Port of Seattle
Lora Lake Apartments Site

Remedial Investigation/ Feasibility Study

Volume II

Appendix G
Lora Lake Parcel
Remedial Investigation Data Report

FINAL

Table of Contents

1.0 Introduction G-1

1.1 PHYSICAL SETTING G-2
1.2 OVERVIEW OF FIELD INVESTIGATION ACTIVITIES G-2
1.3 REPORT ORGANIZATION G-3

2.0 Survey of Physical Drainage Features and Visual Inspections G-5

2.1 SURVEY OF PHYSICAL DRAINAGE FEATURES G-5
2.2 VISUAL INSPECTIONS OF THE LORA LAKE SHORELINE G-5

3.0 Lora Lake, Miller Creek, and Groundwater Water Level Monitoring G-7

3.1 MINOR WORK PLAN DEVIATIONS G-8

4.0 Lora Lake Bathymetric Survey G-9

5.0 Lora Lake Parcel Sediment Investigation Procedures G-11

5.1 LORA LAKE SUBSURFACE SEDIMENT SAMPLING G-11
5.1.1 Field Procedures G-11
5.1.2 Field Observations and Documentation G-13
5.1.3 Minor Work Plan Deviations G-14
5.2 LORA LAKE AND MILLER CREEK SURFACE SEDIMENT SAMPLING G-15
5.2.1 Field Procedures G-15
5.2.2 Field Observations and Documentation G-17
5.2.3 Minor Work Plan Deviations G-18

6.0 Sediment Analytical Results G-19

6.1 ANALYTICAL METHODS G-19
6.1.1 Subsurface Sediment Investigation G-19
6.1.2 Surface Sediment Investigation G-19
6.2 DATA QUALITY G-20
6.2.1 Subsurface Sediment Data G-21
6.2.2 Surface Sediment Data G-21
6.3 RESULTS G-22
6.3.1 Subsurface Sediment Samples G-22
6.3.2 Surface Sediment Samples G-24

7.0 Sediment Bioassay Results G-27

7.1 BIOLOGICAL TESTING METHODS G-27

7.2 DATA QUALITY G-27

7.3 RESULTS G-29

7.3.1 10-day Acute Amphipod (*Hyalella azteca*) for Mortality G-30

7.3.2 20-day Chronic Midge (*Chironomus dilutus*, formerly known as *tentans*) for Mortality and Growth G-30

7.3.3 15-minute 100 Percent Porewater Microtox® Bacteria (*Vibrio fischeri*) Bioluminescence Test G-31

7.3.4 Conclusions of Biological Testing Results G-31

8.0 Shallow Soil Investigation Procedures G-33

8.1 SHALLOW SOIL SAMPLING G-33

8.1.1 Field Procedures G-33

8.1.2 Field Observations and Documentation G-34

8.1.3 Minor Work Plan Deviations G-34

9.0 Shallow Soil Analytical Results G-35

9.1 ANALYTICAL METHODS AND DATA QUALITY G-35

9.2 DATA QUALITY G-35

9.3 RESULTS G-36

9.3.1 Conventionals G-37

9.3.2 Metals G-37

9.3.3 Total Petroleum Hydrocarbons G-37

9.3.4 Semivolatile Organic Compounds G-37

9.3.5 Volatile Organic Compounds G-38

9.3.6 Dioxins/Furans G-38

10.0 References G-39

List of Tables

Table G.1 Surveyed Elevations of Lora Lake Parcel Drainage Features and Water Level Monitoring Locations

Table G.2 Water Elevations of Lora Lake, Miller Creek, and Groundwater

Table G.3 Lora Lake Subsurface Sediment Analytical Results

Table G.4 Lora Lake and Miller Creek Surface Sediment Analytical Results

Table G.5 Lora Lake and Miller Creek Sediment Bioassay Results

Table G.6 Lora Lake Parcel Shallow Soil Analytical Results

List of Figures

Figure G.1 Vicinity Map

Figure G.2 Bathymetric Contours and Visual Observations of Lora Lake

Figure G.3 Lora Lake Parcel Sampling Locations

Figure G.4 Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake Subsurface Sediments

Figure G.5 Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake and Miller Creek Surface Sediments

Figure G.6 Bioassay Results in Lora Lake and Miller Creek Surface Sediments

Figure G.7 Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake Parcel Shallow Soil Samples

List of Attachments

Attachment G.1 Field Photographs

Attachment G.2 Sediment Collection Forms and Bore Logs

Attachment G.3 Laboratory Analytical Data Reports

Attachment G.4 EcoChem Data Validation Reports

Attachment G.5 Surface Sediment Grain Size Distribution Curves

Attachment G.6 Bioassay Reports

List of Abbreviations and Acronyms

Abbreviation/ Acronym	Definition
1,2-DCA	1,2-Dichloroethane
AFDW	Ash-free dry weight
AMEC	AMEC/Geomatrix
AO	Agreed Order
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
bgs	Below ground surface
BTEX	Benzene, toluene, ethlybenzene, and xylenes
CAB	Cellulose acetate butyrate
cis-1,2-DCE	cis-1,2-Dichloroethene
CO_2	Carbon dioxide
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSL	Cleanup screening level
CSM	Conceptual site model
FS	Feasibility Study
GPS	Global positioning system
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
LL Apartments Parcel	Lora Lake Apartments Parcel
LL Parcel	Lora Lake Parcel
MS/MSD	Matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act
Nautilus	Nautilus Environmental
PCE	Tetrachloroethene
PCOC	Preliminary contaminant of concern
PCP	Pentachlorophenol
Port	Port of Seattle
PSEP	Puget Sound Estuary Program
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting limit
RPD	Relative percent difference
RSET	Regional Sediment Evaluation Team

Abbreviation/ Acronym	Definition
RSS	Research Support Services
SIM	Select ion monitoring
Site	Lora Lake Apartments Site
SQS	Sediment Quality Standards
SR 518	State Route 518
STIA	Seattle-Tacoma International Airport
TCE	Trichloroethene
TEF	Toxic equivalency factor
TEQ	Toxic equivalency quotient
TOC	Total organic carbon
trans-1,2-DCE	trans-1,2-Dichloroethene
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound
WAC	Washington Administrative Code
WSDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation

This page left intentionally blank.

1.0 Introduction

This document presents the results of data collection activities conducted according to the Remedial Investigation/Feasibility Study (RI/FS) Work Plan (Floyd|Snider 2011) for the Lora Lake Parcel (LL Parcel) located in SeaTac, Washington (Figure G.1), near the northwest corner of Seattle-Tacoma International Airport (STIA). The LL Parcel is located downgradient of the Lora Lake Apartments Parcel (LL Apartments Parcel). The Lora Lake Apartments Site (Site), as defined by the Model Toxics Control Act (MTCA) 173-340-200, includes the LL Apartments Parcel, and areas beyond this parcel where contamination originating at the LL Apartments Parcel has come to be located. The remedial investigation work at the LL Parcel was performed to determine if contamination associated with the LL Apartments Parcel has come to be located at the LL Parcel and to determine whether the LL Parcel should be included as part of the Site. A separate phase of remedial investigation work was conducted at the LL Apartments Parcel and this work is described in the LL Apartments Parcel Data Report (Appendix F of the Lora Lake Apartments Site RI/FS Report).

The Port of Seattle (Port) and the Washington State Department of Ecology (WSDOE) entered into Agreed Order (AO) Number DE 6703 for the Site on July 10, 2009 (WSDOE 2009). The AO Scope of Work requires the Port to prepare an RI/FS Work Plan, conduct a Remedial Investigation (RI) and Feasibility Study (FS), and prepare a RI/FS Report pursuant to Washington Administrative Code (WAC) 173-340-350 in a manner that complies with requirements of the MTCA cleanup regulation, Chapter 173-340 WAC (WSDOE 2007).

The LL Parcel is currently owned by the Port and occupies approximately 7.1 acres that includes a small urban freshwater lake (Lora Lake) and constructed habitat mitigation area land. It is bounded to the north by the Washington State Department of Transportation (WSDOT) State Route 518 (SR 518) highway interchange, to the east and south by other habitat mitigation area land owned by the Port and the northern boundary of STIA, and to the west and northwest by Des Moines Memorial Drive and the LL Apartments Parcel (Figure G.1). The LL Parcel is the location of a former residential area surrounding Lora Lake, which was created as a result of peat mining activities that began sometime between 1936 and 1946 and continued until the mid- to late-1950s. The Port acquired the LL Parcel in the late 1990s as part of planning for construction of the STIA 3rd Runway Project. Construction of the STIA 3rd Runway was completed in 2008. Consistent with agreements with WSDOE and the U.S. Army Corps of Engineers (USACE), the Port constructed a habitat mitigation area, the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," which includes the LL Parcel and other properties located adjacent to the STIA.

The LL Parcel remedial investigation described in this Data Report was designed to obtain necessary data from the LL Parcel to supplement the LL Apartments Parcel remedial investigation and to determine if contamination from the LL Apartments Parcel has come to lie within the LL Parcel. Prior to this LL Parcel remedial investigation work only limited environmental investigations were performed at the LL Parcel related to the removal of home heating oil tanks between 1998 and 2002. This data report presents the results of the LL Parcel investigation completed in spring 2011, as proposed in the LL Parcel RI/FS Work Plan in support of RI/FS development. All data collection activities were conducted in accordance with the LL Parcel RI/FS Work Plan and Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) and are described in the following sections (Floyd|Snider 2011).

1.1 PHYSICAL SETTING

The LL Apartments Parcel and LL Parcel are located in the Puget Sound Lowlands, within the Miller Creek Watershed, just northwest of STIA. Beyond the LL Apartments Parcel property boundary, the topography gradually slopes towards Lora Lake. Lora Lake receives stormwater runoff from the LL Apartments Parcel, City of Burien residential and commercial drainage area upgradient of the LL Apartments Parcel, and surrounding roadways downgradient of the LL Apartments Parcel (e.g., Des Moines Memorial Drive, SR 518 interchange, City of SeaTac) through a single outfall located near the northwestern edge of the lake (Figure G.2). This City of Burien outfall discharges into the lake's sediment settling basin, which was constructed in the northeastern corner of the lake in 1983 by King County to help prevent future accumulation of sediment within the lake. A discharge culvert and overflow berm is present at the southeast end of the lake. Water from Lora Lake discharges to Miller Creek through the discharge culvert and seasonally by overtopping the overflow berm. When Miller Creek surface water elevations are elevated (i.e., during periods of heavy rainfall), Miller Creek surface water discharges can occur to Lora Lake via the same culvert and overflow berm. The LL Parcel is located within a secure fenced area.

Historical records show that Lora Lake was hydraulically dredged by King County in 1982 because of residential concerns regarding the accumulation of sediment within Lora Lake. Reportedly, King County removed approximately 16,000 cubic yards of sediment from the lake (Stirling Consulting 2011; Appendix B of the Lora Lake Apartments Site RI/FS Report). The dredged sediment was placed in a bermed area on Port property, located approximately 400 feet northeast of Lora Lake. An additional remedial investigation was performed on the 1982 Dredge Materials Containment Area to assess potential soil and groundwater contamination resulting from the stockpiled Lora Lake sediments. This investigation and the results are described in the *1982 Dredged Material Containment Area Data Report* (Appendix H of the Lora Lake Apartments Site RI/FS Report).

