildings, pavement, or other physical barriers that will prevent wildlife from being exposed.
- Insufficient contiguous undeveloped land exists within 500 feet of the Property.
- In addition, current and planned land use makes wildlife exposure unlikely due to the industrial/commercial nature of the Property and surrounding area.

Based on G-Logics and Ecology's TEE assessments conducted for the Site, the protection of vegetation and/or wildlife species is not required. However, Ecology has requested that criteria protective of the Site wildlife receptors be included in the development of Site screening levels. Because of this, contaminant concentrations presented in Table 749-2 (WAC 173-340-900) were included in the development of site-specific soil screening levels.

4.0 PREVIOUS EXPLORATIONS AND CLEANUP ACTIONS

Several environmental explorations and an interim cleanup action were completed on the Property between 2000 and 2009. The following sections summarize the work previously performed on the Property.

4.1 Summary of Previous Environmental Explorations

Beginning in 2000, environmental work began on the Property, which included a Phase I Environmental Site Assessment, several subsurface explorations, and an interim remedial excavation. A Remedial Investigation Report was completed in 2009 by Pacific Crest Environmental (Pacific Crest), which summarized early exploration/cleanup findings.

Historical data from this work are compiled with data collected from more recent explorations performed by SoundEarth Strategies and G-Logics from 2011 to present. All historical data is summarized in G-Logics tables included in this report. Applicable screening levels and locations with exceedances are further discussed in Section 6.0. Historical and recent sampling locations are shown on Figures 8. The reports that discuss historical explorations are listed below.

- *Phase I Environmental Audit*, prepared by Environmental Associates, Inc., dated January 17, 2000.
- *Preliminary Phase II Subsurface Investigation*, prepared by The Riley Group, Inc., dated September 13, 2000.
- *Site Closure Report*, prepared by Farallon Consulting, dated September 25, 2002.
- *Site Closure Report Addendum – Response to Comments*, prepared by Farallon Consulting, dated January 23, 2003.
- *Phase I Environmental Site Assessment,* prepared by Farallon Consulting, dated November 12, 2003.
- *Limited Phase II Subsurface Investigation Report: Gilmur South Parcel*, prepared by Farallon Consulting, dated April 5, 2004.
- *Limited Phase II Subsurface Investigation Report: Gilmur North Parcel*, prepared by Farallon Consulting, dated April 6, 2004.
- *Report of Compliance Monitoring and Request for No Further Action Determination for Groundwater and Soil*, prepared by Farallon Consulting, dated December 8, 2004.

- *Remedial Investigation Report*, prepared by Pacific Crest Environmental, LLC, dated May 11, 2009.

These documents are included on a CD in this report as Appendix H and are summarized below.

4.1.1 2000 Phase I Environmental Audit

In January of 2000, Environmental Associates Inc. conducted a *Phase I Environmental Audit* (a Phase I Environmental Site Assessment, report dated January 17, 2000). Based on their review, Environmental Associates recognized the following environmental conditions on the Property.

- Research indicated that fill material consisting of dredged sediment from the LDW was present on the Property. Chemical analysis had not been conducted on this material to assess the potential for contamination.
- In general, sediment and dredge material from the LDW has been found to contain several contaminants, including PCBs, dioxins, PAHs, and metals.
- In the 1980s, material dredged from the LDW was stored on the Property and was documented to contain PCBs.
- The report states that there was no evidence to suggest the presence of contaminated soil on the Property at the time of the report. However, what appeared to be soil stains were identified in historic aerial photographs. In addition, the report states that "emulsified oil" was noted on the Property by Ecology during a previous site inspection.

4.1.2 2000 Preliminary Phase II Subsurface Investigation

In September of 2000, The Riley Group, Inc. conducted a *Preliminary Phase II Subsurface Investigation* (report dated October 2, 2000). Based on their research, The Riley Group recognized the following environmental conditions on the Property.

- The Riley Group directed the advancement of four test pits (TP-1-R through TP-4-R) and advanced four soil borings (B1-R through B4-R).
- Soil analyzed from the Property was found to be negatively affected due to industrial land use. Contaminants in the soil found to exceed the MTCA Method A cleanup levels included diesel-range organics (DRO), oil-range organics (ORO), PCBs, metals, and PAHs.
- Based on the analysis of groundwater samples, it appeared that there were potential impacts to groundwater on the Property originating from petroleum hydrocarbons present in Site soils.

- The vertical and lateral extent of the contaminants were not completely assessed due to the preliminary nature of the exploration.

4.1.3 2002 Subsurface Investigation and Site Closure Report

In September of 2002, Farallon Consulting prepared a report titled *Site Closure Report* (dated September 25, 2002) which included the findings of a subsurface exploration. A summary of their work and findings is presented below. Remedial actions associated with this work are discussed in Section 4.2

- Farallon advanced 19 soil borings (B1 through B19), completed four soil borings (MW1 through MW4) as groundwater monitoring wells, and advanced four test pits (TP-B4, TP-B5, TP-B7, TP-B12).
- Soil samples collected from the Property were categorized as low, intermediate, and deep. PCBs, ORO, DRO, metals, PAHs, and pentachlorophenol were detected.
- Groundwater levels at the Site were noted to be strongly influenced by tidal fluctuations due to the Site's close proximity to Elliott Bay. Research found that the hydraulic gradient is steeper at low tide and becomes more gradual during high tide.
- Petroleum hydrocarbons, metals, pentachlorophenol, PAHs, and PCBs were detected in the analyzed groundwater samples.

4.1.4 2003 Site Closure Report Addendum

In January of 2003, Farallon prepared and submitted an addendum (dated January 23, 2003) in response to Ecology comments and to support their 2002 *Site Closure Report*. No additional exploration work was conducted at that time. Please refer to the 2003 Farallon report for additional details.

4.1.5 2003 Phase I Environmental Site Assessment

In November of 2003, Farallon prepared a *Phase I Environmental Site Assessment* (report dated November 12, 2003). Based on their research, Farallon recognized the following environmental conditions on the Property.

- Farallon observed "significant" staining on concrete at the Property and "poor housekeeping" practices by Duwamish Metal Fabricators in the shop space inside the building on Parcel 536720-3635.

- Cracks in the concrete floor of the above building also were observed. Cracks and concrete expansion joints were noted as preferential pathways for chemicals released inside the building.
- The report claimed that "uncharacterized fill material" was present on or directly adjacent to the Property and contained dredged sediment from the LDW that was placed on the Property between the early 1900s and the mid-1940s. Additionally, the report stated that PCBs, polychlorinated terphenyls, volatile organic compound (VOCs), and metals generally had been detected in adjacent LDW sediments.

4.1.6 2004 Limited Phase II Subsurface Investigation Report, South Parcel

In April of 2004, Farallon conducted a subsurface investigation on the "South Parcel" (parcels 3447 and 3635) of the Property (report dated April 5, 2004). A summary of this work and findings is presented below.

- Farallon advanced five soil borings (SB1 through SB5). SoundEarth Strategies renamed these borings to SB-1S through SB-5S. G-Logics has retained this naming convention for this RI report.
- Only soil samples from borings SB-3S and SB-4S were analyzed during their exploration.
- Chromium, copper, nickel, and zinc were detected in the analyzed soil samples from borings SB-3S and SB-4S.
- Reconnaissance groundwater samples also were collected from borings SB-1S, SB-4S, and SB-5S. Copper, arsenic, selenium, cPAHs, toluene, DRO, and ORO were detected in one or more of the analyzed samples.

4.1.7 2004 Limited Phase II Subsurface Investigation Report, North Parcel

In 2004, Farallon conducted a subsurface investigation on the "North Parcel" (parcel 4545) of the Property (report dated April 6, 2004). A summary of this work and findings is presented below.

- Farallon advanced five soil borings (SB1, SB1A, SB1B, SB2, and SB3). SoundEarth Strategies renamed these borings to SB-1N, SB-1AN, SB-1BN, SB-2N, SB-3N. Again, these names have been retained by G-Logics.
- Only soil samples from borings SB-1N and SB-3N were analyzed during their exploration.
- Chromium and copper were detected in the analyzed soil samples.

- A grab-groundwater sample was collected from boring SB-3N to assess groundwater conditions proximate to the LDW. Chromium, lead, nickel, and PCBs were detected in the analyzed groundwater sample.

4.1.8 2004 Report of Monitoring and NFA Request for Groundwater and Soil

In 2003 and 2004, Farallon conducted four consecutive quarters of groundwater sampling at well MW3. This well was established by Farallon as the point of compliance for groundwater at the Site (as accepted by Ecology in a letter dated August 11, 2013). A summary of the work and findings is presented below.

- Groundwater samples were analyzed for PCBs, dissolved copper, total mercury, DRO, and ORO.
- None of the analyzed samples contained detectable concentrations of the above contaminants.
- With these results, Farallon recommended that the Site be capped with an impermeable surface (engineered control), as well as have institutional controls placed on the Site to maintain the capped surface and restrict the use of groundwater beneath the Site.
- Assuming the engineered and institutional controls were successfully implemented, Farallon requested a No Further Action (NFA) Determination from Ecology for the Site. Ecology did not grant an NFA for the Site.

4.1.9 2009 Remedial Investigation Report

In May of 2009, Pacific Crest prepared a *Remedial Investigation Report* for the Property. This report included a description of explorations and data collection completed by Pacific Crest in 2008. A summary of their work and findings is presented below.

- Pacific Crest advanced four soil borings (MW-1D through MW-4D), which were completed as monitoring wells.
- Soil samples collected from the Property contained detectable concentrations of metals, DRO, ORO, cPAHs, PCBs, and semivolatile organic compounds (SVOCs).
- Groundwater samples collected from the northern portion of the Property contained concentrations of cPAHs, PCBs, and metals.
- Riverbank sediment/soil samples were collected from five locations adjacent to the Property (sample locations RB-1 through RB-5) and contained concentrations of cPAHs, PCBs, SVOCs, and metals.

- Sediment/soil samples were collected from catch basins CB04, CB05 and CB08 (labeled CB-1, CB-2, and CB-4 in the Pacific Crest report) and contained concentrations of cPAHs, PCBs, SVOCs, and metals.
- The report states that the source of contaminants in the soil and groundwater appeared to be from LDW dredge/fill material placed on the Property, as well as contaminant releases associated with previous operations on the Property.
- As a cleanup action, the report recommended that an engineered barrier be installed over the affected areas to mitigate the potential for ingestion and dermal exposure, as well as minimize surface-water infiltration.

4.2 Interim Cleanup Action

In addition to explorations, an interim cleanup action was performed by Farallon Consulting in 2002 (summarized in their *Site Closure Report)*. The cleanup action is further described below.

- During their 2002 exploration described above, lead was detected at elevated concentrations.
- An interim action was conducted to excavate and dispose soil that contained leachable concentrations of lead above the Toxicity Characteristic Leaching Procedure (TCLP) Dangerous Waste criteria (5 mg/L).
- The excavation is labeled "EX1" on attached Figure 8-1 (same location as testpit TP-3-R). Figure 8-2 presents the excavation diagram and location of confirmation soil samples collected during the interim cleanup action.
- Approximately 50 cubic yards of soil was excavated and transported to Chemical Waste Management of the Northwest for stabilization treatment and disposal.
- Based on confirmation-soil samples and locations presented in the report, it appears that lead above MTCA Method A cleanup levels was successfully removed during the remedial excavation.

4.3 Ecology Opinions Regarding Previous Environmental Work

The Site was first entered into Ecology's Voluntary Cleanup Program (VCP) in 2002 by Farallon Consulting. Farallon had requested NFA Determinations from Ecology on several occasions following investigation and/or remedial work performed on the Property. Based on the December 8, 2004 Farallon report and NFA request, Ecology denied the NFA due to lack of sufficient information regarding contamination at the Site. Specifically, Ecology's denial letter (dated June 1, 2005) stated that the source, as well as lateral and vertical extent, of contaminants found on the DMC Property had not been identified. In addition, MTCA does not allow the Site to be divided and an NFA given for a portion of the Site. Therefore, the NFA was not granted for the DMC Site at this time.

Pacific Crest commenced work on the Site in 2006. Pacific Crest performed exploration work as part of their Remedial Investigation effort between 2006 and 2009 (as described in Section 4.1.9 above). The Remedial Investigation Report prepared by Pacific Crest in 2009 was submitted to Ecology through the VCP. The report presented background information of the Property and a summary of investigations and remedial actions performed to date. Using Site information collected during the previous explorations, a Conceptual Site Model, preliminary cleanup levels, and points of compliance for contaminants of potential concern were developed. It was the opinion of Pacific Crest that contamination at the Site was fully characterized and that a FS should be prepared to evaluate potential remedial options.