1.2 OVERVIEW OF FIELD INVESTIGATION ACTIVITIES

The purpose of the LL Parcel phase of the remedial investigation is to determine if contamination associated with the LL Apartments Parcel has come to be located at the LL Parcel. The potential contamination pathways examined through the data collection activities include the potential discharge of impacted groundwater, stormwater, and storm drain sediments from the LL Apartments Parcel to Lora Lake and the potential transport of impacted soils from the LL Apartments Parcel to the LL Parcel via historical overland flow. Additionally, this investigation will help identify whether other potential sources of contamination have impacted the LL Parcel. Specific activities completed as part of the LL Parcel remedial field investigation include the following:

- Survey of Lora Lake's physical drainage features, including the City of Burien stormwater outfall that discharges to the lake and the lake's discharge culvert into Miller Creek.
- Visual inspections of the shoreline of Lora Lake for any potential additional input sources (e.g., outfalls).
- Three rounds of water level measurements at one location in Lora Lake, three locations in Miller Creek, a piezometer located between Lora Lake and Miller Creek, and four groundwater monitoring wells located outside along Des Moines Memorial Drive between the LL Apartments Parcel and the LL Parcel.
- A bathymetric survey of Lora Lake.
- Collection of subsurface sediment samples at three locations within Lora Lake.
- Collection of surface sediment samples at five locations within Lora Lake and three locations within Miller Creek.
- Collection of shallow soil samples at six locations on the LL Parcel between Des Moines Memorial Drive and Lora Lake, directly downgradient of the LL Apartments Parcel.
- Chemical analysis of subsurface sediment, surface sediment, and soil samples.
- Biological testing (e.g., bioassays) of four of the surface sediment samples collected from Lora Lake and three of the surface sediment samples from Miller Creek.

1.3 REPORT ORGANIZATION

The remaining sections of this report are organized as follows:

- **Section 2.0:** Survey of Physical Drainage Features and Visual Inspections—description of field methods, procedures, and outcomes.
- **Section 3.0**: Lora Lake, Miller Creek, and Groundwater Level Monitoring—description of field methods, procedures, minor Work Plan deviations, and a summary of the water level measurements.
- **Section 4.0:** Lora Lake Bathymetric Survey—description of field methods, documentation procedures, and outcomes.

- **Section 5.0:** Lora Lake Parcel Sediment Investigation Procedures—description of field methods, documentation procedures, and minor Work Plan deviations.
- **Section 6.0:** Sediment Analytical Results—description of laboratory analytical methods and requirements, data quality objectives and compliance, and a summary of sediment analytical results.
- **Section 7.0:** Sediment Bioassay Results—description of laboratory methods and requirements, data quality objectives and compliance, and a summary of sediment bioassay results.
- **Section 8.0:** Shallow Soil Investigation Procedures—description of field methods, documentation procedures, and minor Work Plan deviations.
- **Section 9.0:** Shallow Soil Analytical Results—description of laboratory analytical methods and requirements, data quality objectives and compliance, and a summary of soil analytical results.
- **Section 10.0:** References—provides reference information for materials cited in this document.

2.0 Survey of Physical Drainage Features and Visual Inspections

2.1 SURVEY OF PHYSICAL DRAINAGE FEATURES

The two physical drainage features associated with Lora Lake include the City of Burien storm drain outfall and a drainage culvert located along the southeastern side of Lora Lake that connects the lake to Miller Creek (Figure G.2). These drainage features are described in Section 1.1. The diameters and bottom elevations of the City of Burien storm drain outfall and both ends of the drainage culvert were surveyed by the Port in fall 2010. These survey data were collected for comparison to Lora Lake and Miller Creek surface water elevations, which are described below in Section 3.0. These elevation data will assist in understanding the connectivity and seasonal flow between Lora Lake and Miller Creek, and to assist with developing the conceptual site model (CSM) for the LL Apartments Parcel and the LL Parcel. The physical drainage features were surveyed by the Port to a horizontal and vertical closure of 1:5,000, according to the requirements specified in the AO.

The City of Burien storm drain outfall was described as a 24-inch diameter corrugated polyethylene pipe and the drainage culvert was described as a 12-inch diameter corrugated polyethylene pipe. The surveyed locations and elevations of these two features are provided in Table G.1. These elevation levels can be compared against Lora Lake and Miller Creek surface water levels, discussed further in Section 3.0 and also presented in Table G.1. Site mapping of the drainage features was conducted using the Washington State Plane North Coordinate System and the locations of these physical features are presented on Figure G.2.

2.2 VISUAL INSPECTIONS OF THE LORA LAKE SHORELINE

A preliminary visual inspection for outfall structures along the shoreline of Lora Lake was performed in fall 2010 to identify any unknown current and/or historical input sources to Lora Lake. This preliminary inspection occurred concurrently with the survey of the known physical drainage features within Lora Lake (refer to Section 2.1). Because access along the lake shoreline was limited due to heavy vegetation, Floyd|Snider field staff used an inflatable raft to inspect the entire lake shoreline. No additional input sources to the lake were observed during this preliminary survey.

During the fall preliminary inspection, vegetation surrounding the lake was overgrown making the identification of outfalls along the shoreline difficult. For this reason, an additional inspection was conducted in March 2011 when less shoreline vegetation was present, allowing improved visibility of the shoreline. This inspection was also conducted of the entire lake shoreline by Floyd|Snider field staff using an inflatable raft. To document this visual inspection, photographs were taken along the shoreline perimeter of Lora Lake and observations were documented in a field logbook.

During the March 2011 inspection, the following observations were made:

- Water was observed entering Lora Lake from the nearby wetlands to the south (refer to Figure G.2 for the approximate location), indicating surface water connectivity between the wetlands and lake (refer to Attachment G.1).
- Floyd|Snider field staff observed water from a drainage channel flowing into Lora Lake in the southwest corner of the lake. This drainage channel headed west, then curved north near the base of the slope below Des Moines Memorial Drive (refer to Figure G.2 for the approximate location of this drainage channel and photographs in Attachment G.1). The channel appeared to be manmade, with water approximately 1 foot deep in some locations along the channel. The channel ended near the northwest corner of the lake in a small ponded area. The ponded area was located approximately 75 to 100 feet northwest of the outlet of the City of Burien storm drain outfall into the Lora Lake sediment settling basin. The ponded area appeared to be slightly higher in elevation in comparison to the water level in the sediment settling basin.
- Water was discharging from the City of Burien storm drain outfall (the 24-inch diameter corrugated polyethylene pipe) into the Lora Lake sediment settling basin at the time of the inspection (refer to Figure G.2). Another outfall, made of concrete, was observed during the inspection about 3 feet to the west of this outfall. This concrete outfall was 18 inches in diameter and partially submerged in the sediment settling basin at the time of inspection. No water appeared to be discharging from the outfall (refer to photographs in Attachment G.1). The bottom third of the outfall was filled with silt.

No other outfalls or water inlets were observed along the remainder of the Lora Lake shoreline.

3.0 Lora Lake, Miller Creek, and Groundwater Water Level Monitoring

Surface water and groundwater elevations were obtained in three water level monitoring field events for the purpose of evaluating the hydraulic connections between Lora Lake, Miller Creek, and the groundwater table.

Water level measurements were taken at the following LL Parcel locations, as shown in Figure G.3:

- Lora Lake water level monitoring locations:
    - Near the drainage culvert to Miller Creek located on the southeastern side of Lora Lake.
- Miller Creek water level monitoring locations:
    - Upgradient (east) of the Lora Lake culvert discharge to Miller Creek at location MC-SED1.
    - Directly downgradient (west) of the Lora Lake culvert discharge to Miller Creek at location MC-SED2.
    - Further downgradient (west) of the Lora Lake culvert discharge to Miller Creek at location MC-SED3.
- Groundwater level monitoring locations:
    - Existing piezometer HPA1-1 located between Lora Lake and Miller Creek.
    - Existing Monitoring Wells MW-8, MW-9, MW-10, and MW-11 located upgradient of Lora Lake, southeast of Des Moines Memorial Drive.

Surface water and groundwater levels were measured during three field events: fall 2010, winter 2011, and spring 2011. Prior to conducting the fall 2010 water level monitoring event, the Lora Lake and Miller Creek groundwater level locations were selected and marked with rebar stakes. The use of these stakes within Lora Lake and Miller Creek allowed measurement of water levels during the three field events at consistent locations. The Port surveyed the elevations of the top of each stake in Lora Lake and Miler Creek and at the top of the well casing for piezometer HPA1-1 in fall 2010 to a horizontal and vertical closure of 1:5,000 and to an accuracy of within 0.01 foot, meeting the survey requirements specified in the AO. Due to heavy water flows and debris, the rebar stakes were reset in the same locations and resurveyed by the Port in spring 2011 (as discussed below in Section 3.1). The survey data for these water level monitoring locations are included in Table G.1. The surveyed elevations were used to translate lake and creek water level measurements into surface water elevations for each of the three monitoring events. During each monitoring event at the lake and creek locations, a measuring tape was placed along the length of the stake to measure the depths to water and sediment. Water levels in the four existing monitoring wells and piezometer HPA1-1 were recorded using an electronic water level indicator during each monitoring event.

The water level measurements and field observations were recorded in a field logbook and on groundwater level monitoring forms. The water level elevations from all three field events are summarized in Table G.2.

The evaluation of the hydraulic connections between Lora Lake, Miller Creek, and the groundwater table is included in Section 2.5 of the RI/FS.

3.1 MINOR WORK PLAN DEVIATIONS

Minor deviations from the LL Parcel RI/FS Work Plan during collection of the water level measurements included the following:

- Even though the LL Parcel RI/FS Work Plan scheduled the spring water level monitoring event at the same time as the LL Apartments Parcel spring groundwater monitoring event (to provide concurrent groundwater levels for all upgradient wells), the spring water level monitoring event was not completed concurrently with the LL Apartments Parcel groundwater monitoring event. The majority of water levels were measured concurrently, but the measurement of the water level in Piezometer HPA1-1 was not completed because of a field error. The water level monitoring was repeated approximately 2 weeks later when the deviation from the LL Parcel RI/FS Work Plan was realized. All water levels in Lora Lake, Miller Creek, Monitoring Wells MW-8, MW-9, MW-10, and MW-11, and Piezometer HPA1-1 were monitored at that time.
- As stated in the LL Parcel RI/FS Work Plan, the fall 2010 LL Apartments Parcel groundwater monitoring event was conducted prior to the fall 2010 LL Parcel water level monitoring event. Instead of conducting the winter and spring LL Parcel water level monitoring events concurrently with the LL Apartments Parcel groundwater monitoring, only the winter water level monitoring event was conducted concurrently.
- During winter 2011, debris floating down Miller Creek was caught behind the rebar stakes. The weight of the debris and heavy water flows in the creek caused the rebar stakes to bend slightly. The Port reset the three stakes in Miller Creek at the same locations and re-surveyed the tops of these rebar stakes. The Port also re-surveyed the stake in Lora Lake at the same time for consistency.

4.0 Lora Lake Bathymetric Survey

A survey of the bathymetry of Lora Lake was performed by Floyd|Snider on March 1 and 2, 2011. The purpose of this survey was to gain a general understanding of the bathymetry of Lora Lake and to use the bathymetric data to determine the deepest location within the lake, which was subsequently used as one of the sampling locations during the surface and subsurface sediment investigations (refer to Section 5.0).

The bathymetric survey was performed by collecting water depth measurements at regular intervals along multiple transects throughout the lake. The locations of these transects, along with global positioning system (GPS) coordinates of potential water depth measurement locations to be targeted along the transects, were determined in ArcGIS prior to the survey. Seven transects were established in the north-south direction and five transects were established in the east-west direction. The transects were spaced approximately 60 feet apart in both the north-south direction and the east-west direction. Coordinates were provided for potential measurement locations at 20-foot intervals along each of the transects. The GPS coordinates were pre-loaded into a sub-meter accuracy Trimble GeoXH Handheld GPS unit used during the survey.

To perform the survey, an inflatable raft was used to run the depth measurement transects along both the north-south and east-west alignments within Lora Lake. Water depths were collected at approximately 40-foot intervals along each of the transects. The handheld GPS unit, with Hurricane Antenna, was used to position the inflatable raft within 5 feet of the pre-determined water depth measurement locations. Water depths were then measured directly from the raft using a lead line. Based on the water level measurements collected at the 40-foot intervals along the transects, the deepest point in the lake measured 15.2 feet. Additional water depth measurements were collected along the transects at 20-foot intervals near this deepest point to further characterize the bathymetry in this area and to confirm the location of the deepest point in the lake. The location with the measurement of 15.2 feet remained the deepest location within the lake. A total of 87 water depth measurements were collected along the transects during the survey.

The lead-line-measured water depths collected along each transect were recorded in a field logbook. The tabulated water depth measurements and GPS coordinates were then used to prepare an interpolated Lora Lake bathymetry map using ArcGIS with the 3-D Analyst Extension. The Lora Lake bathymetric map is shown in Figure G.2.

This page intentionally left blank.

5.0 Lora Lake Parcel Sediment Investigation Procedures

Sediment investigation activities on the LL Parcel included the collection and analysis of both subsurface sediment cores and surface sediment grab samples. To investigate potential historical or long-term contributions of contaminants to Lora Lake, the quality of the subsurface sediments was evaluated through the collection and analysis of three subsurface sediment cores from Lora Lake. To evaluate whether the surface sediments within Lora Lake and Miller Creek have been impacted from discharges via groundwater and/or stormwater migration from the LL Apartments Parcel, as well as from other stormwater discharge sources, surface sediment samples from within both Lora Lake and Miller Creek were collected and analyzed. Five surface sediment samples were collected from Lora Lake (three co-located with the subsurface sediment cores) and three surface sediment samples were collected from Miller Creek. The subsurface and surface sediment sampling procedures were performed in accordance with the LL Parcel RI/FS Work Plan and SAP/QAPP (Floyd|Snider 2011), as well as WSDOE's *Sediment Sampling and Analysis Plan Appendix* (WSDOE 2008) and Puget Sound Estuary Program (PSEP) Guidelines (PSEP 1997). These subsurface and surface sediment field investigation activities are described in detail below. The chemical analyses performed on these sediment samples and the results of these analyses are discussed in Section 6.0. The biological toxicity testing performed on select sediment samples and the results of this testing are described in Section 7.0.

5.1 LORA LAKE SUBSURFACE SEDIMENT SAMPLING

5.1.1 Field Procedures

Three subsurface sediment cores (LL-SED1, LL-SED2, and LL-SED3) were collected within Lora Lake on March 15, 2011. The subsurface sediment sampling locations are shown on Figure G.3. The sediment core locations were selected in coordination with WSDOE to meet the project objectives and to provide adequate spatial coverage within Lora Lake. As described in the LL Parcel RI/FS Work Plan, sediment core LL-SED1 was located in the northern portion of Lora Lake, outside of the settling basin area. The actual location for collecting sediment core LL-SED1 was adjusted in the field due to a problem with driving the core tube to the desired depth at the proposed sampling location for LL-SED1 (refer to Section 5.1.3 for further details). Sediment core LL-SED2 was located at the deepest point of Lora Lake, which was determined during the bathymetric survey (refer to Section 4.0). Sediment core LL-SED3 was located in the southeastern portion of the lake, in proximity to the Lora Lake discharge culvert.

An inflatable sediment coring vessel was constructed and used to collect the subsurface sediment samples. The positioning and navigation of this coring vessel to the three subsurface sediment sampling locations described above was accomplished with a Real Time Kinematic differential GPS used on board the sampling vessel. Water depths at the sampling locations were measured by lead line prior to collection of the sediment cores.

The subsurface sediment sampling in Lora Lake was completed using a sampling technique called freeze coring, in accordance with the work plan. Freeze coring was performed by AMEC/Geomatrix (AMEC) under the supervision of Floyd|Snider field staff. Freeze core collection was conducted by driving a hollow iron core tube with a pointed tip into the sediments until the desired sampling depth was reached or if the desired sampling depth could not be reached as deep as the core tube could be driven. The core tube was inserted into the sediments by hand power as deep as possible and then by a hand-powered slide hammer to depth if necessary. Once the core tube was inserted into the sediment, liquid carbon dioxide (CO_2) was injected into the inside of the core tube to freeze the surrounding sediments, thereby causing the sediments to attach firmly to the outside of the core tube. Approximately 40 pounds of liquid CO_2 was used in the collection of each core. The frozen core sample and tube were extracted about 30 minutes after the injection of the liquid CO_2. After extraction, the frozen core was taken to a core processing location on the lakeshore, laid horizontally, and documented. One freeze core was collected for chemical analysis at each of the sampling locations.

According to the LL Parcel RI/FS Work Plan, sediment cores were to be collected to a depth of 5.5 feet, encompassing deposition in Lora Lake following the 1982 dredging event as well as underlying sediment that was not dredged. Each 5.5-foot sediment core was to be divided into three equal intervals for sample collection, with the resulting sample intervals to be 56 cm (22 inches) long: 0–56 cm, 56–112 cm, and 112–168 cm. The actual length of the cores recovered at the three sampling stations and the sample intervals collected from each core are described below:

- **LL-SED1**: The recovered core length at sampling location LL-SED1 was 66 cm (or approximately 2.2 feet). This deviation in the core depth from the work plan's proposed core depth is discussed below in Section 5.1.3. Because of the length of this core, only one sediment sample was collected from the 0–56 cm interval, in accordance with the top sampling interval proposed in the LL Parcel RI/FS Work Plan.
- **LL-SED2**: The recovered core length at sampling location LL-SED2 was 170 cm (or approximately 5.6 feet). Sediment samples from this core were collected in accordance with the proposed sample intervals in the LL Parcel RI/FS Work Plan: 0–56 cm, 56–112 cm, and 112–168 cm. A field duplicate sample was also collected from the 0–56 cm sample interval from this core.
- **LL-SED3:** The recovered core length at sampling location LL-SED3 was 167 cm (or approximately 5.5 feet). The sediment sample intervals for LL-SED3 were modified from the proposed sample intervals listed above based on the observed presence of peat in this core. The LL Parcel RI/FS Work Plan notes that if peat is observed in a sediment core, then the interval lengths may be modified based on the contact of sediment with the underlying native peat. Peat was observed as the primary constituent in this core from 36–141 cm, with the peat content decreasing slightly and becoming siltier below 141 cm. The three sample intervals selected based on these field

observations, and discussed with WSDOE while in the field, included intervals from 0–36 cm, 36–141 cm, and 141–167 cm.

The sediment cores were visually classified in accordance with the American Society for Testing and Materials (ASTM) D 2488 and photographed by Floyd|Snider field staff. Sediment descriptions were recorded on a Subsurface Sediment Collection Form and Log (Attachment G.2). Refer to Section 5.1.2 for additional information.

Because the sediment was still frozen to the core tube during processing of the core, the sediments were broken off the core tube using a hammer and decontaminated chisel. The frozen sediment samples were placed directly into laboratory sample containers. Sample containers were filled, tightly capped, labeled, and immediately placed in a cooler maintained at a temperature of approximately 4º C using crushed ice. Samples were delivered to Analytical Resources Inc. (ARI) in Tukwila, Washington under standard chain-of-custody procedures. Each sample was thawed and homogenized at ARI prior to chemical analysis.

5.1.2 Field Observations and Documentation

As part of subsurface sample collection, the following information was recorded on each Subsurface Sediment Sample Collection Form and Log (included as Attachment G.2):

- Date, time, and name of the person logging the sample
- Weather conditions
- Sample location number
- Depth of water at the location
- Sediment sample depth
- Sample recovery
- Biological structures (e.g., shells, tubes, macrophytes, bioturbation)
- Presence of debris (e.g., wood chips, wood fibers, anthropogenic artifacts)
- Presence and description of sheen, as applicable
- Apparent grain size
- Odor (e.g., hydrogen sulfide)

No sheens, odors, or other indications of contamination were observed in any of the subsurface sediment samples. Sediment types were observed to be variable between the three sampling locations. The core collected from sampling location LL-SED1 was primarily composed of brown silt and sandy silt from the surface to a depth of 45 cm. Below this silty surface layer, a grey medium sand with occasional pieces of gravel was observed in the core from LL-SED1, between 45 cm to 66 cm. The core collected from sampling location LL-SED2 was primarily observed to be silt throughout the length of the core, with colors varying slightly with depth (from brown to greyish brown). A reddish brown silty organic soil layer, possibly a peat layer, was identified in this core between approximately 15 and 36 cm below the sediment surface. The core collected from sampling station LL-SED3 was observed to be greyish brown silt from the surface to a depth of 36 cm. Below this silty surface layer, a reddish brown organic soil (peat layer) was observed in this core. Between 141 and 167 cm, this organic soil (peat layer) in the core from LL-SED3 became silty and turned a brown color. Refer to the Sample Collection Forms in Attachment G.2 for additional details.

The subsurface sediment cores were collected prior to the Lora Lake surface sediment sampling to assist with determining the depth of the biologically active surface layer. According to the LL Parcel RI/FS Work Plan, if the depth of the biologically active surface layer was apparent in the sediment cores, the surface sediment in Lora Lake would have been sampled to the depth of the biologically active layer; however, the depth of the biologically active layer could not be visually identified in the sediment cores, as discussed with and confirmed by WSDOE in the field. Therefore, the Lora Lake surface sediment sample collection defaulted to 15 cm, as described in the work plan.

5.1.3 Minor Work Plan Deviations

Minor deviations from the LL Parcel RI/FS Work Plan occurred during the collection of a core from sampling location LL-SED1. At the proposed sampling location for LL-SED1 (shown in the work plan as located approximately 50 feet south of the southern edge of the sediment settling basin), the core tube could only be driven to a depth of 3 feet before refusal. To attempt to achieve the specified penetration depth of 5.5 feet, the sampling location for LL-SED1 was moved 4 times, each time approximately 10 to 15 feet southeast of the preceding location; however, at each of these locations refusal was reached after the core tube was driven into the sediment only 2 to 3 feet. At the fifth location attempted (approximately 60 feet southeast from the originally proposed sampling location) AMEC was able to drive the core tube approximately 3 feet into the sediment using the slide hammer. Sample freezing was attempted at this location, but when the core was extracted only the top 1 foot of the sediment core was recovered, with only a very thin layer of sediment frozen to the bottom portion of the core tube. Coring was attempted a second time at this location to try and retrieve a complete sample. The core tube was driven to a depth of 3.5 feet during this second attempt. This second core tube had 2.2 feet of sediment recovered; however, similar to the first core collected at this location, only a minimal amount of sediment was frozen to the bottom portion of the core tube. The lack of recovery from the bottom of these core tubes during both attempts was likely due to the nature of the sediment at this location, which was observed to be a medium sand in the bottom portions of the recovered sediment. If the water content was low in this sandy layer, it may have been difficult to freeze this sandy layer to the core tube and extract it. This sand layer also made it difficult to drive the core tube any deeper than 3.5 feet. Despite not reaching the desired core penetration depth and the issues with sample recovery, the second core collected was kept for visual classification and chemical analysis as it represented a very different type of sediment than that found at the other two subsurface sampling locations, and was still located in proximity to the sediment settling basin and discharge outfall. The final sediment sampling location for LL-SED1 was recorded with a Real Time Kinematic differential GPS and is shown in Figure G.3.