Ecology responded to the Pacific Crest RI report in an opinion letter dated August 11, 2009. It was Ecology's opinion that the lateral and vertical extent of contamination in soil, groundwater, and sediment at the Site was not sufficiently delineated. Additionally, the RI was not sufficient to establish cleanup levels or develop cleanup actions alternatives. Ecology subsequently issued a "Termination of VCP Agreement" for the Site on November 23, 2009. Ecology identified the following data gaps in their August 2009 letter:

- Natural conditions at the Site and surrounding areas, including geology, surface water, groundwater, and natural resources, were not presented in the RI report.
- "The lateral and vertical extent of contaminants in soil and groundwater is not presented in sufficient detail to understand distributions across the property." Ecology stated that there was a lack of data to support the contaminant boundaries, as presented in the RI report.
- The RI report did not address the potential for sediment contamination.
- The RI report did not incorporate all exposure pathways that were identified for the draft RI report prepared for the LDW Superfund Site (dated November 5, 2007).

5.0 RECENT SITE EXPLORATIONS AND RESULTS

Based on the previous work conducted (outlined in Section 4.0 above), Ecology had determined that there was insufficient information to fully characterize the contamination at the Site. In September 2011, the Property owners entered into the Agreed Order with Ecology with the ultimate objective of performing a remedial action at the Site. Based on the information collected up to year 2011, the Agreed Order required the preparation of a RI Report (this report), FS, and Draft Cleanup Action Plan (CAP) for the Site. A Final CAP will be issued by Ecology with consideration of the draft CAP.

Since 2011, several additional environmental explorations were conducted by SoundEarth Strategies and G-Logics to address data gaps outlined by SoundEarth Strategies in their *Remedial Investigation/Feasibility Study Work Plan* dated May 13, 2013. The additional exploration work was performed in accordance with the following Ecology-approved workplans. The following documents are included as a CD in this report as Appendix I.

- *Remedial Investigation/Feasibility Study Work Plan*, prepared by SoundEarth Strategies, Inc., dated May 13, 2013.
- *Quality Assurance Project Plan*, prepared by SoundEarth Strategies, Inc., dated May 13, 2013.
- *Sampling and Analysis Plan*, prepared by SoundEarth Strategies, Inc., dated May 13, 2013.
- *Technical Memorandum, Updates to the Remedial Investigation/Feasibility Study Work Plan (TM01)*, prepared by SoundEarth Strategies, Inc., dated October 3, 2013.
- *Technical Memorandum, Updates to the Remedial Investigation/Feasibility Study Work Plan (TM02)*, prepared by SoundEarth Strategies, Inc., dated January 15, 2014.
- *Remedial Investigation Assistance*, prepared by G-Logics, Inc., dated May 11, 2015.
- *Catch Basin and Stormwater Sampling Modifications*, prepared by G-Logics, Inc., dated August 21, 2015.
- *Hollow-Stem Auger Drilling and Groundwater Sampling*, prepared by G-Logics, Inc., dated September 16, 2015.
- *Workplan to Conduct Direct-Push Drilling and Sampling*, prepared by G-Logics, Inc., dated February 11, 2016.

- *Workplan to Conduct a Tidal-Influence Study*, prepared by G-Logics, Inc., dated June 9, 2016.
- *Groundwater Sampling*, prepared by G-Logics, Inc., dated August 1, 2016.

The additional exploration work was summarized in the following reports that were previously submitted to Ecology. The following documents also are included in Appendix I. Field notes associated with G-Logics exploration work are attached as Appendix J.

- *Draft Riverbank Sediment and Seep Tables and Figure*, prepared by SoundEarth Strategies, Inc., dated April 2015.
- *Remedial Investigation Assistance, Stormwater Sampling, and Catch-Basin Sediment Sampling*, prepared by G-Logics, Inc., dated October 15, 2015.
- *Memo Report*, Hollow-Stem Auger Drilling and Soil Sampling, prepared by G-Logics, Inc., dated November 12, 2015.
- *Memo Report, Groundwater Sampling*, prepared by G-Logics, Inc., dated January 14, 2016.
- *Memo Report, April 2016 Groundwater Sampling*, prepared by G-Logics, Inc., dated May 23, 2016.
- *Memo Report, Direct-Push Drilling and Sampling*, Prepared by G-Logics, Inc., dated May 23, 2016.
- *Memo Report*, Summer 2016 Catch-Basin Sediment Sampling, prepared by G-Logics, Inc., dated July 20, 2016.
- *Memo Report, September 2016 Groundwater Sampling*, prepared by G-Logics, Inc., dated October 25, 2016.
- *Tidal-Influence Study*, prepared by G-Logics, Inc., dated September 30, 2016.

With the completion of the exploration work outlined above, sufficient information has been collected to characterize Site contamination and to prepare this RI Report. Information regarding the recent sampling is further discussed below. Sampling locations are shown on Figure 8-1.

5.1 Soil Sampling

On October 19 through 22, 2015, borings MW05 through MW16 (including three well clusters MW09/09D, MW10/10D, and MW12/12D) were advanced using hollow-stem auger drilling and sampling equipment. These borings were completed as groundwater-monitoring wells. The 15 borings were drilled to depths ranging from approximately 20 to 31.5 feet below ground surface. During drilling, soil samples were collected at 2.5-foot intervals using a stainless steel split-spoon sampler. In general, the borings encountered well graded silty, gravelly sands underlain by variably silty sands. Select soil samples were submitted to the laboratory and analyzed for gasoline range organics (GRO), DRO, ORO, metals, PCBs, VOCs, PAHs, and SVOCs.

Based on the sampling locations and results of the October 2015 drilling and sampling, G-Logics conducted a second exploration on March 28 and 29, 2016 using direct-push drilling and sampling equipment. Borings GLB01 through GLB14 were advanced to depths of 20 feet below ground surface (wells were not installed). In general, the borings encountered well-graded silty, gravelly sands (fill) underlain by variably silty sands. Four-foot continuous core samples were obtained by driving/pushing a two-inch sampler to the sampling depth. Selected soil samples were submitted to the laboratory and analyzed for GRO, DRO, ORO, metals, PCBs, VOCs, PAHs, and SVOCs.

Soil boring/well locations are shown on Figure 8-1. Soil sampling results from G-Logics explorations, as well as previously conducted explorations, are included in attached Tables 1-1 through 1-7.

5.2 Groundwater and Seep-Water Sampling

Prior to the first groundwater-sampling event in December 2015, the wells newly installed by G-Logics were developed using a submersible pump and surge block. In addition, the static water level was measured in the monitoring wells prior to each sampling event using a water-level probe.

G-Logics performed three groundwater-sampling events at the Property in December 2015, April 2016, and September of 2016. All samples were collected with a peristaltic pump using low-flow purging and sampling procedures. All groundwater samples were submitted to the laboratory and analyzed for GRO, DRO, ORO, total and dissolved metals, PCBs, VOCs, PAHs, SVOCs, total suspended and dissolved solids, chloride, and geochemical parameters. Samples were collected generally during low tide.

In February 2015, SoundEarth Strategies conducted seep-water sampling along the riverbank adjacent to the Property. One seep was found along the riverbank at the northern portion of the Property. Water from this seep was collected at low tide.

Groundwater-monitoring well locations and seep-water sampling locations are shown on Figure 8-1. Groundwater and seep-water sampling results from G-Logics explorations, as well as previously conducted explorations, are included in attached table 7s 2-1 through 2-9.

5.3 Riverbank and LDW Sediment Sampling

SoundEarth Strategies collected riverbank-sediment/soil samples in February 2015 from six locations (RB06 through RB11). According to their workplan dated January 15, 2014, riverbank samples were collected within the intertidal zone along the LDW and less than one foot deep from the riverbank surface (SoundEarth Strategies, 2014). Riverbank-sampling locations are shown on Figure 8-1. Sediment/soil sampling results from Pacific Crest (discussed in Section 4.1.9) and SoundEarth Strategies' explorations are included in attached Tables 3-1 through 3-7.

In addition to the explorations conducted on the Property, G-Logics has reviewed data for sediment samples collected in the adjacent LDW, obtained from Ecology's Environmental Information Management (EIM) database. LDW sediment data from locations up to 250 feet from the Property shoreline were reviewed for this report. Reviewed LDW sediment data were collected between 1995 and 2011 by various public and private organizations. The collected sediment data has been included in the attached Tables 4-1 through 4-7.

5.4 Catch-Basin Sediment Sampling

Sediment samples were collected from five on-Property catch basins in October 2015 (CB01, CB03, CB04, CB05, and CB12). In the winter of 2016, the on-Property stormwater system was cleaned of sediment and debris by LineScape, LLC. The removed sediment and debris were disposed at an offsite facility that could accept waste containing detected concentrations of COPCs.

After cleaning, sediment was allowed to re-accumulate in the catch basins over a period of approximately six months. Samples of sediment were collected in June 2016 from two on-Property catch basins, CB01 and CB12. G-Logics attempted to collect sediment samples from several additional catch basins, CB02, CB03, CB04, CB05, CB06, CB07, and CB08. However, during sampling, these catch basins were either not accessible or did not contain sufficient volumes of sediment to sample. In addition, sediment volumes present in catch basins CB01 and CB12 were not sufficient for grain-size analysis.

Catch basin locations are shown on Figure 8-1. Catch-basin sediment sampling results from G-Logics explorations, as well as previously conducted explorations, are included in attached Tables 5-1 through 5-8.

5.5 Stormwater Sampling

As described in Section 2.5.1.3, STB and Duwamish Metal Fabricators manage stormwater collected on the Property. In addition to the analytical requirements for the Industrial Stormwater General Permits, Blue Environmental has collected stormwater samples for analysis of COPCs associated with the Property. Specifically, between 2015 and 2017, samples have been collected and analyzed from the stormwater systems inlet, SWC1 (pretreatment), as well as from discharge outfalls OUT1 and OUT2. Ecology also collected several samples from OUT1 in 2015.

In addition, stormwater data collected by King County from the Michigan St CSO, collected in 2007 and 2008, has been reviewed for this report. Stormwater collection points are shown on Figure 8-1. Stormwater analytical results are included as Tables 6-1 through 6-8.

5.6 Stormwater-System Cleaning and Video Survey

In June 2015, a video survey was conducted of the stormwater-system piping on the Property. Specifically, the piping between catch basins CB01 through CB07 and CB14 to outfall OUT2 were reviewed for sediment accumulation, deformations, breaks, and water levels. Because catch basin CB08 is pumped into CB07 through an overland hose, a survey was not conducted on the piping between these points. As the pipe between catch basins CB08 and CB09 is no longer in use and close on both ends, therefore a survey was not conducted. Piping associated with catch basins CB10 through CB13 were not surveyed during this event.

The catch basins and stormwater piping were subsequently cleaned in the winter of 2015/2016. A follow-up video survey of the piping has not been performed. Catch basin samples were collected prior to and after the cleaning, as described in Section 5.4 above.

5.6.1 Stormwater Video-Survey Results

Figure 5-2 presents the results of the video survey conducted on the stormwater system in June 2015. At the time of the survey, sediment had accumulated inside of the stormwater piping in several areas. Most of sediment found inside of the piping had accumulated within eight inches of a joint. This may be due to the impediment of flow at the pipe joints and/or slight sumps in the piping at joint locations. In some locations, the joints may be allowing sediment to infiltrate into the stormwater system.

Conversely, water from the stormwater system may have leaked out and into the surrounding soil in these locations. As stated in Section 2.6, stormwater piping on the Property is located at elevations above the average water-table elevation during high tide. Therefore, it is unlikely that groundwater has infiltrated into the stormwater system in these locations. Figure 5-2 indicates the percentage of the cross-sectional area of that pipe that was blocked by sediment.

The video survey indicated a broken/cracked pipe located just upgradient of catch basin CB04. This area could indicate a location where water may leak out of the stormwater piping and infiltrate into the surrounding soil. As of the date of this report, this pipe has not been repaired.

Additionally, one area located between catch basins CB05 and CB06 had a deformed pipe and a crack that previously had been repaired. This area currently does not appear to be cracked but could indicate a location where water previously may have leaked out of the stormwater piping and infiltrated into the surrounding soil.

Lastly, one section of piping between catch basins CB05 and CB06 had accumulated sediment greater than 60% of the pipe cross-sectional area. The survey equipment was unable to pass through approximately 40 feet of the piping in this area due to the sediment accumulation.

5.7 Tidal-Influence Study

As described in Section 3.3.2, a tidal-influence study was conducted on the Property in 2016. Please see that section for further information.

5.8 Data Validation

To satisfy the requirements of the Agreed Order, Stage 2A data validation was performed on soil, sediment, and groundwater sample analytical results collected by G-Logics. Additionally, Stage 4 data validation was performed on any dioxin/furan analyses. ECOCHEM Data Quality (ECOCHEM) performed the data-validation services using the guidance and quality control criteria outlined in the SoundEarth Strategies document titled *Quality Assurance Project Plan* and dated May 13, 2013. During G-Logics explorations, data was collected in years 2015 and 2016. As such, data-validation reports were compiled for each year sampling was conducted, as presented in Appendix K (ECOCHEM, 2017).

Results were estimated or flagged due to one or more of the following reasons: method-blank contamination, surrogate-recovery outliers, laboratory-duplicate sample precision outliers, matrix spike/matrix spike duplicate outliers, laboratory-duplicate outliers, holding-time exceedances, matrix-spike recovery outliers, ion-ratio outliers, field-duplicate precision outliers, and sample-cooler temperatures. These results have been flagged in the tables included in this report to indicate being outside of standards or as estimated concentrations. Qualified results are acceptable for use for the purpose of this RI.

Several results were rejected due to surrogate and laboratory control sample outliers, and very low surrogate recoveries. These results have been "R" flagged in the tables included in this report to indicate being rejected. These data should not be used for this RI. While some of the data were rejected or flagged through the data-validation process, the overall data-validation results indicate that the collected data is suitable for the purposes of this RI.

5.8.1 Use of Method Detection Limits

During G-Logics 2015 and 2016 explorations, cleanup/screening levels were being developed to compare to analytical results. At the time of sampling, if the standard practical quantitation limit (PQL) for an analyte was greater than the selected screening level at that time, the laboratory would use the method detection limit (MDL) as the reporting limit. Concentrations detected between the MDL and PQL values were "J" flagged as an estimated concentration. Analytes generally reported to the MDL during G-Logics sampling events are indicated on Tables 1-1, 2-1, 3-1, 5-1, and 6-1.

In general, the PQLs for most analytes were used as the reporting limits. Several analyses/media required the use of MDLs to achieve sufficiently low reporting limits. Depending on the sampling media, the laboratory was unable to achieve sufficiently low PQLs/MDLs for several analytes (i.e., several PCB Aroclors and cPAHs for groundwater samples), as indicated in the analytical summary tables provided in this RI.

6.0 CONCEPTUAL SITE MODEL, SCREENING LEVELS, AND CONTAMINANTS OF POTENTIAL CONCERN

As presented in the MTCA regulations WAC 173-340-700(5), the following criteria should be considered when developing cleanup/screening levels for a site.

- (1) Current and potential exposure pathways and potential receptors.
- (2) Current and potential land resource use.
- (3) Nature of contamination.

These criteria also provide the substantive components of the Conceptual Site Model (CSM), as defined in WAC 173-340-200. Figures depicting the CSM, the exposure pathways, and potential receptors are attached as Figures 10-1 and 10-2.

Due to the complexity of the Site, Method A cleanup levels are not applicable. Accordingly, screening levels have been developed under guidance of Ecology's *Preliminary Cleanup Level Workbook* (Ecology, 2017) for LDW upland sites. Comparison of detected concentrations to the selected screening levels has allowed for the identification of COPCs for the Site. For each media, additional information is presented below.

6.1 Soil

Information regarding soil-exposure pathways, potential receptors, screening levels, and COPCs is presented below.

6.1.1 Soil Conceptual Site Model

Potential sources of soil contaminants at the Site include 1) surface leaks/spills from current and/or historical Site operations, 2) contaminated fill material originating from LDW dredge spoils and/or offsite sources, and 3) contaminated water infiltrating into soils from breaches in the stormwater system. Potential transport/secondary release mechanisms from the contaminated soil include leaching to groundwater and surface-soil/riverbank erosion into the adjacent LDW.

Exposure pathways include direct/dermal contact, incidental ingestion, and inhalation/ingestion of airborne dust. Current potential receptors of soil COPCs include on-property workers and, although unlikely, plant/animal life. However, it is our understanding that the Property will be paved in the near future, ultimately mitigating all soil-exposure pathways at the Site, through this engineered control.

6.1.2 Soil Screening Levels

Under the guidance of Ecology, detected contaminants have been compared to the following cleanup and screening levels:

- MTCA Method B Non-Cancer and Cancer cleanup levels as presented in Ecology's "Cleanup Levels and Risk Calculations" (CLARC) website
- TEE Industrial/Commercial site cleanup levels as presented in MTCA Table 749-2
- Background concentrations of metals as presented in the Ecology Publication No. 94-115, Natural Background Soil Metals Concentrations in Washington State

Soil screening levels for the Site are listed in Table 1-1. These screening levels are described to be protective of the direct-contact/ingestion pathways and are protective of human and ecological receptors at the Site. The most conservative values (the lowest value) of the three screening criteria (MTCA Method B Non-Cancer, Method B Cancer, and TEE) have been used as the screening level for each contaminant. The migration-to-groundwater pathway was not considered when developing Site-specific soil-screening levels. However, this pathway is used when identifying soil COPCs for the Site (see Section 6.1.3). Table 1-1 also identifies the chosen screening level for each contaminant.

Detected metal concentrations in soil also were compared to background levels established in Ecology's 1994 Publication No. 94-115. Arsenic was the only metal with background levels (7.30 mg/kg) greater than the most conservative screening levels. Therefore, the background concentration of 7.30 mg/kg was used as the screening level for arsenic.

For this Site, the analytical laboratories generally were able to achieve PQLs and MDLs that were below the most conservative screening levels for all analytes. There were several sampling events in which the PQLs/MDLs for certain analytes were greater than the most conservative screening levels (these events have been flagged in their respective tables).

6.1.3 Soil Contaminants of Potential Concern

The list of contaminants of potential concern was developed by comparing soil analytical results to the following criteria (as presented in Table 1-1). All analytical data (including previously collected samples) collected from the Site has been used for the following review.

- Exceedance factors (contaminant concentration over screening level) were calculated using the highest detected soil concentration for each contaminant. Contaminants with an exceedance factor greater than two (i.e., two times the screening level) were considered for the COPC list.
- The lateral extent of contamination was considered when developing the COPC list. For soil screening-level exceedances, the sum of "different locations" was compared to the total number of borings/wells/testpits advanced at the Site. "Different locations" only includes different boring/well/testpit where soil screening levels were exceeded and not different depths within the same boring/well/testpit. Contaminants were considered for the COPC list if the ratio of different to total locations is greater than five percent.
- For each contaminant, the total number of soil samples with screening-level exceedances was compared to the total number of analyzed samples. Contaminants were considered for the COPC list if this ratio was greater than five percent.

If the all three above criteria are exceeded, the suspect contaminant has been included in the final COPC list. In addition, if the detected concentration for a contaminant in any single sample was greater than 10 times the selected screening level, the contaminant also was included in the COPC list. Furthermore, any contaminant identified as a groundwater COPC (as discussed in Section 6.2) also has been included in the soil COPC list.

The list of COPCs, as defined above, is summarized in Table 1-1a. The nature and extent of each identified COPC contaminant is summarized in the following section.

6.1.4 Nature and Extent of Soil Contaminants

Locations with screening-level exceedances of soil COPCs have been shown on the figures specified below. The figures have been depicted as dot distribution-choropleth maps (graduated dot sizes and a color progression represent increasing concentration ranges) to indicate the highest contaminant concentrations at each sampling location. Locations where groundwater-sample concentrations exceed their respective screening level have been indicated on the figures with a blue cross. In addition, near-shore riverbank sediment/soil data have been included on the figures for comparison purposes. All soil COPCs listed below, except chromium, also are groundwater COPCs (as discussed below in Section 6.2).

Supplemental figures have been included in Appendix L that present vertical distribution of COPCs across the Site (highest concentrations are presented for each five-foot vertical interval). Details regarding the interpreted nature and extent of each soil COPC are presented below.

6.1.4.1 Metals

- **Arsenic:** Figure 11-1 (and supplemental Figure 11-1a) shows the distribution of arsenic in soil across the Site. The natural background concentration of 7.30 mg/kg has been used as the screening level for arsenic. In general, arsenic concentrations exceeding the screening level are pervasive across the Site at depths between zero and ten feet. At depths greater than 10 feet, elevated arsenic concentrations are predominantly located near the LDW shoreline where fill material is present to the greatest depth.

  Based on this distribution and the common presence of arsenic in LDW sediment and dredge material, arsenic is likely associated with fill material used on the Property (including LDW-dredge spoils).

- **Chromium:** Figure 11-2 (and supplemental Figure 11-2a) shows the distribution of chromium in soil across the Site. The TEE Industrial/Commercial screening level of 135 mg/kg has been used for the Site. All screening-level exceedances of chromium in soil occurred at depths shallower than 10 feet. The two primary locations where chromium is present are in the north/central portion of the Property (near B3 and B4) and near the shoreline south of the South Dock (in borings GLB07 and GLB10).

  Many industrial processes and materials can be sources of chromium. Processes can include welding and chrome electroplating. Materials containing chromium include cement and cement dust, road dust, catalytic converters, brake pads, antifreeze, paints, and wood preservatives. Based on the industrial use of the Property and the storage and use of one or more of the mentioned materials, chromium contaminants could have been released from surface sources located on the Property, as well as from fill material found on the Property (including LDW dredge spoils).

- **Copper:** Figure 11-3 (and supplemental Figure 11-3a) shows the distribution of copper in soil across the Site. The TEE Industrial/Commercial screening level of 550 mg/kg has been used for the Site. Screening-level exceedances of copper in soil occurred in only four borings (B7, GLB02, GLB07, and MW12) and predominantly at depths shallower than 10 feet (with one exception in boring GLB02).

  According to the US Center for Disease Control (CDC), major anthropogenic sources of copper include mining, agriculture, sludge from sewage-treatment facilities, and municipal/industrial solid waste. Copper compounds also are used in anti-fouling paints used for ship hulls. Based on the limited and sporadic distribution of copper on the Property, copper contaminants likely originate from fill material originating from the LDW (dredge spoils) that previously were contaminated from outfalls discharging into the LDW and/or solid-waste storage in the area.

- **Lead:** Figure 11-4 (and supplemental Figure 11-4a) shows the distribution of lead in soil across the Site. The TEE Industrial/Commercial screening level of 220 mg/kg has been used for the Site. In general, lead concentrations exceeding the screening level are widespread across the Site, predominantly at depths between zero and ten feet.

  One possible source of elevated lead concentrations on the Property could be the junk dealer formerly located on Parcel 4565. Sources of lead also could include lead-based paint, lead pipes and plumbing materials, solders, and batteries. Lead-impacted soil may have been inadvertently spread across the Property from regrading practices or vehicle tracking. Additionally, the widespread distribution of lead could suggest that lead-impacted fill material (including LDW dredge spoils) is a potential source.

- **Mercury:** Figure 11-5 (and supplemental Figures 11-5a) shows the distribution of mercury in soil across the Site. The TEE Industrial/Commercial screening level of 0.70 mg/kg has been used for the Site. Screening-level exceedances of mercury in soil occurred in only five borings (B-3-R, TP-1-R, B18, MW07, and MW16) and at varying depths from zero to 20 feet below ground surface.

  Given the sporadic vertical and lateral distribution in soil, the specific source(s) of mercury could potentially be resultant of contaminated fill (including LDW dredge material) or is otherwise unknown.

- **Nickel:** Figure 11-6 (and supplemental Figure 11-6a) shows the distribution of nickel in soil across the Site. The MTCA Method B (Non-Cancer) screening level of 1,600 mg/kg has been used for the Site. Nickel concentrations did not exceed the selected screening level in any soil samples. However, nickel has been included as a soil COPC due to the presence of elevated concentrations in groundwater that exceed the selected groundwater screening level.

  Elevated concentrations of nickel are present in the soil across the Property at concentrations greater than the natural background levels for the Puget Sound area (38.2 mg/kg), predominantly at depths between zero and ten feet below ground surface. In general, industrial processes (i.e., metal plating and combustion of fossil fuels) and waste (including sewage sludge) are the major sources of nickel in the environment (Wuana & Okieimen, 2011). No specific onsite sources of nickel are known at this time.

- **Zinc:** Figure 11-7 (and supplemental Figure 11-7a) shows the distribution of zinc in soil across the Site. The TEE Industrial/Commercial screening level of 570 mg/kg has been used for the Site. In general, zinc concentrations exceeding the screening level are located on Parcel 4565, predominantly at depths between zero and ten feet.

  Shipping containers are often coated with a zinc-containing anti-fouling spray/paint to prevent corrosion during transport and storage. Because Parcel 4565 is predominantly used for shipping-container storage, the primary source of zinc at the Site is thought to be from the zinc-coating on shipping containers.

6.1.4.2 Polychlorinated Biphenyls

When establishing soil-screening levels for the protection of human health, MTCA specifies that PCB mixtures shall be considered a single hazardous substance (WAC 173-340-708). CLARC and TEE guidelines present cleanup levels for Total PCBs (summation of all PCB Aroclor and/or Congener concentrations within a sample) that have been used for the DMC Site.

- **Total PCBs:** Figure 11-8 (and supplemental Figure 11-8a) shows the distribution of total PCB Aroclors in soil across the Site (PCB Congeners were not analyzed in soil during exploration work performed on the Property). The MTCA Method B (Cancer) screening level of 0.50 mg/kg has been used for the Site. Except for boring GLB06, all screening-level exceedances of PCB concentrations in soil occurred on the northern half of Parcel 4565 and within 10 feet of ground surface.

  PCB contaminants are often released to the environment due to leaks from old electrical transformers, PCB-containing paints and caulks, dumping or disposal of PCB-containing waste, and burning of PCB-containing waste. Because a junk dealer was formerly located on Parcel 4565, PCB contaminants in soil may be associated with the storage/disposal of PCB-containing waste during that time. In addition, based on the common presence of PCBs in LDW sediment and dredge spoils, PCB contaminants present on the Site also could be associated with fill material used on the Property (including LDW-dredge spoils).