5.2 LORA LAKE AND MILLER CREEK SURFACE SEDIMENT SAMPLING

5.2.1 Field Procedures

5.2.1.1 Lora Lake Sampling

Surface sediment samples were collected from a total of four locations (LL-SED1, LL-SED2, LL-SED3, and LL-SED4) within Lora Lake and from one location (LL-SED5) within the sediment settling basin located in the northwestern corner of Lora Lake on March 29, 2011. These surface sediment sampling locations are shown on Figure G.3. The five surface sediment sample locations were selected in coordination with WSDOE to meet the project objectives and provide adequate spatial coverage of Lora Lake.

The surface sediment sampling location LL-SED1 was located in the northern portion of Lora Lake outside of the settling basin area. Surface sediment sampling location LL-SED2 was located at the deepest point within Lora Lake, as determined by the bathymetric survey. Surface sediment sampling location LL-SED3 was located in the southeastern portion of the lake, in proximity to the discharge culvert inlet point. The locations of these three surface sediment sampling locations were co-located with the three subsurface sediment sampling locations, described above in Section 5.1. The location for the fourth surface sediment sampling location LL-SED4 was selected to obtain adequate spatial coverage of Lora Lake and was placed in the southwest corner of the lake. The fifth surface sediment sampling location LL-SED5 was placed within the shallow vegetated sediment settling basin area, approximately 10 to 15 feet from the mouth of the stormwater outfall discharge point. Positioning and navigation to the surface sediment sampling locations within Lora Lake (LL-SED1 through LL-SED4) was accomplished with a Real Time Kinematic differential GPS used on board the inflatable sampling vessel. Water depths were measured directly by lead line prior to collecting the surface sediment samples. Positioning data were also collected using a Real Time Kinematic differential GPS at LL-SED5. The water depth at sampling location LL-SED5 was collected using a measuring tape.

The surface sediment sampling was performed from an inflatable raft by Research Support Services (RSS) divers under the supervision of Floyd|Snider field staff for the surface sediment samples collected from Lora Lake sampling locations LL-SED1 through LL-SED4. The surface sediment samples were collected from a depth of 0 to 15 cm. As discussed above in Section 5.1.2, the depth of the biologically active layer in the Lora Lake sediment could not be visually identified in the sediment cores collected prior to this surface sediment sampling, therefore the default depth of 0 to 15 cm included in the LL Parcel RI/FS Work Plan was applied as the surface sediment sampling depth. These surface sediment samples were collected using clear 3.75-inch diameter cellulose acetate butyrate (CAB) core tubes cut to a length of 15 cm. This sampling method deviated from the work plan, which stated that a 14-inch diver-assisted hand corer ("cookie cutter") would be used. This deviation is further discussed in Section 5.2.3 below. The divers pushed the core tubes into the sediment to the target surface interval of 0 to 15 cm, then used plastic caps to cover the top and bottom of each core tube. The core tubes were then brought to the surface and the sediment from the core tubes was placed into a stainless steel bowl located on the inflatable sampling vessel. Multiple surface sediment grabs were required at each sampling location to obtain the volume of sediment required for the biological testing and conventional and chemical analyses to be performed on these samples. Each core tube held approximately 1 liter of sediment, and between 15 and 18 core tubes of sediment were collected per location.

Because surface sediment sampling location LL-SED5 was located in the shallow vegetated sediment settling basin area, the sediment sampling at this station was performed by a RSS diver wading to this sampling location. The depth of the surface sediment sample collected at this station was from 0 to 15 cm. The 14-inch diver-assisted hand corer was used to collect this sample. The hand corer was inserted into the upper 15 cm of the sediment and then brought to the shore where it was placed in a stainless steel bowl.

Sample processing for the surface sediment samples collected from sampling locations LL-SED1 through LL-SED5 occurred on shore. These samples were visually classified in accordance with ASTM D 2488 and photographed by Floyd|Snider field staff. Sediment descriptions were recorded on Surface Sediment Sample Collection Forms (Attachment G.2). Refer to Section 5.2.2 for additional information. Prior to homogenization of the samples, sediment samples were collected for volatile organic compound (VOC) analysis using U.S. Environmental Protection Agency (USEPA) Method 5035A. The samples were then homogenized to a uniform appearance in stainless steel bowls (several bowls were required for each location). Following homogenization, the remaining sample containers were filled. All sampling containers were tightly capped, labeled, and immediately placed in a cooler maintained at a temperature of approximately 4º C using crushed ice. Samples for conventional and chemical analysis were delivered to ARI in Tukwila, Washington and samples for biological testing were delivered to Nautilus Environmental (Nautilus) in Tacoma, Washington under standard chain-of-custody procedures.

5.2.1.2 Miller Creek Sampling

Surface sediment samples were collected from three locations in Miller Creek (MC-SED1 through MC-SED3) on March 29, 2011. These Miller Creek surface sediment sampling locations are shown on Figure G.3. The Miller Creek surface sediment sampling locations were co-located with the water level monitoring locations that were marked with rebar stakes, described above in Section 3.0. Surface sediment sampling location MC-SED1 was located upgradient (east) from the Lora Lake discharge culvert to Miller Creek. Surface sediment sampling location MC-SED2 was located directly downgradient (west) of the Lora Lake discharge culvert, and surface sediment sampling location MC-SED3 was located further downgradient from the Lora Lake discharge culvert as shown in Figure G.3.

The surface sediment samples in Miller Creek were collected by hand using a stainless steel spoon by an RSS diver under the supervision of Floyd|Snider field staff. The surface sediment samples were collected from the target surface interval of 0 to 10 cm, in accordance with the LL Parcel RI/FS Work Plan, and placed into a stainless-steel bowl sitting just downstream and underwater. During collection of the samples, quarry spalls present in the sampling location were moved by the diver in order to collect the interstitial sediment. Once the stainless-steel bowl was filled with sediment, the bowl was placed on the shore and the sediment allowed to settle out before any overlying water was decanted from the bowls. Cobbles and large gravels, that cannot be analyzed, were then removed from the sampling bowls. The sediment samples were collected between 0 to 2 feet upstream of the rebar stake for all three samples. During surface sediment sample collection, Miller Creek water depths were also measured at the rebar stake located at each sampling location using a measuring tape.

Sample processing for the surface sediment samples collected from sampling locations MC-SED1 though MC-SED3 occurred on shore. These samples were visually classified in accordance with ASTM D 2488 and photographed by Floyd|Snider field staff. Sediment descriptions were recorded on Surface Sediment Sample Collection Forms (Attachment G.2). Refer to Section 5.2.2 for additional information. Prior to homogenization of the samples, sediment samples were collected for VOC analysis using USEPA Method 5035A. The samples were then homogenized to a uniform appearance in stainless-steel bowls (several bowls were required for each location). Following homogenization, the remaining sample containers were filled. All sampling containers were tightly capped, labeled, and immediately placed in a cooler maintained at a temperature of approximately 4º C using crushed ice. Samples for conventional and chemical analysis were delivered to ARI in Tukwila, Washington and samples for biological testing were delivered to Nautilus in Tacoma, Washington under standard chain-of-custody procedures.

5.2.2 Field Observations and Documentation

As part of Lora Lake and Miller Creek surface sample collection, the following information was recorded on each Surface Sediment Sample Collection Form (included as Attachment G.2):

- Date, time, and name of the person logging the sample
- Weather conditions
- Sample location number
- Depth of water at the location

- Sediment sample depth
- Sample recovery
- Biological structures (e.g., shells, tubes, macrophytes, bioturbation)
- Presence of debris (e.g., wood chips, wood fibers, anthropogenic artifacts)
- Presence and description of sheen as applicable
- Apparent grain size
- Odor (e.g., hydrogen sulfide)

No indications of contamination were observed in any of the Lora Lake or Miller Creek surface sediment samples. The surface sediment samples from sampling stations LL-SED3 and LL-SED5 were noted to have a slight organic odor. A biological (or organic) sheen was observed on the sediment surface in the sediment samples collected at sampling locations LL-SED2, LL-SED3, and LL-SED4. No odors or sheens were noted in the Miller Creek surface sediment samples.

Generally, the surface sediment samples from sampling locations LL-SED 1, LL-SED3, and LL-SED4 were brown silt or sandy silt with black streaks. Some of the core tubes collected from sampling locations LL-SED3 and LL-SED4 had organic soil (peat) observed at the bottom of the sampling interval. The surface sediment collected from sampling location LL-SED2 was a dark grey silt with some brown mottling. Several worms were observed in this sample. The surface sediment collected at sampling location LL-SED5, within the sediment settling basin, was markedly different from the lake samples, and generally consisted of brown coarse sand with some silt and gravel present.

The three surface sediment samples in Miller Creek generally consisted of grey to black sandy gravel. Worms and some organic material (bark and twigs) were observed in the sediment collected at MC-SED1. In the sediment from sampling location MC-SED2, broken glass and porcelain were observed. Refer to the Sample Collection Forms in Attachment G.2 for additional details.

5.2.3 Minor Work Plan Deviations

One minor deviation from the LL Parcel RI/FS Work Plan occurred during the collection of surface sediment from sampling locations LL-SED1 through LL-SED4. Field staff determined prior to sampling that, due to the unconsolidated nature of the surface sediment in Lora Lake, a 14-inch deep diver-assisted hand corer would be difficult to use for sampling. If the hand corer was used, overlying water would need to be removed prior to removal of the sediment from the corer. This removal of the overlying water would be difficult to perform without resulting in the loss of some of the sediment sample. To prevent the loss of sample and to obtain the desired sampling depth, 15 cm deep CAB core tubes (discussed above in Section 5.2.1) were used to collect the sediments at sampling locations LL-SED1 through LL-SED4.

6.0 Sediment Analytical Results

6.1 ANALYTICAL METHODS

6.1.1 Subsurface Sediment Investigation

The subsurface sediment samples collected from Lora Lake were analyzed for the following constituents by the methods indicated below, in accordance with the LL Parcel RI/FS Work Plan:

- Total organic carbon (TOC) by PSEP protocol
- Arsenic and lead by USEPA Method 6010B
- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) by USEPA Method 8270D-Select Ion Monitoring (SIM; low level)
- Pentachlorophenol (PCP) by USEPA Method 8041
- Dioxins/furans by USEPA Method 1613

Because of the presence of peat in the two deeper sampling intervals collected from the LL-SED3 core, these two samples (LL-SED3-36-141-031511 and LL-SED3-141-167-031511) were also analyzed for total sulfide by PSEP protocol.

The chemical analyses were performed by ARI with Frontier Analytical Laboratory performing the dioxins/furans analysis.

The freeze coring methodology that was used to collect subsurface sediment cores and samples, as described in Section 5.1.1.2, results in the potential release of VOCs during freezing and thawing and the potential alteration of the grain size distribution and water content. Therefore, no VOC, grain size, or total solids analyses were requested for these subsurface sediment samples; however, total solids analyses of all sediment samples were performed by the laboratory in order to determine the dry weight contaminant concentrations. Therefore, the results of the total solids analyses are included in the LL Parcel data tables, but are assumed approximate for the subsurface sediment samples collected using the freeze coring methodology. The co-located surface sediment samples were analyzed for these constituents. Analytical results for the subsurface sediment samples are presented in Table G.3 and detected concentrations of the preliminary contaminants of concern (PCOCs) are presented in Figure G.4. The analytical reports, including Chain-of-Custody Forms, are presented in Attachment G.3.

6.1.2 Surface Sediment Investigation

Surface sediment samples collected from Lora Lake and Miller Creek were analyzed for the following constituents by the methods indicated below:

- Total solids by USEPA Method 160.3
- TOC by PSEP protocol
- Grain size by PSEP protocol
- Ammonia by USEPA Method 350.1
- Total sulfides by PSEP protocol
- Arsenic and lead by USEPA Method 6010B
- cPAHs by USEPA Method 8270D-SIM (low level)
- PCP by USEPA Method 8041
- Tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), and 1,2-dichloroethane (1,2-DCA) by USEPA Method 8260C
- Dioxins/furans by USEPA Method 1613

The chemical analyses were performed by ARI with Frontier Analytical Laboratory performing the dioxins/furans analysis.