6.1.4.3 Semivolatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

- **Acenaphthene:** Figure 11-9 (and supplemental Figure 11-9a) shows the distribution of acenaphthene in soil across the Site. The MTCA Method B (Non-Cancer) screening level of 4,800 mg/kg has been used for the Site. Acenaphthene concentrations did not exceed the selected screening level in any soil samples. However, acenaphthene has been included as a soil COPC due to the presence of elevated concentrations in groundwater that exceed the selected groundwater screening level see Section 6.2.4).

Acenaphthene occurs as a byproduct of incomplete combustion and is a chemical associated with creosote used for wood preservation (i.e., pilings). The two wells where acenaphthene concentrations exceeded groundwater screening levels (MW-3D, and MW16) were found to contain significant fill material, including wood and trash debris. Acenaphthene contaminants found in these locations may originate from buried treated wood and/or the fill material (including trash/burn debris and LDW dredge spoils) used on the Property.

- **Fluorene:** Figure 11-10 (and supplemental Figure 11-10a) shows the distribution of fluorene in soil across the Site. The MTCA Method B (Non-Cancer) screening level of 3,200 mg/kg has been used for the Site. Fluorene concentrations did not exceed the selected screening level in any soil samples. However, fluorene has been included as a soil COPC due to the presence of elevated concentrations in groundwater that exceed the selected groundwater screening level.

  Fluorene also occurs as a byproduct of incomplete combustion and is a chemical associated with creosote used for wood preservation (i.e., pilings). The three wells where fluorene concentrations exceeded groundwater screening levels (MW-2D, MW-3D, and MW16) were found to contain significant fill material, including wood and trash debris. Fluorene contaminants found in these locations may originate from buried treated wood and/or the fill material (including trash/burn debris and LDW dredge spoils) used on the Property.

- **Bis(2-ethylhexyl)phthalate:** Figure 11-11 (and supplemental Figure 11-11a) shows the distribution of bis(2-ethylhexyl)phthalate in soil across the Site. The MTCA Method B (Cancer) screening level of 71.4 mg/kg has been used for the Site. Bis(2-ethylhexyl)phthalate concentrations did not exceed the selected screening level in any soil samples. However, bis(2-ethylhexyl)phthalate has been included as a soil COPC due to the presence of elevated concentrations in groundwater that exceed the selected groundwater screening level.

  Bis(2-ethylhexyl)phthalate is ubiquitous in the environment and is a common artifact of sampling and analysis procedures due to its use in plastics. Bis(2-ethylhexyl)phthalate can be found in the materials used for laboratory and sampling equipment, monitoring wells, plastic debris in landfills or junkyards, as well as non-plastic goods such as inks, adhesives, coatings, pesticides, and cosmetics (Wisconsin DNR, 2002).

No specific onsite releases of Bis(2-ethylhexyl)phthalate are known at this time and concentrations detected during sampling may likely originate from sampling and analysis procedures.

- **Pentachlorophenol:** Figure 11-12 (and supplemental Figure 11-12a) shows the distribution of pentachlorophenol in soil across the Site. The MTCA Method B (Cancer) screening level of 2.50 mg/kg has been used for the Site. Pentachlorophenol was only detected in one soil sample from well MW06 (at a depth of six feet) at a concentration exceeding the selected soil-screening level.

  Pentachlorophenol was a common pesticide, preservative, and disinfectant from the 1950s to the 1980s. It was commonly used to treat wood and can be released into the environment directly from pentachlorophenol-treated products. A concrete pad exists in the area of well MW06 and is generally used for the storage of metal and other materials. In addition, the area previously was used as an equipment-wash area. The source of pentachlorophenol is unknown, but potentially was released from stored treated-wood materials in the area.

6.1.4.4 Carcinogenic Polycyclic Aromatic Hydrocarbons

When establishing soil screening levels for the protection of human health, MTCA specifies that cPAH mixtures (includes the compounds benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene)shall be considered a single hazardous substance (WAC 173-340-708). Using the procedures outlined in WAC 173-340-708, toxicity equivalency quotients (TEQs) were calculated for each sample, with the corresponding result compared to the most conservative screening level for benzo(a)pyrene. For the purposes of this section, "cPAH" is used to indicate the TEQ values calculated for each sample.

- **Carcinogenic PAH (cPAH):** Figure 11-13 (and supplemental Figure 11-13a) shows the distribution of cPAHs in soil across the Site. The MTCA Method B (Cancer) screening level of 0.137 mg/kg has been used. The cPAHs are distributed north to south across the Site. Most of the cPAH-contaminants in soil are located on the west half of the Property, adjacent to the LDW, and within 15 feet of ground surface.

  The cPAHs are ubiquitous contaminants in the environment. Sources of cPAHs include burning of fossil fuels and other material (i.e., wood or trash), oil spills, and wood preservatives (e.g., creosote). In addition, several studies have shown that particulate matter created by the erosion of asphalt pavement and sealants can produce concentrations exceeding screening levels (Simon & Sobieraj, 2006). Based on the widespread distribution across the Site and the common presence of cPAHs in LDW sediment and dredge material, cPAH contaminants in soil at the Site are likely associated with fill material used on the Property (including LDW-dredge spoils). Onsite sources could include oil spills/leaks, the burning of wood/materials, and/or the use or storage of treated wood.

6.1.4.5 Petroleum Hydrocarbon

For the purposes of this RI Report, petroleum contaminants have been compared to MTCA Method A and Method B cleanup levels, as well as criteria protective of the wildlife receptors (TEE screening levels).

- **Diesel Range Organics:** Figure 11-14 (and supplemental Figure 11-14a) shows the distribution of DRO contaminants in soil across the Site. The MTCA Method A screening level of 2,000 mg/kg has been used for the Site. DRO concentrations only exceeded the soil screening level in two locations, B3-R and B5, located in the west-central portion of the Site. Low-level concentrations below the soil screening level were present in soils, predominantly in the top five feet. Concentrations also were detected in deeper soils (depths of 10 to 20 feet) in several locations, mostly along the west boundary of the Property.

  Petroleum contaminants generally are associated with leaks and/or spills from vehicles, equipment, aboveground storage tanks, and underground storage tanks. Due to the amount of equipment and vehicle traffic, petroleum contaminants, especially found near the ground surface, likely originate from surface leaks from equipment and vehicle use on the Property.

- **Oil Range Organics:** Figure 11-15 (and supplemental Figure 11-15a) shows the distribution of ORO contaminants in soil across the Site. The MTCA Method A screening level of 2,000 mg/kg has been used. ORO concentrations exceeded the soil screening level in several locations, with all exceedances occurring within the 15 feet of the ground surface. Additionally, low-level concentrations (below the soil screening level) were found in a majority of boring locations across the Site at depths between the ground surface and 10 feet.

  Again, petroleum contaminants generally are associated with leaks and/or spills from vehicles, equipment, aboveground storage tanks, and underground storage tanks. Due to the amount of equipment and vehicle traffic, petroleum contaminants, especially found near the ground surface, likely originate from surface leaks from equipment and vehicle use on the Property.

6.2 Groundwater

Information regarding groundwater-exposure pathways, potential receptors, screening levels, and COPCs is presented below.

6.2.1 Groundwater Conceptual Site Model

The primary source of groundwater contaminants at the Site is leachate from contaminated soil. Site contaminants can be transported from the source areas and distributed by dispersive (solution) and advective (movement) transport mechanisms within the saturated zone. Capillary and adsorption forces also are present at and above the water table, causing contaminants to be retained in and onto fine-grain soils located above and below the saturated zone. These forces are affected by factors such as soil grain size, soil permeability, soil porosity, sorption/retardation characteristics of the soil, the volume of the release, and biodegradation of the contaminants.

Potential transport/secondary release mechanisms from contaminated groundwater include groundwater discharge into the adjacent LDW surface/river water and contaminant volatilization into soil gas. Per the criteria outlined in WAC 173-340-720(2), groundwater in the area of the Site is not a viable source of drinking water for people and can be considered non-potable. Specifically, the groundwater at the Property is not a viable source of drinking water based on the following criteria:

- WAC 173-340-720(2)(a): Groundwater at the Property does not serve as a current source of drinking water.
- WAC 173-340-720(2)(b): Groundwater at the property is not a potential future source of drinking water due to high concentrations of total dissolved solids (TDS) in samples collected from onsite wells. Specifically, samples collected from six of the onsite wells contain TDS concentrations greater than 500 mg/L (the USEPA drinking water standard for drinking water).
- WAC 173-340-720(2)(c): Based on the proximity to the LDW and groundwater-flow gradients at the Site, groundwater at the Property eventually flows into the LDW (which is not classified as a domestic water supply). Therefore, it is unlikely that hazardous substances will be transported from the Property to a current or potential future source of drinking water.

- WAC 173-340-720(2)(d): Groundwater on the Property also should be considered non-potable due to the Property's proximity to the LDW (a surface water body not used as a domestic water supply), the known points of entry of groundwater into the LDW (i.e., seeps), and the hydraulic connectivity between the groundwater and LDW surface/river water at the Site (as shown in G-Logics *Tidal Influence Study*).

Because of these reasons, there are no primary groundwater-exposure pathways at the Site.

Secondary-exposure pathways include groundwater discharge into the LDW surface/river water, surface water to LDW sediment, ingestion of edible fish/biota by subsistence and recreational users, direct contact for utility workers, and vapor intrusion of soil gas into overlying buildings. Current potential receptors of groundwater COPCs include LDW plant/animal life, subsistence users, and recreational users.

6.2.2 Groundwater Screening Levels

Under the guidance of Ecology and due to the potential for groundwater discharge into the LDW, detected groundwater-contaminant concentrations have been compared to surface-water cleanup levels presented in Ecology's CLARC website. These criteria are listed below.

- MTCA Method B Non-Cancer and Cancer cleanup levels.
- MTCA Method C Non-Cancer and Cancer cleanup levels.
- Aquatic Life, Marine/Acute, WAC 173-201A.
- Aquatic Life, Marine/Acute, National Toxics Rule (NTR) 40 Code of Federal Regulations (CFR) 131.
- Aquatic Life, Marine/Acute, Clean Water Act (CWA) 304.
- Aquatic Life, Marine/Chronic, WAC 173-201A.
- Aquatic Life, Marine/Chronic, NTR 40 CFR 131.
- Aquatic Life, Marine/Chronic, CWA 304.
- Human Health, Marine Waters, WAC 173-201A.
- Human Health, Marine Waters, NTR 40 CFR 131.
- Human Health, Marine Waters, CWA 304.

Groundwater-screening levels for the Site are listed in Table 2-1. These screening levels are described to be protective of human direct contact/ingestion and ecological receptors at the Site. The most conservative values (a.k.a., the lowest value) of the screening criteria have been used as the screening level for each contaminant.

For this Site, the analytical laboratories generally were able to achieve PQLs/MDLs that were below the most conservative screening levels for all analytes. However, the laboratory was unable to achieve sufficiently low PQLs/MDLs for several analytes (i.e., several PCB Aroclors and cPAHs), as indicated in Tables 2-1 through 2-9. These analytes and the respective sampling events also have been flagged in the groundwater-analytical tables.

6.2.3 Groundwater Contaminants of Potential Concern

The list of contaminants of potential concern was developed by comparing groundwater analytical results to the following criteria (also presented in Table 2-1). All analytical data collected from the Site has been used for the following review.

- Exceedance factors (contaminant concentration over screening level) were calculated using the highest detected groundwater concentration for each contaminant. Contaminants with an exceedance factor greater than two (i.e., two times the screening level) were considered for the COPC list.
- The lateral extent of contaminants was considered when developing the COPC list. For groundwater screening-level exceedances, the sum of "different locations" was compared to the total number of well locations located at the Site. "Different locations" only includes different well locations where groundwater screening levels were exceeded and not different sampling events within the same well. Contaminants were considered for the COPC list if the number of different locations was greater than two.
- For each contaminant, the total number of groundwater samples with screening-level exceedances was compared to the total number of analyzed samples. Contaminants were considered for the COPC list if this ratio was greater than five percent.

If the all three above criteria are exceeded, the suspect contaminant has been included in the final COPC list. In addition, if the detected concentration for a contaminant in any single sample was greater than 10 times the selected screening level, the contaminant also was included in the COPC list.

The list of COPCs, as defined above, is summarized in Table 2-1a. The nature and extent of each identified contaminant is summarized in the following section.

6.2.4 Nature and Extent of Groundwater Contaminants

Isoconcentration-contour maps representing the interpreted extent of groundwater COPCs have been shown on the figures specified below. Between one and four isoconcentration-contour maps have been included for each COPC to present concentrations during different sampling events (sampling dates specified on each map).

Data collected during the most recent sampling events (December 2015, April 2016, and September 2016) were used to assess the current nature and extent of contaminants at the Site. If concentrations did not exceed applicable screening levels during these sampling events, historical data collected between 2002 and 2008 were used. Figures were not produced for sampling events with no groundwater screening-level exceedances. Additionally, where well-clusters exist (i.e., MW09 and MW09D), the higher contaminant concentration between the two locations were used for the isoconcentration contours. This approach was used due to the proximity of the well locations and the skewing of contours when significantly different concentrations were present between the shallow and deep samples.

Data collected from upgradient wells MW09, MW09D, MW10, MW10D, and MW15 (located near the eastern boundary of the Property) also were used to interpret the nature of onsite contamination and potential contributions from neighboring properties. These wells are collectively known as the "upgradient wells" in the following COPC sections.

Supplemental Figures 12a, 12b, and 12c also have been included in Appendix L to present summary tables with analytical data for selected COPCs. The interpreted nature and extent of each groundwater COPC are presented below.

6.2.4.1 Metals

- **Arsenic:** Figure 12-1 shows the distribution of arsenic in groundwater across the Site. The MTCA Method B (Cancer) screening level of 0.098 µg/L has been used for the Site. Arsenic concentrations exceeding the selected screening level were detected in every groundwater sample collected at the Site. In general, the highest total arsenic concentrations were found in wells MW07, MW12, and MW13.

The distribution of arsenic in soil is similar to that in groundwater and is likely the source of elevated arsenic concentrations in groundwater. Concentrations in upgradient wells do not indicate a significant offsite source contributing to arsenic in groundwater.

- **Copper:** Figure 12-2 shows the distribution of copper in groundwater across the Site. The screening level of 3.10 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Detected copper concentrations varied greatly between sampling events. Screening-level exceedances of copper could be a result of leaching from soil in areas with elevated copper concentrations (i.e., B7, GLB02, and MW12).

  Movement of the contaminant and fluctuations in concentrations could result from seasonal variations in groundwater influx and the tide level at the time of sample collection. Because of the large temporal variations in groundwater concentrations, it is difficult to assess contributions from upgradient sources.

- **Lead:** Figure 12-3 shows the distribution of lead in groundwater across the Site. The screening level of 8.10 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Screening-level exceedances generally were isolated to the southwest portion of the Site near well MW14, with slight variances depending on the sampling date.

  Based on the distribution and the locations of the highest lead concentrations in soil, lead-impacted groundwater does not appear to be a direct result of leaching from on-Property sources. However, due to the complex nature of groundwater flow in the tidally-influenced areas of the Site, it is difficult to predict contaminant movement and distinguish between on and off-property sources (from the LDW). Lead concentrations in groundwater do not appear to originate from upgradient sources.

- **Mercury:** Figure 12-4 shows the distribution of mercury in groundwater across the Site in March 2002. The screening level of 0.025 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). During the 2015 and 2016 sampling events, concentrations of total mercury did not exceed the selected screening level.

  Samples collected from the upgradient wells do not suggest a significant upgradient source of mercury in groundwater. However, based on the sporadic nature of mercury in soil and the lack of screening-level exceedances during the most recent groundwater-sampling events, mercury does appear to be originating from contaminated LDW dredge material and sediment located within the LDW. Mercury concentrations in groundwater do not appear to originate from on-Property sources.

- **Nickel:** Figure 12-5 shows the distribution of nickel in groundwater across the Site. The screening level of 8.20 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Similar to copper, detected nickel concentrations varied greatly between sampling events. In addition, screening-level exceedances in groundwater do not correlate well with locations of elevated nickel concentrations in soil.

  Based on the sporadic nature and the locations of detected concentrations, nickel could be originating from contaminated river water from the LDW infiltrating onto the Site during high tide in the LDW. Nickel concentrations in groundwater may originate from on-Property or upgradient sources, however, no known sources of nickel contaminants have been identified.

- **Zinc:** Figure 12-6 shows the distribution of zinc in groundwater across the Site. The screening level of 81.0 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Detected zinc concentrations varied greatly between sampling events in several areas of the Site. Screening-level exceedances of zinc in most areas of the Site could be resultant of leaching from soil in areas with elevated zinc concentrations (i.e., B3-R and MW12). Movement of the contaminants and fluctuations in concentrations could result from seasonal variations in groundwater influx and the tide level at the time of sample collection.

  Screening-level exceedances did occur consistently in groundwater collected from well MW14. However, no obvious sources (from soil or other sources) are present in this area and zinc concentrations found in well MW14 may be attributable to off-property sources from the LDW. In addition, zinc concentrations in groundwater do not appear to originate from upgradient sources.

6.2.4.2 Polychlorinated Biphenyls

Similar to soils, screening levels for Total PCB Aroclors and Total PCB Congeners (summation of all PCB Aroclors and Congener concentrations, respectively, within a sample) have been used to compare detected groundwater concentrations at the Site. The selected screening level for PCBs is significantly lower than the laboratory PQLs and MDLs. Because of this, laboratory reporting limits have been used for Figures 12-7a and 12-7b.

- **Total PCBs:** Figures 12-7a and 12-7b show the distribution of PCB Aroclors and Congeners, respectively, in groundwater across the Site. The screening level of 7×10^{-6} µg/L (for both Aroclors and Congeners) is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Detectable concentrations of PCB Aroclors were only found in wells MW2 and MW4 during a March 2002 groundwater sampling event (conducted by Farallon).

PCB Aroclors were not detected in any of the subsequent sampling events on the Property. Additionally, Ecology conducted a PCB Congener study in 2017 and sampled three wells on the Property (MW08, MW10, and MW16). PCBs were detected in groundwater collected from all three wells above the PCB screening level.

Based on the locations with screening-level exceedances, PCB concentrations in groundwater may be attributed to leaching of PCBs from on-Property soils.

6.2.4.3 Semivolatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

- **Acenaphthene:** Figure 12-8 shows the distribution of acenaphthene in groundwater across the Site. The screening level of 30.0 µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Screening-level exceedances occurred consistently in groundwater collected from well MW16. These concentrations may be attributed to leaching from on-Property soils that contain treated wood and/or burn debris.

- **Fluorene:** Figure 12-9 shows the distribution of fluorene in groundwater across the Site. The screening level of 10.0 µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Screening-level exceedances of fluorene contaminants, like acenaphthene, occurred consistently in groundwater collected from well MW16. Fluorene also may be attributed to leaching from on-Property soils that contain treated wood and/or burn debris.

- **Bis(2-ethylhexyl)phthalate**: Figure 12-10 shows the distribution of bis(2-ethylhexyl)phthalate in groundwater across the Site. The screening level of 30.0 µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Concentrations exceeding the selected screening level were detected in every groundwater sample collected at the Site during the April and September 2016 sampling events. Bis(2-ethylhexyl)phthalate also was detected in the associated laboratory method blanks that were analyzed during the April 2016 event, thus data from this sampling event was not used for comparison purposes.

Again, bis(2-ethylhexyl)phthalate is ubiquitous in the environment due to its use in plastics (California Office of Environmental Health Hazard Assessment, 2009) and is a common artifact of sampling procedures due to its presence in sampling equipment and tubing (Wisconsin Department of Natural Resources, 2002). Bis(2-ethylhexyl)phthalate concentrations detected during sampling likely are attributed to this fact.

- **Pentachlorophenol:** Figure 12-11 shows the distribution of pentachlorophenol in groundwater across the Site. The screening level of 0.0020 µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Because the laboratory MDL was greater than the selected screening level, any detection of pentachlorophenol in groundwater was above the selected screening level. Concentrations exceeding the screening level only were detected in groundwater collected from well MW06 (which also is the only location with soil exceedances). Pentachlorophenol concentrations in groundwater likely are attributed to leaching from nearby impacted soils. Based on the analytical data, upgradient sources are not likely contributing to the elevated concentrations in onsite groundwater.

6.2.4.4 Carcinogenic Polycyclic Aromatic Hydrocarbons

All analyzed cPAH compounds (benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene) were detected in one or more groundwater samples collected at the Site. Benzo(a)anthracene and chrysene were the most prevalent cPAH contaminants detected during the explorations and generally were detected concurrent to other less-prevalent compounds. Because of this, benzo(a)anthracene and chrysene were used as indicator compounds to represent the distribution and relative concentrations of all cPAH compounds.

- **Benzo(a)anthracene and Chrysene:** Figures 12-12 and 12-13 show the distribution of benzo(a)anthracene and chrysene, respectively, in groundwater across the Site. The screening levels for benzo(a)anthracene and chrysene, 1.60×10^{-4} and 0.016 µg/L, respectively, are based on the Human Health criteria for marine waters (NTR 40 CFR 131). Screening-level exceedances occurred consistently along the southwest Property boundary and adjacent to the LDW (wells MW14 and MW16).

  Due to the widespread distribution of cPAH contaminants in soil, concentrations of benzo(a)anthracene and chrysene (as well as other cPAH compounds) in groundwater likely are attributed to leaching from onsite impacted soils. Based on the analytical data, upgradient sources are not likely contributing to elevated concentrations in onsite groundwater.

6.2.4.5 Petroleum Hydrocarbon

- **Diesel Range Organics:** Figure 12-14 shows the distribution of DRO in groundwater across the Site. The screening level for DRO is 500 µg/L and is based on MTCA Method A criteria. Screening-level exceedances occurred consistently along the west-southwest Property boundary and adjacent to the LDW (specifically wells MW14 and MW16). Based on the distribution of DRO in soil, concentrations in groundwater may be attributed to leaching from onsite impacted soils. Based on the analytical data, upgradient sources are not likely contributing to elevated concentrations in onsite groundwater.

- **Oil Range Organics:** Figure 12-15 shows the distribution of ORO in groundwater across the Site. The screening level for ORO is 500 µg/L and is based on MTCA Method A criteria. Screening-level exceedances occurred consistently in the southwest portion of the Property (wells MW13 and MW 14) and variably in nearby wells (wells MW05 and MW12). Based on the distribution of ORO in soil, some concentrations found in groundwater may be attributed to leaching from onsite impacted soils. However, a majority of ORO-impacted soil is located in the northern half of the Property. Based on the analytical data, upgradient sources are not likely contributing to elevated concentrations in onsite groundwater.

6.3 Riverbank and LDW Sediment

Information regarding riverbank sediment-exposure pathways, potential receptors, screening levels, and COPCs is presented below. Due to the potential for erosion and direct discharge into the LDW, riverbank samples collected by Pacific Crest Environmental and SoundEarth Strategies have been compared to sediment-cleanup standards, irrespective of their elevation compared to the LDW MHHW level. In addition, sediment data for sampling locations within the LDW, and adjacent to the Property, have been included in this report for comparison purposes.

6.3.1 Sediment Conceptual Site Model

Potential sources of riverbank sediment contamination at the Site include 1) surface leaks/spills from current and/or historical Site operations directly to riverbank sediment, 2) contaminated upland surface-water sheet flow, 3) contaminated upland surface soil erosion, and 4) contaminated stormwater discharges. Potential transport/secondary release mechanisms from contaminated sediment include leaching to surface water and riverbank-sediment erosion into the adjacent LDW.

Exposure pathways include direct/dermal contact, incidental ingestion by humans/edible fish/biota, and the ingestion of fish/biota by subsistence and recreational users. Current potential receptors of sediment COPCs include LDW plant/animal life, subsistence users, and recreational users.

6.3.2 Riverbank Sediment Screening Levels

Under the guidance of Ecology, detected sediment-contaminant concentrations have been compared to the following cleanup and screening levels:

- Apparent Effects Threshold (AET), Sediment Cleanup Objective (SCO) for Benthic Criteria in Marine Sediment, Sediment Management Standards (SMS) WAC 173-204.
- AET, Cleanup Screening Level for Benthic Criteria in Marine Sediment, SMS WAC 173-204.
- LDW Sediment Cleanup Level for Benthic Invertebrate, Most Conservative Value of the LDW-Wide Remedial Action Objectives (RAOs) 3, Table 20 from USEPA Record of Decision (2014a).

Generally, the AET "sediment cleanup objective" screening levels for an analyte are more conservative (lower concentrations) than the respective AET "cleanup screening levels". Riverbank sediment screening levels for the Site are listed in Table 3-1. These screening levels are described to be protective of benthic invertebrates in the LDW. For this Site, the most conservative values (a.k.a., the lowest value) of the three screening criteria will be used as the screening level for each contaminant. The analytical laboratories generally were able to achieve PQLs/MDLs that were below the most conservative screening levels for all analytes.

6.3.3 Sediment Contaminants of Potential Concern

The list of contaminants of potential concern was developed by comparing sediment analytical results to the following criteria (as presented in Table 3-1).

- Exceedance factors (contaminant concentration over screening level) were calculated using the highest detected sediment concentration for each contaminant. Contaminants with an exceedance factor greater than two (i.e., two times the screening level) were considered for the COPC list.
- The lateral extent of contamination was considered when developing the COPC list. For sediment screening-level exceedances, the sum of "different locations" was compared to the total number of sampling locations at the Site. "Different locations" only includes different sampling locations where

sediment screening levels were exceeded and not different depths at the same point. Contaminants were considered for the COPC list if the number of different locations was greater than two.