The analyses of ammonia and total sulfides was also used to provide information on the biological testing sediment conditions. Analytical results for all surface sediment samples are presented in Table G.4 and detected concentrations of the PCOCs are presented in Figure G.5. Analytical reports, including Chain-of-Custody Forms, are presented in Attachment G.3.

6.2 DATA QUALITY

A Level III Data Quality Review (Summary Validation) was performed on all the analytical data, except dioxins/furans, that had a Level IV, Tier III Data Quality Review (Full Validation). All data validation was performed by EcoChem, Inc. Refer to Attachment G.4 for the EcoChem Data Validation Reports.

Data validation was based on the quality control (QC) criteria as recommended in the methods identified in the LL Parcel RI/FS Work Plan and in the National Functional Guidelines for Organic and/or Inorganic Data Review (USEPA 2004 and 2008). The dioxin/furan data were also evaluated using the *USEPA National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* (USEPA 2005).

As determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted below, accuracy was acceptable, as demonstrated by the surrogate, laboratory control sample/laboratory control sample duplicate (LCS/LCSD), and matrix spike/matrix spike duplicate (MS/MSD) recoveries. Precision was also acceptable as demonstrated by the MS/MSD, LCS/LCSD, and field duplicate relative percentage difference (RPD) values. The data validation results for the subsurface and surface sediment data are described below.

6.2.1 Subsurface Sediment Data

- **TOC and Sulfide.** Sulfide data detection limits for Samples LL-SED3-36-141-031511 and LL-SED3-141-167-031511 were estimated (UJ) based on the low MS recovery for sulfide in Sample LL-SED3-141-167-031511. Reporting limits (RLs) were elevated for TOC and sulfide due to the high moisture content in the samples. All data, as qualified, are acceptable for use.
- **Arsenic and Lead.** RLs were elevated for these analytes due to the high moisture content in the samples. All data, as reported by the laboratory, are acceptable for use.
- **cPAHs.** Internal standard recoveries for perylene-d12 were less than the lower control limits for Samples LL-SED2-112-168-031511, LL-SED2-0-56-031511-D, and LL-SED1-0-56-031511 in both the initial analyses and re-analyses of these samples. Because of these internal standard outliers, the results for three analytes—benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene—were qualified as estimated (J/UJ) for detected values and non-detects in these three samples. Results from the initial analyses were used and the re-analysis data for these samples were labeled as do-not-report (DNR). RLs were elevated for all analytes due to the high moisture content in the samples. With the exception of the data labeled as DNR, all other data, as qualified, are acceptable for use.
- **PCP.** RLs were elevated due to the high moisture content in the samples, and in one sample, LL-SED1-0-56-031511, due to matrix interference. All data are acceptable for use as reported by the laboratory.
- **Dioxins/Furans.** Labeled compound recoveries were less than the lower control limits for select analytes in Samples LL-SED2-0-56-031511, LL-SED2-0-56-031511-D, LL-SED3-0-36-031511, and LL-SED3-141-167-031511. Both the detected and non-detected results of these select analytes in these samples were qualified as estimated (J/UJ). Several samples were reanalyzed at dilution due to analyte concentrations that exceeded the calibration range of the instrument with only the most appropriate positive result from either the original or diluted analysis reported. All data, as qualified, are acceptable for use.

6.2.2 Surface Sediment Data

- **Conventionals (Total Solids, TOC, Sulfide, Ammonia, Grain Size).** The matrix spike recovery for TOC was greater than the upper control limit. All TOC results were therefore qualified as estimated (J). RLs were elevated due to the high moisture content in the samples. All data, as qualified, are acceptable for use.

- **Arsenic and Lead.** All data, as reported by the laboratory, are acceptable for use.
- **cPAHs.** The surrogate recovery for 2-methylnaphthalene-d10 was less than the lower control limit for Sample MC-SED1-0-10-032911. No cPAHs were detected in this sample. The non-detected results for this sample were qualified as estimated (UJ) due to the low surrogate recovery. The internal standard recoveries for naphthalene-d8, acenaphthene-d10, phenanthrene-d10, and chrysene-d12 were greater than the upper control limit in Sample LL-SED5-0-15-032911. The results for the associated compounds chrysene and benzo(a)anthracene were qualified as estimated (J). All data, as qualified, are acceptable for use.
- **PCP.** The PCP result for Sample LL-SED1-0-15-032911 was "P" flagged by the laboratory to indicate that the percent difference between confirmation columns was greater than 40 percent. The result was qualified as estimated (J) for this sample. Surface Sample LL-SED2-0-15-032911 was run at 1x and 10x dilutions. PCP was not detected in either analysis. The result from the 1x dilution was used and the result from the 10x dilution was qualified as do-not-report (DNR). With the exception of the data labeled as DNR, all other data, as qualified, are acceptable for use.
- **VOCs.** All data, as reported by the laboratory, are acceptable for use.
- **Dioxins/Furans.** Labeled compound recoveries were less than the lower control limit for select analytes in Samples LL-SED1-0-15-032911MC-SED3-0-10-032911, and LL-SED1-0-15-032911-ER (the equipment rinsate blank). Both the detected and non-detected results of these select analytes in these samples were qualified as estimated (J/UJ). For Sample LL-SED1-0-15-032911-D, the labeled compound recovery for octachlorodibenzo-p-dioxin (OCDD) was greater than the upper control limit and OCDD was qualified as estimated (J) in this sample. Several samples were reanalyzed at dilution due to analyte concentrations that exceeded the calibration range of the instrument with only the most appropriate positive result from either the original or diluted analysis reported by the laboratory. All data, as qualified, are acceptable for use.

6.3 RESULTS

6.3.1 Subsurface Sediment Samples

The Lora Lake subsurface sediment analytical results are summarized below. The analytical results for the subsurface sediment samples are presented in Table G.3.

6.3.1.1 Conventionals

TOC levels in the subsurface sediment samples ranged from 4.22 to 26.1 percent. The highest TOC level was detected in the 56–112 cm sampling interval from the LL-SED2 core. Sulfide was not detected in either of the deeper LL-SED3 core samples that were tested (36–141 cm or 141–167 cm) where peat was observed.

6.3.1.2 Metals

Arsenic was detected in all of the subsurface sediment samples with the exception of the sample interval from 36–141 cm in the LL-SED3 core. Arsenic concentrations ranged from 9 mg/kg in the 0–56 cm sample interval from the LL-SED1 core to 80 mg/kg in all three sample intervals from the LL-SED2 core.

Lead was detected only in the top sample intervals of the three cores. Concentrations of lead ranged from 29 mg/kg in the 0–56 cm sample interval from the LL-SED1 core to 450 mg/kg in the 0–36 cm sample interval from the LL-SED2 core.

6.3.1.3 Semivolatile Organic Compounds

cPAHs were detected in all of the top sample intervals from the three cores (0–56 cm for the cores from sampling locations LL-SED1 and LL-SED2 and 0–36 cm for core from sampling location LL-SED3). Chrysene was the only cPAH detected in a deeper sample interval, from 36–141 cm, in the core collected from sampling location LL-SED3. No cPAHs were detected in the 56–112 cm and 112–168 cm sample intervals in the LL-SED2 core and in the 141–167 cm sample interval in the LL-SED3 core. Toxic equivalency quotients (TEQs) for cPAHs were calculated according to MTCA (WAC 173-340-900, Table 708-1) in two ways: with non-detect values set to zero and with non-detects set to one-half of the RL. Of the Lora Lake subsurface sediment samples, the sample interval from 36–141 cm from the LL-SED3 core showed the minimum detected TEQ of 0.18 µg/kg (non-detect = 0) and 11 µg/kg (non-detect = ½ RL). The maximum TEQ calculated was 580 J µg/kg (no non-detect values) in the 0–56 cm sample interval from the LL-SED2 core.

Pentachlorophenol was not detected in any of the subsurface sediment samples.

6.3.1.4 Dioxins/Furans

TEQs for all chlorinated dibenzo-p-dioxins and dibenzofuran congeners were calculated according to toxic equivalency factors (TEFs) specified in MTCA (WAC 173-340-900, Table 708-2). For those samples with concentrations flagged as undetected, the TEQ was calculated in two ways: with "non-detect" values set to zero, and with "non-detect" values set to one-half of the detection limit. All Lora Lake subsurface sediment sample results showed at least one detected dioxin/furan congener, with the minimum TEQs of 0.00444 J pg/g (non-detect = 0) and 1.58 J pg/g (non-detect = ½ the detection limit) in the 141–167 cm sample interval from the LL-SED3 core. The maximum TEQ detected in these subsurface sediment samples was 202 J pg/g (no non-detect values), detected in the 0–36 cm sample interval from the LL-SED3 core.

Dioxin/furan TEQs were highest in the top sample intervals in the cores from LL-SED2 and LL-SED3. The original sample and field duplicate results collected from the 0--56 cm sample interval in the LL-SED2 core showed dioxin/furan TEQs of 103 J pg/g and 154 J pg/g (no non-detect values), respectively. The two lower sample intervals in the LL-SED2 core had dioxin/furan TEQs of 0.648 J and 0.143 J pg/g (non-detect = 0) and 1.30 J and 0.659 J pg/g (non-detect = ½ detection limit) for the 56–112 cm and 112–168 cm sample intervals, respectively. As stated above, the 0–36 cm sample interval from the LL-SED3 core had a dioxin/furan TEQ of 202 J pg/g. The 36–141 cm and 141–167 cm sample intervals from the LL-SED3 core had dioxin/furan TEQs of 0.283 J and 0.00444 J pg/g (non-detect = 0) and 0.657 J and 1.58 pg/g (non-detect = ½ the detection limit), respectively. Only one sample interval, from 0–56 cm, was collected from the LL-SED1 core and this sample had a dioxin/furan TEQ of 23.2 J pg/g (no non-detect values).

6.3.2 Surface Sediment Samples

The Lora Lake and Miller Creek surface sediment analytical results are summarized below. The analytical results for these surface sediment samples are presented in Table G.4.

6.3.2.1 Conventionals

TOC percentages, total solids percentages, sulfide concentrations, and grain size distributions varied widely between the surface sediment samples collected within Lora Lake (samples from LL-SED1 though LL-SED4) and the Lora Lake surface sediment sample collected from the sediment settling basin (the LL-SED5 sample) and the Miller Creek surface sediment samples (samples from MC-SED1 through MC-SED3).

TOC levels in the Lora Lake surface sediment samples from LL-SED1 through LL-SED4 ranged from 5.8 to 10.6 percent, while the LL-SED5 sample result, from the lake's sediment settling basin, was 0.90 percent TOC. TOC levels in the Miller Creek surface sediment samples ranged from 0.15 to 0.54 percent.

Total solids in the LL-SED1 through LL-SED4 surface sediment samples ranged from 15.4 to 20.7 percent. The LL-SED5 sample was 81.6 percent total solids and the Miller Creek surface sediment samples ranged between 77.2 and 85.2 percent total solids.

Surface sediment sample results from LL-SED1 through LL-SED4 showed sulfide concentrations ranging between 1,120 and 2,670 mg/kg. The highest concentration was detected in the LL-SED2 surface sediment sample. The surface sediment sample result from LL-SED5 showed sulfide detected at a concentration of 31.4 mg/kg. Sulfide was only detected in one of the Miller Creek surface sediment samples, the sample from MC-SED1, with a concentration of 48.6 mg/kg.