If both of the two listed criteria are exceeded, the suspect contaminant has been included in the final COPC list. In addition, if the detected concentration for a contaminant in any single sample was greater than 10 times the selected screening level, the contaminant also was included in the COPC list.

The list of COPCs, as defined above, is summarized in Table 3-1a. The nature and extent of each identified COPC contaminant is summarized in the following section.

6.3.4 Nature and Extent of Sediment Contaminants

Locations with screening-level exceedances of sediment COPCs have been shown on the figures specified below. The figures have been depicted as dot distribution-choropleth maps (graduated dot sizes and a color progression represent increasing concentration ranges) to indicate the highest contaminant concentrations at each sampling location. Soil data from borings/wells located adjacent to the Property's riverbank have been included for comparison purposes. Additionally, sediment data from nearby samples collected within the LDW (from locations up to approximately 250 feet from the Property shoreline) have been included for comparison purposes. Details regarding the interpreted nature and extent of each riverbank sediment COPC are presented below.

6.3.4.1 Metals

- **Copper:** Figure 13-1 shows the distribution of copper in sediment across the Site. The screening level of 390 mg/kg is based on the Benthic criteria SCO (WAC 173-204). Screening-level exceedances of copper in sediment occurred in only two locations, RB06-02 and RB07-02. Screening-level exceedances of copper in LDW sediment were not present in samples collected from nearby locations. Based on the limited distribution in collected sediment samples, copper contaminants may have originated from previous outfall discharges (including the Michigan St CSO) in the area.

- **Mercury:** Figure 13-2 shows the distribution of mercury in sediment across the Site. The screening level of 0.410 mg/kg is based on the Benthic criteria SCO (WAC 173-204). Screening-level exceedances of mercury in sediment occurred in only two locations, RB06-02 and RB09-01. Screening-level exceedances of mercury in LDW sediment were not present in samples collected from nearby locations. Based on the limited and sporadic distribution in collected sediment samples, the specific source(s) of mercury potentially could be resultant of outfall discharges (including the Michigan St CSO), dumping in the area, or another unknown source..

6.3.4.2 Polychlorinated Biphenyls

When establishing sediment screening levels for the protection of human health, MTCA specifies that PCB mixtures shall be considered a single hazardous substance (WAC 173-340-708). The *Sediment Management Standards* (WAC 173-204) present screening levels for Total PCBs (summation of all PCB Aroclors and/or Congener concentrations within a sample) that have been used for the DMC Site.

- **Total PCBs:** Figure 13-3 shows the distribution of total PCB Aroclors in sediment across the Site (PCB Congeners were not analyzed in riverbank sediment during exploration work performed on the Property). The screening level of 0.130 µg/L was based on the Benthic criteria SCO (WAC 173-204). Sediment-sample locations with screening-level exceedances are widespread across the Site and the LDW. The highest concentrations of PCBs at the Site were detected in samples RB06-02, RB09-02, and RB11-2.

  Based on the common presence of PCBs in riverbank and LDW sediment and the widespread distribution of screening-level exceedances, elevated concentrations could be associated with the LDW (outfall discharges and historical industrial processes).

6.4 Catch-Basin Sediment

Sediment traps are used in on-Property catch-basins to prevent high volumes of sediment from entering the stormwater-treatment system. Accumulated catch-basin sediment is removed periodically and disposed at an appropriate offsite facility. As described in Section 2.5 above, all on-Property catch-basins drain to a common sump (SWC1). Stormwater from this sump is then transferred to a treatment system prior to being discharged to the LDW (through outfall OUT1).

Information regarding catch-basin sediment exposure pathways, potential receptors, screening levels, and COPCs is presented below. Note: catch-basin identifications used by Pacific Crest in their 2009 RI report were relabeled by SoundEarth Strategies and subsequently adopted by G-Logics. Specifically, Pacific Crest catch basins labeled CB-1, CB-2, and CB-4 have been relabeled as CB04, CB05, and CB08 (as indicated in Tables 5-1 through 5-8).

6.4.1 *Catch-Basin Sediment Conceptual Site Model*

Potential sources of catch-basin sediment contaminants at the Site include 1) surface leaks/spills from current Site operations, 2) contaminated upland surface water/stormwater, and 3) contaminated surface soil. Potential transport/secondary release mechanisms from contaminated catch-basin sediment include leaching to stormwater and potential discharge to the LDW.

Exposure pathways include direct/dermal contact, incidental ingestion by humans/edible fish/biota, and the ingestion of fish/biota by subsistence and recreational users. Current potential receptors of catch-basin sediment COPCs include on-property workers. Secondary receptors (after potential discharge into the LDW) include LDW plant/animal life, subsistence users, and recreational users.

6.4.2 *Catch-Basin Sediment Screening Levels*

Under the guidance of Ecology, detected sediment-contaminant concentrations have been compared to the following cleanup and screening levels:

- Lower Screening Level for Storm Drain Solids, Appendix D, Ecology Lower Duwamish Waterway, Guidance for Stormwater Source Control Evaluations at Upland Sites (Ecology, 2015)
- Upper Screening Level for Storm Drain Solids, Appendix D, Ecology Lower Duwamish Waterway, Guidance for Stormwater Source Control Evaluations at Upland Sites (Ecology, 2015).

Catch-basin sediment screening levels for the Site are listed in Table 5-1. These screening levels are based on Sediment Cleanup Objectives presented in Section 173-204 WAC, Ecology's *Sediment Management Standards*. For this Site, the Upper Screening Levels will be used for each contaminant. The analytical laboratories generally were able to achieve PQLs/MDLs that were below the most conservative screening levels for all analytes.

6.4.3 *Catch-Basin Sediment Contaminants of Potential Concern*

The list of contaminants of potential concern was developed by comparing sediment analytical results to the following criteria (as presented in Table 5-1).

- Exceedance factors (contaminant concentration over screening level) were calculated using the highest detected sediment concentration for each contaminant. Contaminants with an exceedance factor greater than two (i.e., two times the screening level) were considered for the COPC list.

- For sediment screening-level exceedances, the sum of “different locations” was compared to the total number of sampling locations at the Site. “Different locations” only includes different sampling locations where sediment screening levels were exceeded and not different depths at the same point. Contaminants were considered for the COPC list two or more locations had screening-level exceedances.

If both criteria are exceeded, the suspect contaminant has been included in the final COPC list. In addition, if the detected concentration for a contaminant in any single sample was greater than 10 times the selected screening level, the contaminant also was included in the COPC list.

The list of COPCs, as defined above, is summarized in Table 5-1a. The nature and extent of each identified COPC contaminant is summarized in the following section.

6.4.4 Nature and Extent of Catch-Basin Sediment Contaminants

Locations with screening-level exceedances of catch-basin sediment COPCs have been shown on the figures specified below. The figures have been depicted as dot distribution-choropleth maps (graduated dot sizes and a color progression represent increasing concentration ranges) to indicate the highest contaminant concentrations at each sampling location. Details regarding the interpreted nature and extent of each catch-basin sediment COPC are presented below.

6.4.4.1 Semivolatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

- **Bis(2-ethylhexyl)phthalate:** Figure 14-1 shows the locations with screening-level exceedances of bis(2-ethylhexyl)phthalate in catch-basin sediment across the Site. The Upper Screening Level for Storm Drain Solids of 1.90 mg/kg has been used for the Site. Sediment from catch basins CB03 and CB12 contained the highest concentrations of bis(2-ethylhexyl)phthalate. Again, bis(2-ethylhexyl)phthalate is ubiquitous in the environment, as well as a common artifact of sampling and laboratory-analysis procedures, due to its use in plastics.

- **Fluoranthene:** Figure 14-2 shows the locations with screening-level exceedances of fluoranthene in catch-basin sediment across the Site. The Upper Screening Level for Storm Drain Solids of 2.50 mg/kg has been used for the Site. Only two locations, CB04 and SWC1, contained concentrations greater than the applicable screening level. Fluoranthene, like fluorene, can originate from treated wood and also is released during the burning of fossil fuels or wood.

Due to the high volume of equipment and vehicle traffic across the Site, fluoranthene could be associated with small leaks and potentially from vehicle/equipment emissions.

6.5 Stormwater

Two outfalls exist on the DMC Property: OUT1, which discharges effluent from the onsite stormwater treatment system, and OUT2, which discharges effluent from catch basin CB14 (located on the north-adjacent property). In addition, the Michigan St CSO is located just to the south of the Property. For comparison purposes, analytical data from outfall OUT2 and the Michigan St Regulator (upstream of the Michigan St CSO) have been included on the associated tables and figures. However, because the contributing catch basins for OUT2 and the Michigan St CSO are located off-Property, the following sections do not apply to these outfalls.

Because stormwater samples have been collected at the point of discharge into the LDW, COPC concentrations have been compared to surface-water standards. Information regarding stormwater-exposure pathways, potential receptors, screening levels, and COPCs is presented below.

6.5.1 Stormwater Conceptual Site Model

Potential sources of stormwater contaminants at the Site include 1) surface leaks/spills from current Site operations entering the stormwater system through catch basins, 2) contaminated-upland surface water/stormwater entering the stormwater system through catch basins, 3) contaminated surface soil erosion and entering the stormwater system through catch basins, 4) contaminated catch-basin sediment, and 5) contaminated soil entering the stormwater system through joints and/or cracks in the piping. Potential transport/secondary release mechanisms from contaminated stormwater include the potential discharge to the LDW surface water and sediment.

Exposure pathways include direct/dermal contact, incidental ingestion by humans/edible fish/biota, and the ingestion of fish/biota by subsistence and recreational users. Current potential receptors of stormwater COPCs include on-property workers. Secondary receptors (after potential discharge into the LDW) include LDW plant/animal life, subsistence users, and recreational users.

6.5.2 Stormwater Screening Levels

Detected stormwater-contaminant concentrations have been compared to surface-water cleanup levels, as presented in Ecology's CLARC website. These criteria are listed below.

- MTCA Method B Non-Cancer and Cancer cleanup levels.
- MTCA Method C Non-Cancer and Cancer cleanup levels.
- Aquatic Life, Marine/Acute, WAC 173-201A.
- Aquatic Life, Marine/Acute, NTR 40 CFR 131.
- Aquatic Life, Marine/Acute, CWA 304.
- Aquatic Life, Marine/Chronic, WAC 173-201A.
- Aquatic Life, Marine/Chronic, NTR 40 CFR 131.
- Aquatic Life, Marine/Chronic, CWA 304.
- Human Health, Marine Waters, WAC 173-201A.
- Human Health, Marine Waters, NTR 40 CFR 131.
- Human Health, Marine Waters, CWA 304.

Stormwater screening levels for the Site are listed in Table 6-1. These screening levels are described to be protective of human direct contact/ingestion and ecological receptors at the Site. The most conservative values (the lowest value) of the screening criteria have been used as the screening level for each contaminant.

For this Site, the analytical laboratories generally were able to achieve PQLs/MDLs that were below the most conservative screening levels for all analytes. However, the laboratory was unable to achieve sufficiently low PQLs/MDLs for several analytes (i.e., several PCB Aroclors and cPAHs), as indicated in Tables 6-1 through 6-8. These analytes and the respective sampling events also have been flagged in the groundwater-analytical tables.

6.5.3 Stormwater Contaminants of Potential Concern

The list of contaminants of potential concern was developed by comparing stormwater-analytical results from outfall OUT1 to the following criteria (also presented in Table 6-1). All analytical data collected from the Site has been used for the following review.

- Exceedance factors (contaminant concentration over screening level) were calculated using the highest detected groundwater concentration for each contaminant. Contaminants with an exceedance factor greater than two (i.e., two times the screening level) were considered for the COPC list.

- For each contaminant, the total number of stormwater samples with screening-level exceedances was compared to the total number of analyzed samples. Contaminants were considered for the COPC list if there were more than two screening-level exceedances.

If both criteria are exceeded, the suspect contaminant has been included in the final COPC list. In addition, if the detected concentration for a contaminant in any single sample was greater than 10 times the selected screening level, the contaminant also was included in the COPC list. The list of COPCs, as defined above, is summarized in Table 6-1a. The nature and extent of each identified contaminant is summarized in the following section.

6.5.4 Nature and Extent of Stormwater Contaminants

Screening-level exceedances of stormwater COPCs have been shown on Figures 15-1 and 15-2. The figures present the COPC analytical data for several stormwater sampling events conducted at outfall OUT1. Analytical results also have been presented for outfall OUT2 for comparison purposes. Details regarding the interpreted nature and extent of each stormwater COPC are presented below.

6.5.4.1 Metals

- **Arsenic:** The screening level of 0.098 µg/L is based on MTCA Method B (Cancer) criteria. Arsenic concentrations exceeding the most conservative screening level consistently were detected (five of the seven sampling events) in stormwater samples collected at the Site.

- **Copper:** The screening level of 3.10 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Copper concentrations in analyzed stormwater samples also consistently exceeded the most conservative screening level. Samples collected during all but one sampling event contained copper concentrations exceeding the applicable screening level.

- **Mercury:** The screening level of 0.025 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Detected concentrations of mercury varied greatly from each sampling event. Screening level exceedances of mercury were only detected in two of seven analyzed stormwater samples.

- **Nickel:** The screening level of 8.20 µg/L is based on the Aquatic Life criteria for marine waters (WAC 173-201A). Detected concentrations of nickel also varied greatly from each sampling event. Screening level exceedances of nickel were only detected in two of seven analyzed stormwater samples.

6.5.4.2 Polychlorinated Biphenyls

A screening level of 7×10^{-6} µg/L (Human Health criteria for marine waters, NTR 40 CFR 131) is used for Total PCB Aroclors and Total PCB Congeners (summation of all PCB Aroclors and Congener concentrations, respectively, within a sample). This screening level has been used to compare detected stormwater concentrations at the Site. The selected screening level for PCBs is significantly lower than the laboratory PQLs and MDLs. Screening-level exceedances of PCB Congeners were detected in outfall OUT1 during a February 2015 groundwater sampling event conducted by Ecology/Leidos. PCB Aroclor concentrations have not been detected in stormwater samples collected on the Property by Blue Environmental.

6.5.4.3 Semivolatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

- **Bis(2-ethylhexyl)phthalate:** The screening level of 0.046 µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Screening level exceedances of bis(2-ethylhexyl)phthalate were only detected in two of five analyzed stormwater samples.

- **Pentachlorophenol:** The screening level of 2.0×10^{-3} µg/L is based on the Human Health criteria for marine waters (NTR 40 CFR 131). Detected concentrations of pentachlorophenol varied greatly from each sampling event. Screening-level exceedances of pentachlorophenol were detected in three of six analyzed stormwater samples.

6.5.4.4 Carcinogenic Polycyclic Aromatic Hydrocarbons

All analyzed cPAH compounds (benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene) were detected in one or more stormwater samples collected at the Site. Concentrations of cPAHs varied greatly between sampling events. One or more of the cPAH compounds exceeded the most conservative screening levels in four of six analyzed stormwater samples. Screening levels for all cPAH compounds have been compared to Human Health criteria for marine waters (NTR 40 CFR 131). Please refer to Tables 6-1 and 6-1a for individual screening levels.

6.6 Potential Vapor Intrusion

Information regarding the potential for vapor intrusion, indoor-air exposure pathways, potential receptors, cleanup levels, and COPCs is presented below. The following assessment has been conducted in accordance with several documents produced by Ecology and the USEPA. These documents are listed below.

- *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Vapor Intrusion Guidance), Review Draft, Washington State Department of Ecology, October 2009, Revised February 2016, Publication Number 09-09-047
- *Implementation Memorandum No. 14: Updated Process for Initially Assessing the Potential for Petroleum Vapor Intrusion*, Washington State Department of Ecology, March 31, 2016
- *Implementation Memorandum No. 18: Petroleum Vapor Intrusion (PVI): Updated Screening Levels, Cleanup Levels, and Sampling Considerations, Washington State Department of Ecology,* August 7, 2017, Revised November 9, 2017
- *OSWER Technical Guide For Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, June 2015, Publication 9200.2-154
- *Technical Guide for Assessing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites*, U.S. Environmental Protection Agency, Office of Underground Storage Tanks, June 2015, Publication 510-R-15-001

6.6.1 Vapor Intrusion Conceptual Site Model

Certain contaminants have the potential to volatilize into subsurface soil-gas. Contaminants that are sufficiently volatile and are known/suspected to be toxic should be considered when assessing the exposure risks. Sources of soil gas contaminants at the Site include soil and/or groundwater that contain sufficiently volatile/toxic compounds. Soil gas can be transported through diffusion and advection (assuming subsurface pressure differences) and has the potential to migrate to indoor air via vapor intrusion.

The exposure pathway primarily consists of inhalation of contaminated vapors either from direct exposure to contaminated media (i.e., exposure during construction or excavation work in contaminated areas) or from exposure to contaminated indoor air (via vapor intrusion). Because direct exposure to subsurface soil gas is unlikely at the Site (i.e., no ongoing excavations for subsurface utility work), this report will focus on potential indoor air exposures via vapor intrusion. The current potential receptor of contaminated-vapor COPCs is the on-property workers.

6.6.2 Vapor Intrusion Screening Levels

During the initial “Tier I” vapor-intrusion assessment, Ecology allows for the use of groundwater analytical data (if groundwater is present) to evaluate the potential risk to indoor air (Ecology, 2009). A Tier I assessment focuses on whether subsurface contamination has the potential to contaminate indoor air in a nearby or overlying structure. Detected groundwater-contaminant concentrations have been compared to Method B groundwater screening levels for potential vapor intrusion, as presented in Ecology’s CLARC website. These criteria are listed below.

- MTCA Method B Non-Cancer, Groundwater Screening Level for Potential Vapor Intrusion.
- MTCA Method B Cancer, Groundwater Screening Level for Potential Vapor Intrusion.

Groundwater screening levels for potential vapor intrusion at the Site are listed in Table 7. These screening levels are described to be protective of human inhalation of indoor air at the Site. The most conservative values (a.k.a., the lowest value) of the screening criteria have been used as the screening level for each contaminant.

6.6.3 Vapor Intrusion Contaminants of Potential Concern

The list of contaminants of potential concern was developed by comparing groundwater-analytical results to the following criteria (also presented in Table 7). All analytical data collected from the Site has been used for the following review.

- For each contaminant, the total number of groundwater samples with vapor intrusion screening-level exceedances was compared to the total number of analyzed samples. Contaminants were considered for the COPC list if this ratio was greater than five percent.

If the above criteria are exceeded, the suspect contaminant has been included in the final COPC list. The list of COPCs, as defined above, is included in Table 7. The nature and extent of each identified contaminant is summarized in the following section.

6.6.4 Nature and Extent of Potential Vapor Intrusion

For this Site, naphthalene was the only contaminant that was found to present a possible vapor-intrusion risk. Because naphthalene is primarily found in association with petroleum hydrocarbons, guidelines regarding petroleum vapor intrusion (PVI) have been used to assess the nature and extent of naphthalene vapor intrusion.

Based on the petroleum vapor-intrusion guidance documents published by the United States Environmental Protection Agency (USEPA, 2015) and Ecology (Ecology, 2009, 2016, 2017), existing and/or future buildings located laterally and/or vertically within set distances of subsurface contamination may experience unacceptable vapor-intrusion impacts.

Based on the soil-vapor guidance documents, buildings that are laterally within 30 feet of subsurface petroleum contamination with groundwater concentrations above screening levels may experience unacceptable vapor-intrusion impacts. This distance is referred to as the lateral-inclusion zone and is defined as the area surrounding a petroleum-contaminant source through which vapor-phase contamination might travel and intrude into buildings at unacceptable concentrations.

The lateral distance to subsurface contamination should first be identified to assess if a building or buildings are within the lateral-inclusion zone. If existing or planned buildings are not in the lateral inclusion zone (30 feet), then the initial PVI assessment process is finished and the pathway is incomplete. Specifically, a 30-foot horizontal separation distance from the edge of the contamination to a structure is likely to provide an adequate separation distance to exclude vapor intrusion concerns. Figure 16 presents locations with exceedances of vapor-intrusion screening levels for naphthalene in groundwater at the Site. This figure also presents a 30-foot radius circle around locations with screening-level exceedances of naphthalene. As can be seen on the figure, locations with screening-level exceedances are located along the western boundary of the Site. No exceedances occurred within 30 feet of an occupied structure, therefore the vapor-intrusion pathway is not complete at the Site.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Environmental-investigation work has been ongoing at the Site since 2000. After conducting Phase I and Phase II investigations, an interim action was conducted in 2002 to excavate lead-contaminated soils. A 2004 Phase II investigation determined that additional contaminants existed on the Property and an RI report completed by Pacific Crest Environmental in 2008 stated that data gaps remained at the Site. In 2011, Ecology determined in the Agreed Order that a more comprehensive RI was required.

To address data gaps identified by Ecology and comply with the Agreed Order, SoundEarth Strategies and G-Logics completed additional exploration and sampling work on the Property. This work has been completed with the objectives to close the previously-identified data gaps, characterize the nature and extent of Site contaminants, and assess exposure risks and pathways to human health and the environment. The data included in this RI report includes both "historical" data (data collected prior to 2011) and "new" data (data collected between 2011 and 2018) collected during various explorations at the Site and the adjacent LDW. The following sections summarize Ecology's identified data gaps, as well as G-Logics findings, conclusions, and recommendations for the Site.

7.1 Data Gaps Identified by Ecology

Ecology prepared an opinion letter dated August 11, 2009 in response to the RI report that was prepared by Pacific Crest Environmental (dated May 11, 2009). It was Ecology's opinion that the lateral and vertical extent of contamination in soil, groundwater, and sediment at the Site was not sufficiently delineated. Additionally, the RI was not sufficient to establish cleanup levels or develop cleanup actions alternatives. Ecology identified the following data gaps in their August 2009 letter:

- Natural conditions at the Site and surrounding areas, including geology, surface water, groundwater, and natural resources, were not presented in the RI report.
- "The lateral and vertical extent of contaminants in soil and groundwater is not presented in sufficient detail to understand distributions across the property". Ecology stated that there was a lack of data to support the contaminant boundaries, as presented in the RI report.
- The RI report did not address the potential for sediment contamination.
- The RI report did not incorporate all exposure pathways that were identified for the draft RI report prepared for the LDW Superfund Site (dated November 5, 2007).

The work performed by SoundEarth Strategies and G-Logics between 2012 and 2019 have been performed to address the data gaps identified above. This RI report presents the exploration activities, findings, opinions, and conclusions of the performed work.

7.2 Site Description and Physical Setting

The Property consists of six legal parcels located adjacent to the east shore of the LDW. The Property is located between Slips 2 and 3 and River Mile (RM) 1.7 and RM 2.0. Parcel 4565 extends into the LDW, with approximately 0.5 acres submerged during high tide. The remaining five parcels are located in the upland region and do not extend into the LDW. The Site includes areas of soil, groundwater, surface water, and/or sediment that have been impacted with COPCs associated with the Property (and may extend off Property).

The Property previously was located within a bend of a river meander, as seen in the *Geologic Map of Seattle* (Troost & Booth, 2008). The old river channel, the Property, and surrounding areas were filled and elevated, with fill materials consisting of dredge spoils from the LDW and potentially other offsite soils. The Property is generally flat at an elevation ranging between 13.5 and 17.5 feet (NAVD 88).

Geologic deposits beneath the Property include the following:

- A large portion of the Property is located on artificial fill and dredge material from the Duwamish River, generated during the creation of the LDW. The fill material generally consists of silty, gravelly sands with varying amounts of concrete, metal, lumber, wood, and other miscellaneous debris. The thickness of the fill varies across the Property to a maximum interpreted thickness/depth of 16 feet.
- The fill unit generally is underlain by silty sands and gravelly sands with thin silt lenses, interpreted as undisturbed alluvial deposits. These deposits are present in all borings to the maximum explored depths.
- In several borings, a well-defined silt unit was present within the alluvial deposit, with thicknesses ranging between one and eight feet.

Groundwater in the Duwamish Valley is present within a single, large unconfined aquifer system (WindWard, 2010). The maximum depth of this aquifer system is approximately 100 feet below the ground surface. The thickness of this aquifer generally decreases to the north, east, and west of the valley. Discontinuous silt units are present within the regional aquifer and can act as local aquitards within the aquifer. Where present, these units can effectively separate the aquifer into locally distinct shallow and deeper zones (WindWard, 2010).

Tidal fluctuations influence the near-shore groundwater elevations, which can affect groundwater flows and directions. Groundwater-elevation fluctuations (due to tidal influence) ranged from 3.89 to 7.33 feet across the Property. The magnitude of water-level changes in wells is greatest near the LDW and also in the northern portion of the Property. Groundwater generally flows to the west toward the LDW during low tide. However, high tides in the river results in temporary groundwater-flow reversals to the east-southeast.

7.3 Updated Conceptual Site Model

With the information presented in this report, an updated conceptual site model has been summarized below.

7.3.1 Summary of COPCs

As presented in Section 6.0 above, contaminants have been identified as COPCs based on screening levels, lateral and vertical distribution, frequency of screening-level exceedances, and relative magnitude of concentrations when compared to the identified screening levels. The following table presents the preliminary list of COPCs for each media based on the criteria presented in Section 6.0 (the table also is attached as Table 8).