Generally, grain size in the surface sediment samples collected within Lora Lake corresponded with field observations of silty sediment. These Lora Lake surface sediment samples, with the exception of the sample from LL-SED1, were greater than 70 percent fines. The surface sediment sample result from LL-SED1 showed a lower percentage of fines, at approximately 50 percent, also reflective of the sandier sediment materials observed in the field at this location. The surface sediment sample from LL-SED5, collected from the settling basin, was predominately sand (greater than 62.5 microns) with some gravel. The grain size distribution of the Miller Creek surface sediment samples reflected the gravelly nature of these sediments. Generally, over 95 percent of the Miller Creek surface sediment samples consisted of materials greater than 250 µm in diameter, with greater than 50 percent of the sample consisting of gravel. Grain size distribution curves are presented in Attachment G.5.

6.3.2.2 Metals

Arsenic was detected in all of the surface sediment samples from Lora Lake. The arsenic concentrations in these samples ranged from 7 mg/kg in the sample from LL-SED5 to 70 mg/kg in the sample from LL-SED3. Arsenic was detected in only one of the Miller Creek surface sediment samples, the sample from MC-SED1, with a concentration of 8 mg/kg.

Lead was detected in all of the Lora Lake surface sediment samples. The lowest concentration detected in the lake surface sediment samples was 48 mg/kg in the sample from LL-SED5 (collected from within the sediment settling basin). The other Lora Lake surface sediment sample results showed arsenic concentrations ranging from 281 to 492 mg/kg. The highest concentration was detected in the sample from LL-SED4. Lead detections in the surface sediment samples from Miller Creek, ranging from 4 to 12 mg/kg, were considerably less than the lead concentrations detected in the lake surface sediment samples.

6.3.2.3 Semivolatile Organic Compounds

cPAHs were detected in all of the Lora Lake surface sediment samples. No cPAHs were detected in the Miller Creek surface sediment samples. For the Lora Lake surface sediment samples, the results from LL-SED4 showed the lowest cPAH TEQ of 43 µg/kg (no non-detect values). The maximum cPAH TEQ calculated was 180 µg/kg (no non-detect values) for the LL-SED1 surface sediment sample.

PCP was detected in two of the Lora Lake surface sediment samples, the LL-SED1 and LL-SED5 samples, at concentrations of 50 J µg/kg and 33 µg/kg, respectively. PCP was not detected in the Miller Creek surface sediment samples.

6.3.2.4 Volatile Organic Compounds

PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-DCA were not detected in any of the Lora Lake or Miller Creek surface sediment samples.

6.3.2.5 Dioxins/Furans

At least one dioxin/furan congener was detected in all surface samples from Lora Lake and Miller Creek. The lowest TEQs were calculated for the Miller Creek surface sediment samples, with the TEQs for these samples ranging from 0.0121 J to 0.109 J pg/g (non-detect = 0) and 0.327 J to 0.435 J pg/g (non-detect = ½ the detection limit). For the Lora Lake surface sediment samples, the lowest TEQs calculated of 7.41 J pg/g (non-detect = 0) and 7.55 J pg/g (non-detect = ½ the detection limit) was for the LL SED5. Samples collected within the lake, LL-SED1 through LL-SED4, had dioxin/furan TEQs ranging from 149 to 217 pg/g (no non-detect values), with the maximum TEQ detected in the LL-SED2 sample.

7.0 Sediment Bioassay Results

Freshwater biological toxicity testing (biological testing) was performed on Lora Lake and Miller Creek sediments to determine if there are adverse biological effects in the biologically active zone of these surface sediments. The biologically active zones are estimated to be at a depth of 0 to 15 cm in Lora Lake and 0 to 10 cm in Miller Creek. The surface sediment samples from Lora Lake and Miller Creek were collected at these depths, as described above in Section 5.2. The deeper estimated depth in Lora Lake is related to the unconsolidated nature of the lake sediment. Seven surface sediment samples were collected from Lora Lake and Miller Creek for freshwater biological testing (samples from sampling locations LL-SED1 through LL-SED4 and MC-SED1 through MC-SED-3). The surface sediment sample from sampling location LL-SED5, collected in the sediment settling basin area of Lora Lake, was not submitted for biological testing, as this environment is substantially different than other sediment sampling locations in Lora Lake. The sediment settling basin is located in a manmade shallow vegetated area that is seasonally submerged and dominated by large aquatic plants.

The biological testing performed on these samples, the corresponding data quality review, and the results of the biological testing are summarized below.

7.1 BIOLOGICAL TESTING METHODS

The species used for the freshwater biological tests are presented below:

- 10-day acute amphipod (*Hyalella azteca*) for mortality
- 20-day chronic midge (*Chironomus dilutus*, formerly known as *tentans*) for mortality and growth
- 15-minute 100 percent porewater Microtox® bacteria (*Vibrio fischeri*) bioluminescence test

Biological testing was performed by Nautilus according to guidelines for the *Hyalella azteca*, *Chironomus dilutus*, and Microtox® tests (USEPA 2000, ASTM 2000, and WSDOE 2008) and in accordance with the LL Parcel RI/FS Work Plan.

The biological testing methods are described in further detail in the *Port of Seattle Lora Lake RI/FS Sediment Characterization Toxicological Results Report* prepared by Nautilus, which is included as Attachment G.6. An addendum to this report, reporting results for the LL-SED2 repeat testing, is also included as Attachment G.6.

7.2 DATA QUALITY

A review of the biological tests performed on surface sediment samples collected from Lora Lake and Miller Creek is necessary to confirm that appropriate and thorough laboratory testing and documentation procedures were followed. Biological test data were compiled and reviewed for validity using the appropriate guidelines set forth in the LL Parcel RI/FS Work Plan. Data were reported according to the established quality assurance/quality control (QA/QC) procedures described in WSDOE's *Sediment Sampling and Analysis Plan Appendix* (WSDOE 2008). Nautilus documented and provided an explanation of the exceptions to the established procedures (refer to Attachment G.6). Additionally, Nautilus completed test quality control checklists (originally included as Attachment B.1 of the LL Parcel RI/FS Work Plan) to ensure that the appropriate test elements were followed (refer to Attachment G.6).

The data quality review compares biological testing holding conditions, test setup, test implementation, and test termination to pertinent biological testing protocols. The following test setup procedures were reviewed: organism procurement, number of organisms, number of replicates, volume of sediment, and general test initiation conditions. The review of test implementation evaluates daily monitoring variables and summaries of information pertinent to the negative and positive control samples.

As determined by this data quality evaluation, the laboratory followed the specified biological testing methods. The Microtox tests met control acceptance criteria and there were no deviations from method protocols. Exceptions or issues that arose during the *Chironomus dilutus* and the *Hyalella azteca* testing are noted below (refer to Attachment G.6 for additional details):

- ***Chironomus dilutus* testing for mortality and growth.** The initial *Chironomus dilutus* test started within a week of sample collection did not meet the test control limits because the organisms used for the testing appeared to be of low quality due to a low hatching rate. Therefore, the laboratory initiated a second test with a new batch of organisms within 2 weeks of sample collection. This second test was outside the time frame of initiating the test within 1 week of sample collection, as stated in the LL Parcel RI/FS Work Plan; however, it was well within the sample holding time requirement of 8 weeks that is specified in the USEPA and ASTM methods.
- The growth for the control sample for this second test was just less than the acceptability criteria of 0.48 mg/individual ash-free dry weight (AFDW), which was attributed by the laboratory to the temperature the test was run at and the sand used for the testing. The test was run at 20°C to help prevent the molting of larvae into pupae during the testing; however, the growth requirement for this test is based at a test temperature of 23°C, and cooler temperatures are known to reduce growth in organisms, so the growth criteria are not directly applicable to tests run at 20°C. Previous testing conducted by the laboratory at 20°C was able to meet the growth criteria, but these tests were conducted with clean beach sand as the control, instead of the silica sand that was used for the control during this testing. The beach sand likely contained additional organic material in comparison to the silica sand. Regardless of this issue with the control, the test sediments organisms grew more than the minimum required and more than the control; therefore, the test was considered to be acceptable.

- The surface sediment sample from LL-SED2 was found to be toxic, based on the mortality results, following the first round of testing. It was noted during termination of the test that seven of the eight replicates contained *Chaoborus sp.*, which is a carnivorous midge that could have been responsible for the mortality of the *Chironomus dilutus* observed in the sample and possibly the reason the sediment was found to be toxic. Testing on this sample was repeated within the method holding time, following sieving of the sediment through a 0.5 mm sieve to remove any *Chaoborus sp.* larvae or eggs.
- ***Hyalella azteca* for mortality.** The reference toxicant test, run in conjunction with the testing performed on the sediment samples and control, did not meet the control requirements and exhibited no dose-response curve. No conclusive explanation was reached by the laboratory for this inability to meet the control criterion. As there was no evidence of toxicity in the test sediments and the associated control, and the organisms in the reference toxicant test were clearly sensitive, the laboratory determined that these sediment toxicity test results should still be considered valid.

7.3 RESULTS

Biological test results were evaluated by comparing test data to the criteria presented in the *Sediment Evaluation Framework for the Pacific Northwest* (RSET 2009) and the Draft Freshwater Benthic Sediment Quality Value technical report prepared for WSDOE (Avocet 2010). Currently, freshwater reference areas for collecting reference sediments for biological testing have not been identified. Therefore, the results of the Lora Lake and Miller Creek biological tests were compared to the negative control tests completed concurrently with the tests. The RSET freshwater decision criteria approach, which is consistent with WSDOE's marine biological testing Sediment Cleanup Objectives (SCO) and Cleanup Screening Level (CSL) criteria, was used to evaluate the biological test results, but comparison to reference results was replaced with comparison to the negative control results. RSET's decision criteria consist of two levels of observed response in the test organisms. These are known as "one-hit" or "two-hit" failures. A one-hit (CSL) failure is a marked response in any one biological test. A two-hit (SCO) failure is a lower intensity of response. A two-hit failure must be found in two or more biological tests for the test sediment to potentially cause adverse impacts to ecological receptors. The one modification to the RSET biological testing decision criteria is the two-hit (SCO) criteria for the 10-day amphipod mortality test. The decision criteria as modified and used are consistent with the Draft Freshwater Benthic Sediment Quality Value technical report prepared for WSDOE (Avocet 2010) and the Sediment Management Standards (WSDOE 2013).

A summary of the biological test results is included in Table G.5 and Figure G.6. A discussion of the biological test results in comparison to the decision criteria is included below. For more details on the biological test results, refer to the Toxicological Results Reports included as Attachment G.6.

7.3.1 10-day Acute Amphipod (*Hyalella azteca*) for Mortality

For the amphipod biological test, mean test mortality greater than 10 percent over the mean control response and statistically different from the control (alpha = 0.05) is considered a two-hit (SQS) failure. A one-hit (CSL) failure is defined as a mean test mortality greater than 25 percent over the mean control response and statistically different from the control (alpha = 0.05).

Mortality in the Lora Lake and Miller Creek sediment samples ranged from 0 to 8.8 percent, compared with 3.8 percent in the control. None of the samples were significantly different from the control; therefore, none of the samples meet the one-hit or two-hit criteria for survival.

7.3.2 20-day Chronic Midge (*Chironomus dilutus*, formerly known as *tentans*) for Mortality and Growth

For the midge 20-day mortality test, a mean mortality in test sediment of 15 percent over the mean control response and statistically different from the control (alpha = 0.05) is considered a two-hit (SQS) failure. A mean mortality in test sediment of 25 percent over the mean control response, and statistically different from the control (alpha = 0.05) is considered a one-hit failure (CSL).

For the midge 20-day growth test, a mean reduction in biomass greater than 25 percent and statistically different from control (alpha = 0.05) is considered a two-hit (SQS) failure, while a one-hit (CSL) failure is considered a mean reduction in biomass greater than 40 percent and statistically different from control (alpha = 0.05).

Mortality in the Lora Lake and Miller Creek sediment samples ranged from 20.8 to 77.1 percent, compared with 7.3 percent in the control. All of the sediment samples, except the samples from sampling stations LL-SED1 and MC-SED2, were significantly different from the control and showed percent mortalities greater than 15 percent compared to the control, failing the two-hit criterion for survival. The LL-SED2 sediment sample had a percent mortality greater than 25 percent compared to the control and was significantly different from the control, therefore failing the one-hit criterion for survival. As discussed above in Section 7.2, the LL-SED2 sediment sample was discovered to contain *Chaoborus sp.* at the termination of this test. *Chaoborus sp.* are carnivorous and were potentially responsible for the mortality of *Chironomus dilutus* observed during this initial testing of this sample, and as a result a repeat test of the sediment from LL-SED2 was conducted that used sediments that were sieved to remove any remaining *Chaoborus sp.* larvae or eggs. In this second test, the percent mortality of the LL-SED sediment sample was 51.0 percent compared with 10.4 percent in the control. The 40.6 percent difference between the LL-SED2 sediment sample and control was significantly different, resulting in confirmation of failure of the one-hit criterion for survival for the sample.

Growth in the samples ranged from 0.85 to 1.41 mg/individual AFDW, compared with 0.41 mg/individual AFDW in the control. As all samples were greater than the control, the samples did not meet the one-hit or two-hit criteria for growth. In the second test performed on the LL-SED2 sediment sample, the mean growth was 0.75 mg/individual AFDW in the sample compared to the control mean growth of 0.81 0.75 mg/individual AFDW. This difference between the sample and control was not significantly different, and consistent with the initial results this sample did not meet the one-hit or two-hit criteria for growth.

7.3.3 15-minute 100 Percent Porewater Microtox® Bacteria (*Vibrio fischeri*) Bioluminescence Test

For the Microtox® 15-minute bioluminescence test, a mean test output less than 90 percent of the control mean output and statistically significantly different (alpha = 0.05) from the control mean output indicates a two-hit (SQS) failure. A one-hit (CSL) failure is defined as a mean test output less than 75 percent of the control mean output and statistically significantly different (alpha = 0.05) from the control mean output.

The change in light output in the samples at 15 minutes ranged from 82 to 90 percent, compared with 83 and 89 percent in the controls. No samples were significantly different from the controls; therefore, none of them meet the one-hit or two-hit criteria for bioluminescence.

7.3.4 Conclusions of Biological Testing Results

Surface sediment samples from sampling locations LL-SED1 and MC-SED2 did not have any one-hit or two-hit failures. The LL-SED3, LL-SED4, MC-SED1, and MC-SED3 sediment samples failed the two-hit criterion for midge survival; however, because these samples did not have a second hit in the midge growth, the amphipod mortality, or Microtox® tests, these samples are considered unlikely to cause adverse impacts to ecological receptors. The LL-SED2 sediment sample failed the one-hit criterion for midge survival, both in the initial test and the repeat test.

This page intentionally left blank

8.0 Shallow Soil Investigation Procedures

A shallow soil investigation on the LL Parcel was performed to assess if LL Apartments Parcel contaminants have come to be located along the western edge of the LL Parcel (the side of the LL Parcel located downgradient and directly across Des Moines Memorial Drive from the LL Apartments Parcel) as a result of historical overland flow. This investigation included collecting shallow soil samples for chemical analysis from six locations on the LL Parcel located between Des Moines Memorial Drive and Lora Lake. The sample locations were selected in coordination with WSDOE to meet the project objectives and address public comments regarding potential transport pathways from the LL Apartments Parcel. Additionally, the sample locations were selected to help bound the horizontal extent of shallow dioxin/furan contamination along the eastern edge of the LL Apartments Parcel. The shallow soil investigation procedures were performed in accordance with the LL Parcel RI/FS Work Plan. The shallow soil field investigation activities are discussed in detail below. The chemical analyses performed on these soil samples and the results of these analyses are discussed in Section 9.0.

8.1 SHALLOW SOIL SAMPLING

8.1.1 Field Procedures

The shallow soil samples were collected at six locations (LL-SB1 through LL-SB6) on the LL Parcel directly downgradient from the LL Apartments Parcel and parallel to Des Moines Memorial Drive on April 18 and 19, 2011. The shallow soil sample locations are shown on Figure G.3. A soil boring was installed at each location using a hand auger by Floyd|Snider field staff, with soil samples collected from each boring at three depth intervals: 0–0.5 foot, 1.5–2 feet, and 2–4 feet. The hand auger has a cutting end (bit) that advances the device through the subsurface as it is manually turned. A disturbed soil sample was collected at each depth interval and lifted within the auger to the surface where the sample was transferred to a decontaminated stainless-steel bowl for visual classification, field screening for contamination, and sample collection for chemical analysis.

The soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) and photographed. Soil descriptions were recorded on Soil Boring Logs (Attachment G.2).

Field screening was performed to identify areas of potential contamination according to the methods described in the LL Parcel RI/FS Work Plan. To determine if a sheen was present, a small volume of each soil sample was placed in a stainless-steel bowl of water. Any sheen observed forming on the surface of the water was then recorded. Visual and olfactory indications of contamination were also recorded on the boring logs (Attachment G.2). Refer to Section 8.1.2 for additional information.

Prior to homogenization of the samples, soil samples were collected for VOC analysis using USEPA Method 5035A. The samples were then homogenized until uniform in color and texture. Following homogenization, the remaining laboratory-provided sample containers were filled. All sample containers were tightly capped, labeled, and immediately placed in a cooler maintained at a temperature of approximately 4º C using crushed ice. The soil samples were delivered to ARI in Tukwila, Washington under standard chain-of-custody procedures.

8.1.2 Field Observations and Documentation

As part of the soil sample collection, the following information was recorded on each Soil Boring Log (included as Attachment G.2):

- Date, time, and name of the person logging the sample
- Weather conditions
- Sample location number
- Soil sample depth and soil description
- Sample recovery
- Presence of debris
- Presence of sheen or any other indications of contamination

No sheens, odors, or other indications of contamination were observed in any of the hand auger boring soil samples. Generally, soil types consisted of brown, grey-brown, or orange-brown silty fine sand or fine sand. A gravelly sand was noted in boring LL-SB3 from 2 to 4 feet below ground surface (bgs). Organic materials, such as plant roots and wood chips, were noted in the surface samples from each of the borings.

8.1.3 Minor Work Plan Deviations

One minor deviation from the LL Parcel RI/FS Work Plan occurred during the collection of the soil samples. At location LL-SB2 the required penetration depth of 4 feet bgs could not be achieved due to the presence of large cobbles at depth. Refusal in this boring occurred at 3.5 feet bgs, and the deepest sample was collected from the 2-3.5 foot interval.

9.0 Shallow Soil Analytical Results

9.1 ANALYTICAL METHODS AND DATA QUALITY

The shallow soil samples collected during the LL Parcel shallow soil investigation were analyzed for the following chemicals by the methods indicated below, in accordance with the LL Parcel RI/FS Work Plan:

- Arsenic and lead by USEPA Method 6010
- Total petroleum hydrocarbons (TPH; diesel range and oil range) by NWTPH-Dx
- TPH (gasoline range) by NWTPH-G
- cPAHs by USEPA Method 8270
- PCP by USEPA Method 8041
- PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-DCA by USEPA Method 8260C
- Benzene, toluene, ethlybenzene, and xylenes (BTEX) by USEPA Method 8021
- Dioxins/furans by USEPA Method 1613

These samples were also analyzed for total solids by USEPA Method 160.3 and TOC by PSEP protocol. The chemical analyses were performed by ARI with Frontier Analytical Laboratory performing the dioxin/furan analyses.

Analytical results for the shallow soil samples are presented in Table G.6 and detected concentrations of the PCOCs are presented in Figure G.7. The laboratory analytical data reports, including Chain-of-Custody Forms, are presented in Attachment G.3.

9.2 DATA QUALITY

A Level III Data Quality Review (Summary Validation) was performed on all the analytical data, except dioxins/furans, that had a Level IV, Tier III Data Quality Review (Full Validation). All data validation was performed by EcoChem, Inc. Refer to Attachment G.4 for the EcoChem Data Validation Reports.

Data validation was based on the QC criteria as recommended in the methods identified in the the LL Parcel RI/FS Work Plan and in the National Functional Guidelines for Organic and/or Inorganic Data Review (USEPA 2004 and 2008). The dioxin/furan data were also evaluated using the *USEPA National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* (USEPA 2005).

As determined by this evaluation, the laboratory followed the specified analytical methods. With the exceptions noted below, accuracy was acceptable, as demonstrated by the surrogate, LCS/LCSD, and MS/MSD recoveries. Precision was also acceptable as demonstrated by the MS/MSD, LCS/LCSD, and field duplicate RPD values. The data validation results for the shallow soil data are described below:

- **TOC and Total Solids.** All data, as reported by the laboratory, are acceptable for use.
- **Arsenic and Lead.** All data, as reported by the laboratory, are acceptable for use.
- **Gasoline Range TPH.** All data, as reported by the laboratory, are acceptable for use.
- **Diesel Range TPH.** All data, as reported by the laboratory, are acceptable for use.
- **cPAHs.** The surrogate recovery for dibenzo(a,h)anthracene-d14 was less than the lower control limit for Sample LL-SB5-0-0.5-041811 and the surrogate recovery for 2-methylnaphthalene-d10 was less than the lower control limit for Sample LL-SB3-1.5-2-041911. Due to these low surrogate recoveries, all results for these two samples were qualified as estimated (J/UJ) for detected values and non-detects. All data, as qualified, are acceptable for use.
- **PCP.** All data, as reported by the laboratory, are acceptable for use.
- **VOCs.** All data, as reported by the laboratory, are acceptable for use.
- **Dioxins/Furans.** Labeled compound recoveries were less than the lower control limit for select analytes in the following samples:

LL-SB1-0-0.5-041911	LL-SB2-1.5-2-041911
LL-SB1-0-0.5-041911-D	LL-SB2-2-3.5-041911
LL-SB1-1.5-2-041911	LL-SB3-1.5-2-041911
LL-SB1-2-4-041911	LL-SB3-2-4-041911
LL-SB2-0-0.5-041911	LL-SB4-2-4-041911

Both the detected and non-detected results of these select analytes in these samples were qualified as estimated (J/UJ). For Sample LL-SB5-0-0.5-041811, the labeled compound recovery for 1,2,3,4,7,8,9-HpCDF was greater than the upper control limit and this analyte was qualified as estimated (J) in this sample. All data, as qualified, are acceptable for use.

9.3 RESULTS

The Lora Lake Parcel shallow soil analytical results are summarized below. The analytical results for the shallow soil samples are presented in Table G.6.

9.3.1 Conventionals

Total solids were found to be fairly consistent across all soil samples, with percentages of total solids ranging from 74.0 to 92.9 percent. The majority of the percentages fell in the 88 to 92 percent range. TOC among samples was slightly more variable, with percentages ranging from 0.072 percent (sample interval from 2–3.5 feet bgs from Boring LL-SB2) to 8.78 percent (the sample interval from 0–0.5 foot bgs from Boring LL-SB5).

9.3.2 Metals

Arsenic was detected in 13 of the soil samples. Arsenic concentrations ranged from 6 mg/kg in the samples from the 1.5–2 feet bgs sample interval from Borings LL-SB1 and LL-SB3 to 13 mg/kg in the samples from the 0–0.5 foot bgs sample interval from Borings LL-SB2 and LL-SB4. Lead was detected in all but one of the soil samples. Lead concentrations ranged from 2 mg/kg (multiple locations and depths) to 64 mg/kg in the sample interval from 0–0.5 foot bgs from Boring LL-SB5.