Chemical	Media					
	Soil	Groundwater	Riverbank Sediment	Catch-Basin Sediment	Stormwater	Vapor Intrusion
Arsenic	X	X			X	
Chromium (III)	X					
Copper	X	X	X		X	
Lead	X	X				
Mercury	X**	X	X		X	
Nickel	X**	X			X	
Zinc	X	X				
Total PCBs	X	X	X		X	
Acenaphthene	X**	X				
Bis(2-ethylhexyl)phthalate	X**	X		X	X	
Fluoranthene				X		
Fluorene	X**	X				
Naphthalene						X
Pentachlorophenol	X	X			X	
cPAH TEQ	X					
Benzo(a)anthracene		X			X	
Benzo(a)pyrene		X			X	
Benzo(b)fluoranthene		X			X	
Benzo(k)fluoranthene		X				
Chrysene		X			X	
Indeno(1,2,3-cd)pyrene		X			X	
Dibenzo(a,h)anthracene		X			X	
Diesel range organics	X**	X				
Oil range organics	X	X				

Note: X indicates the contaminant is listed as a COPC for the selected media. Asterisks (**) indicate that contaminant was included as a soil COPC based on groundwater COPC evaluation. Selected soil-screening levels were not exceeded.

7.3.2 Nature and Extent of Contamination

The nature and extent of contaminants for soil, groundwater, riverbank sediment, catch-basin sediment, stormwater, and soil gas are summarized below.

7.3.2.1 Soil Contaminants

Soil COPCs consist of metals, PCBs, cPAHs, PAHs, SVOCs, and petroleum hydrocarbons. Below is a summary of each category.

- **Metals:** Arsenic and lead were detected at concentrations exceeding soil screening levels at widespread locations across the Site and to depths of 20 feet below ground surface, suggesting a non-point source release. Elevated concentrations of chromium, copper, mercury, nickel, and zinc were more confined to specific areas of the Site, predominantly parcel 4565 and on the Port of Seattle property. Elevated concentrations of these contaminants were found to depths up to 20 feet below ground surface.
- **Total PCBs:** All screening-level exceedances of PCB concentrations in soil occurred on the northern half of Parcel 4565 (near the former junk dealer) and within 10 feet of ground surface.
- **SVOCs and PAHs:** Pentachlorophenol was detected in one soil sample (collected from well MW06) at a concentration exceeding the selected soil screening level. In addition, the nature and extent of acenaphthene, fluorene, and bis(2-ethylhexyl)phthalate in soil have been evaluated based on their presence in groundwater above applicable screening levels. Elevated concentrations of these contaminants were found predominantly on parcel 4565 and at depths between 5 and 15 feet below ground surface.
- **cPAHs:** cPAHs were found at concentrations exceeding soil screening levels at many locations across the Site, predominantly between the ground surface and depths up to 15 feet. The cPAH concentrations did not exceed screening levels in borings/wells located in the eastern portion of the Site.
- **Petroleum Hydrocarbons:** DRO and ORO were found at concentrations exceeding soil screening levels at locations on parcel 4565 near the former junk yard, parcel 3447 near the equipment wash, and on the adjacent Port of Seattle property. All screening-level exceedances were found between the ground surface and depths up to 15 feet.

7.3.2.2 Groundwater Contaminants

Groundwater COPCs also consist of metals, PCBs, cPAHs, PAHs, SVOCs, and petroleum hydrocarbons. Below is a summary of each category.

- **Metals:** Arsenic concentrations consistently exceeded groundwater screening levels at all well locations across the Site. Lead screening level exceedances were consistent along the southwest portion of the Property adjacent to the LDW. Concentrations and locations of copper, mercury, nickel, and zinc detections fluctuated greatly between sampling events.

- **Total PCBs:** Total PCB Aroclors were only detected during a 2002 sampling event in wells MW2 and MW4. Concentrations of total PCB Congeners exceeded groundwater screening levels in all three wells recently sampled at locations across the Site.
- **SVOCs and PAHs:** Bis(2-ethylhexyl)phthalate concentrations exceeded groundwater screening levels in all sampled wells during one sampling event and is thought to be an artifact of sampling/laboratory-analysis procedures. Additionally, pentachlorophenol only was detected in groundwater collected from well MW06 at concentrations exceeding the groundwater screening level. Acenaphthene and fluorene concentrations consistently exceeded groundwater screening levels in well MW16 in the central-western portion of the Site.
- **cPAHs:** cPAHs were found at concentrations exceeding groundwater screening levels in wells located along the western and southwestern Property boundary (adjacent to the LDW).
- **Petroleum Hydrocarbons**: DRO and ORO were found at concentrations exceeding groundwater screening levels in wells located along the western and southwestern Property boundary (adjacent to the LDW).

7.3.2.3 Riverbank Sediment Contaminants

Riverbank Sediment COPCs consist of metals and PCBs. Below is a summary of each category.

- **Metals:** Copper and mercury concentrations exceeded riverbank sediment screening levels in several locations, predominantly in the southern half of the Property shoreline.
- **Total PCBs:** Total PCB Aroclor concentrations exceeded riverbank-sediment screening levels in a majority of riverbank samples collected on and adjacent to the Property (PCB Congeners were not analyzed as part of the riverbank-sediment explorations conducted for the Site). Additionally, several LDW-sediment samples collected adjacent to the Property (collected by others) exceeded the applicable PCB-screening levels.

7.3.2.4 Catch-Basin Sediment Contaminants

Catch-basin Sediment COPCs consist of metals and PCBs. Below is a summary of each category.

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- **SVOCs and PAHs:** Bis(2-ethylhexyl)phthalate concentrations exceeded screening levels in a majority of sampled catch basins during the sampling events and is thought to be an artifact of sampling/laboratory-analysis procedures. Fluoranthene screening level exceedances only occurred in catch basins CB08 and SWC1.

7.3.2.5 Stormwater Contaminants

Stormwater COPCs consist of metals, PCBs, cPAHs, PAHs, and SVOCs. Stormwater is conveyed across the Property through thirteen catch basins. With the exception of catch basin CB09, collected stormwater is directed into a common sump, which then is pumped into a treatment system. Treated stormwater is discharged to the LDW through outfall OUT1, where samples have been collected and analyzed to assess potential contaminant concentrations entering the LDW. Because stormwater samples only have been collected from this discharge point, the exact source and/or location of contaminants found in surface water/stormwater is not possible to interpret.

7.3.2.6 Soil Gas Contaminants and Potential Vapor Intrusion

Naphthalene is the only COPC present at the Site with concentrations exceeding groundwater screening levels for vapor intrusion concerns. Screening level exceedances occurred in several wells, all located on the western portion of parcel 4565.

7.3.3 Contaminant Fate and Transport

The fate and transport of Site COPCs is summarized below.

7.3.3.1 Potential Sources and Transport Mechanisms

Potential sources for COPCs are presented below.

- **Metals:** LDW dredge spoils and other fill material used at the Site, industrial processes (i.e., welding and marine railway), material storage (i.e., shipping containers, building material, junk yard items, paints, treated wood, etc.), stormwater discharge to the LDW, and/or upgradient sources.
- **PCBs:** LDW dredge spoils and other fill material used at the Site, material storage (i.e., junk yard items, paints, etc.), stormwater discharge to the LDW, and/or upgradient sources.
- **SVOCs and PAHs:** Treated wood/pilings, LDW dredge spoils and/or burn/trash debris used as fill material, sampling/laboratory artifact (for bis(2-ethylhexyl)phthalate), and/or a burning of fossil fuels/wood/debris.

- **cPAHs:** Treated wood/pilings, LDW dredge spoils and/or burn/trash debris used as fill material, motor-oil spills/leaks, and/or a burning of fossil fuels/wood/debris.
- **Petroleum Hydrocarbons:** Incidental surface spills/leaks from vehicles and equipment.

Many of the COPCs could have originated at the surface or near surface and first impacted shallow soil and/or surface water at the Site. Fill material has been found on the Property up to a depth of approximately 16 feet. If contaminants were present in the fill material when placed on the Property, COPCs could be present in the soil in certain areas of the Site to depths of 16 feet. Additionally, COPCs found in groundwater, deeper soils, and riverbank sediments located near the LDW could have originated from sources upstream in the LDW.

From the contaminant sources noted above, several transport/release mechanisms could contribute to migration of COPCs into other media. These mechanisms include the following:

- Soil leaching to groundwater,
- Soil leaching to catch-basin sediment,
- Surface soil/riverbank erosion to surface water,
- Surface soil/riverbank erosion to sediment,
- Groundwater discharge to LDW surface water,
- Sheet flow into LDW surface water,
- Sheet flow into stormwater system,
- Catch-basin sediment to stormwater,
- Stormwater leaching to soil through cracks in piping,
- Stormwater into LDW surface water, and
- LDW Surface water to LDW sediment.

7.3.3.2 Groundwater-Plume Areas

Because the Property is mostly unpaved, surface water infiltrating into the soil has the ability to mobilize COPCs through leaching. COPCs could then migrate to the water table, where they could be transported by groundwater in the direction of groundwater flow towards the LDW.

Based on site investigations conducted at the Site, groundwater COPCs are consistently present in four distinct areas: The northern portion of the Site (predominantly on parcel 4565), the western border of the Site (near the LDW shoreline and in the vicinity of wells MW14 to MW16), the central portion of the Site (near wells MW07, MW12, and MW13), and the southern portion of the Site (near well MW06). COPCs associated with each area are described below and presented on Figure 17. These areas and discovered contaminants are listed below.

- **Northern Plume:** Total PCB Congeners.
- **Western Plume:** Metals (lead and zinc), Total PCB Aroclors, SVOCs/PAHs (acenaphthene and fluorene), cPAHs, and petroleum hydrocarbon (DRO and ORO).
- **Central Plume:** Arsenic
- **Southern Plume:** Pentachlorophenol.

Two groundwater COPCs, arsenic and bis(2-ethylhexyl)phthalate, were present in all wells at concentrations exceeding screening levels during one or more sampling events. The highest concentrations of arsenic in groundwater were located in the Central Plume (described above). Arsenic concentrations may be within background concentrations in other areas of the Site. Bis(2-ethylhexyl)phthalate was detected at similar concentrations during all sampling events and is thought to be an artifact of sampling/laboratory-analysis procedures.

While detected, concentrations of copper, nickel, and mercury were inconsistent in both magnitude of detected concentrations and locations found at the Site.

7.3.4 Exposure Pathways and Potential Receptors

Given the COPCs, affected media, and transport/release mechanisms listed above, possible exposure pathways and potential receptors are listed below.

Exposure Medium	Exposure Pathway	Potential Receptors
Surface Soil	Incidental Ingestion/Direct Contact	On-Property Workers
Subsurface Soil	Direct Contact	On-Property Workers
Groundwater	Discharge to LDW Surface Water/Direct Contact	Subsistence Users Recreational Users Ecological Receptors Utility Workers
Catch-Basin Sediment	Direct Contact	On-Property Workers
Stormwater	Direct Contact with Stormwater, Discharge to LDW Surface Water	On-Property Workers Subsistence Users Recreational Users Ecological Receptors
Indoor Air	Inhalation	None
Outdoor Air/Particulate	Inhalation	On-Property Workers
LDW Surface Water	Direct Contact	Subsistence Users Recreational Users Ecological Receptors
Riverbank and LDW Sediment	Direct Contact	Subsistence Users Recreational Users Ecological Receptors
LDW Edible Biota	Plant Ingestion/ Aquatic Invertebrate Ingestion	Subsistence Users Recreational Users Ecological Receptors
LDW Edible Fish	Ingestion	Subsistence Users Recreational Users Ecological Receptors

7.4 Recommendations and Opinions

Based on the evaluation of the current data set for this Site, G-Logics believes that the nature and extent of hazardous substances at the Site have been sufficiently characterized to initiate the FS process for the Site. While preparing the FS, G-Logics recommends performing the following additional actions at the Site.

- Check all onsite wells for damage. Replace/repair damaged wells as necessary.
- Install new wells near former MW-1D, MW2 and MW-2D well locations. Data previously collected from these wells indicate elevated concentrations of contaminants may be present. New groundwater data would be used to further assess the presence and delineate the extent of COPCs in these areas.
- Install new well near boring GLB09. This location would bound the site to the northeast.
- Resample all wells for the identified COPCs.

8.0 LIMITATIONS

The performed scope of services was intended to provide an assessment of potential contamination in soil, groundwater, sediment, soil gas, and/or surface water at the Duwamish Marine Center Site. However, this effort may not identify all potential concerns or to eliminate all risk associated with the Site. The scope of work for this project was presented in the SoundEarth Strategies workplan dated January 15, 2014 and limited to those items specifically identified. Other activities not specifically included in the presented scope of work (in a workplan, correspondence, or this report) are excluded and are therefore not part of our services.

This report is prepared for the sole use of our client and the Washington Department of Ecology. The scope of services performed during this exploration may not be appropriate for the needs of other party. Re-use of this document or the findings, conclusions, or recommendations presented herein, are at the sole risk of said party(s). Any party other than our client who would like to use this report shall notify G-Logics of such intended use by executing the "Permission and Conditions for Use and Copying" contained in this document. Based on the intended use of the report, G-Logics may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements will release G-Logics from any liability resulting from the use of this report by any unauthorized party.

Land use, site conditions (both onsite and offsite), and other factors will change over time. Since site activities and regulations beyond our control could change at any time after the completion of this report, our observations, findings, and opinions can be considered valid only as of the date of the performed exploration.

No warranty, express or implied, is made.

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