9.3.3 Total Petroleum Hydrocarbons

Gasoline range TPH was detected in only one of the soil samples, at a concentration of 12 mg/kg in the sample interval from 1.5–2 feet bgs in Boring LL-SB2. Diesel range TPH was detected at concentrations of 6.1 and 13 mg/kg in the sample interval from 0-0.5 foot bgs from Boring LL-SB4 and the sample interval from 0–0.5 foot bgs from Boring LL-SB5, respectively. Heavy oil range TPH was detected in 7 of the soil samples ranging in concentration from 16 mg/kg in the sample interval from 0–0.5 foot bgs from Boring LL-SB3 to 150 mg/kg in the sample interval from 0–0.5 foot bgs from Boring LL-SB5.

9.3.4 Semivolatile Organic Compounds

cPAHs were detected in nine of the shallow soil samples. The analytical results showed that cPAHs were detected in samples taken from the 0–0.5 foot bgs sampling interval at all sample locations (except LL-SB1). For the 1.5–2 feet bgs sample interval, cPAHs were detected in only the sample taken from location LL-SB5. The sample results for Borings LL-SB1, LL-SB5, and LL-SB6 showed detections of cPAHs in the 2–4 feet bgs sample interval. TEQs for cPAHs were calculated according to MTCA (WAC 173-340-900, Table 708-1) in two ways: with non-detect values set to zero, and with non-detects set to one-half of the RL. For the soil samples collected from the sample interval from 0–0.5 foot bgs, the lowest detected TEQs were 1.4 µg/kg (non-detect = 0) and 4.4 µg/kg (non-detect = ½ RL) from Boring LL-SB2 and the highest detected TEQs were 25 J µg/kg (non-detect = 0) and 26 J µg/kg (non-detect = ½ RL) from Boring LL-SB5. Soil samples with cPAHs detected in the 1.5–2 feet bgs and 2–4 feet bgs sample intervals had cPAH TEQs ranging from 0.049 µg/kg (non-detect = 0) and 3.3 µg/kg (non-detect = ½ RL) from Boring LL-SB1 (2–4 feet bgs interval) to 7.0 µg/kg (non-detect = 0) and 7.7 µg/kg (non-detect = ½ RL) from Boring LL-SB5 (1.5–2 feet bgs interval).

PCP was detected in only one of the soil samples, at a concentration of 24 µg/kg in the sample interval from 0–0.5 foot bgs in Boring LL-SB6.

9.3.5 Volatile Organic Compounds

PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and 1,2-DCA were not detected in any of the Lora Lake shallow soil samples. Additionally, BTEX were not detected in any of these soil samples.

9.3.6 Dioxins/Furans

All of the Lora Lake parcel soil samples had at least one dioxin/furan congener detected. TEQs for all chlorinated dibenzo-p-dioxins and dibenzofuran congeners were calculated according to TEFs specified in MTCA (WAC 173-340-900, Table 708-2). For those samples with concentrations flagged as undetected, the TEQ was calculated in two ways: with "non-detect" values set to zero, and with "non-detect" values set to one-half of the detection limit. The minimum TEQs calculated were 0.015 J pg/g (non-detect= 0) and 0.31 J pg/g (non-detect = one-half the detection limit) in the sample interval from 2–4 feet bgs from Boring LL-SB4. The maximum TEQ was 40.4 pg/g (no non-detect values) in the sample interval from 0-0.5 foot bgs from Boring LL-SB6.

10.0 References

American Society for Testing and Materials (ASTM). 2000.

Avocet Consulting. 2010. *Development of Benthic SQVs for Freshwater Sediments in Washington, Oregon, and Idaho.* Prepared for Washington Department of Ecology and Oregon Department of Environmental Quality. June.

Floyd|Snider. 2011. *Remedial Investigation/Feasibility Study Work Plan, Port of Seattle Lora Lake Parcel*. Prepared for Port of Seattle. 11 February.

Puget Sound Estuary Program (PSEP). 1997. *Final Report: Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound*. Prepared for U.S. Environmental Protection Agency. Seattle, Washington.

Regional Sediment Evaluation Team (RSET). 2009. *Sediment Evaluation Framework for the Pacific Northwest.*

Stirling Consulting. 2011. *History of the Port of Seattle Lora Lake 1982 Dredged Material Containment Area.* Prepared for Floyd|Snider. August.

Washington Department of Ecology (WSDOE). 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment associated Contaminants with Freshwater Invertebrates*. Publication EPA/600/R 99/064.

———. 2004. *USEPA National Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* OSWER 9240.1-45, EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation (OSRTI), Washington, D.C. October.

———. 2005. *USEPA Contract Laboratory Program, National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* EPA-540/R-05/001. September.

———. 2008. *USEPA Contract Laboratory Program, National Functional Guidelines for Organic Data Review*. EPA-540/R-99/008. October. Washington State Department of Ecology (WSDOE). 2007. *Model Toxics Control Act Chapter 70.105D RCW.* Publication No. 94-06. Revised November.

———. 2008. *Sediment Sampling and Analysis Plan Appendix*. Ecology Publication No. 03-09-043. February.

———. 2009. Agreed Order No. DE-6703 issued to the Port of Seattle.

———. 2013. *Sediment Management Standards. Chapter 173-204 Washington Administrative Code.* Revised February 2013, Effective September 2013.

Port of Seattle
Lora Lake Apartments Site

Remedial Investigation/ Feasibility Study

Volume II

Appendix G
Lora Lake Parcel
Remedial Investigation Data Report

Tables

FINAL

Table G.1
Surveyed Elevations of Lora Lake Parcel Drainage Features and Water Level Monitoring Locations

Feature	Date	Northing	Easting	Elevation (feet)
Lora Lake Parcel Drainage Features				
City of Burien storm drain outfall	10/11/2010	174424.2	1272789.2	264.8
Drainage culvert (Outlet from Lora Lake)	10/11/2010	174035.9	1273109.7	263.2
Drainage culvert (Inlet to Miller Creek)	10/11/2010	174022.2	1273121.6	263.1
Water Level Monitoring Locations				
Top of MC–SED1 rebar stake	10/11/2010	174088.1	1273156.5	264.9
Top of MC–SED2 rebar stake	10/11/2010	174017.3	1273121.4	264.7
Top of MC–SED3 rebar stake	10/11/2010	173946.2	1272961.2	263.6
Top of Lora Lake station rebar stake	10/11/2010	174039.7	1273102.5	264.8
Top of MC–SED1 rebar stake	4/26/2011	174088.1	1273156.5	264.3
Top of MC–SED2 rebar stake	4/26/2011	174017.3	1273121.4	264.1
Top of MC–SED3 rebar stake	4/26/2011	173946.2	1272961.2	263.4
Top of Lora Lake station rebar stake	4/26/2011	174039.7	1273102.5	264.8

Note:

1 Coordinates are presented in North American Datum of 1983 State Plane Coordinate System, Washington North Zone, units of survey feet. Elevation data are presented relative to National Geodetic Vertical Datum of 1929.

Table G.2
Water Elevations of Lora Lake, Miller Creek, and Groundwater[1]

Location	Fall 2010[2] Water Elevation (feet)	Winter 2011 Water Elevation (feet)	Spring (April)[3] 2011 Water Elevation (feet)	Spring (May)[3] 2011 Water Elevation (feet)
Lora Lake Station (near culvert)	263.93	263.86	263.97	264.46
MC-SED1	263.77	264.11	263.71	263.80
MC-SED2	263.42	263.70	263.38	263.46
MC-SED3	262.60	263.09	262.47	262.97
HP A1-1	264.23	262.67	--	264.52
MW-8	273.00	273.73	273.60	273.27
MW-9	270.37	271.21	271.08	270.92
MW-10	270.50	271.36	271.17	271.05
MW-11	273.20	274.35	274.16	273.99

Notes:

-- Not available.

1 Elevation data are presented relative to National Geodetic Vertical Datum of 1929.

2 For fall 2010 and winter 2011, water elevation was calculated using surveyed rebar elevations collected October 11, 2010. Spring 2011 water elevations were calculated based on re-surveyed rebar elevations collected of April 26, 2011. Refer to Table G.1 for surveyed rebar elevations.

3 During the spring 2011 water level monitoring field effort, the measurement of the water level in piezometer HPA1-1 was not completed due to a field error. The water levels monitoring was therefore repeated approximately 2 weeks later when the deviation from the Lora Lake Parcel Remedial Investigation/Feasibility Study Work Plan was realized. All water levels in Lora Lake, Miller Creek, Monitoring Wells MW-8, MW-9, MW-10, and MW-11, and Piezometer HPA1-1 were monitored at that time.

Table G.3
Lora Lake Subsurface Sediment Analytical Results

Location		LL-SED1	LL-SED2				LL-SED3		
Sample ID		LL-SED1-0-56-031511	LL-SED2-0-56-031511	LL-SED2-0-56-031511-D	LL-SED2-56-112-031511	LL-SED2-112-168-031511	LL-SED3-0-36-031511	LL-SED3-36-141-031511	LL-SED3-141-167-031511
Sample Date		3/15/2011	3/15/2011	3/15/2011	3/15/2011	3/15/2011	3/15/2011	3/15/2011	3/15/2011
Sample Depth (cm bgs)		0–56	0–56	0–56	56–112	112–168	0–36	36–141	141–167
Conventionals									
Total Organic Carbon	%	4.22	17.2	12.1	26.1	22.9	8.32	25.7	21.1
Total Solids	%	41.3	7.0	5.7	13.8	11.9	12.8	12.1	12.7
Total Solids (preserved)	%	NA	NA	NA	NA	NA	NA	12.3	12.3
Sulfide	mg/kg	NA	NA	NA	NA	NA	NA	7.85 UJ	7.91 UJ
Metals									
Arsenic	mg/kg	9	70	80	80	80	70	40 U	50
Lead	mg/kg	29	350	380	10 U	20 U	450	20 U	20 U
Semivolatile Organic Compounds									
Pentachlorophenol	µg/kg	110 U	44 U	55 U	45 U	51 U	25 U	53 U	51 U
Carcinogenic Polycyclic Aromatic Hydrocarbons									
Benzo(a)pyrene	µg/kg	55 J	170	400 J	15 U	15 UJ	88	15 U	15 U
Benzo(a)anthracene	µg/kg	37	130	270	15 U	15 U	62	15 U	15 U
Benzofluoranthenes (total)[1]	µg/kg	140	470	1100	15 U	15 U	180	15 U	15 U
Chrysene	µg/kg	81	300	620	15 U	15 U	140	18	15 U
Dibenzo(a,h)anthracene	µg/kg	5.8 J	30	74 J	15 U	15 UJ	8.4 U	15 U	15 U
Indeno(1,2,3-cd)pyrene	µg/kg	38 J	110	280 J	15 U	15 UJ	68	15 U	15 U
Summed cPAH TEQ[2,3]	µg/kg	78 J	250	580 J	0 U	0 UJ	120	0.2	0 U
Summed cPAH TEQ with One-Half of the Reporting Limit[2,4]	µg/kg	78 J	250	580 J	11 U	11 UJ	120	11	11 U
Dioxins/Furans									
2,3,7,8-TCDD	pg/g	1.48	7.13 J	9.9	0.422 U	0.318 U	15	0.217 U	0.93 UJ
1,2,3,7,8-PeCDD	pg/g	2.46 J	13.4	18.2	0.485 U	0.308 U	25.9	0.294 U	1.16 U
1,2,3,4,7,8-HxCDD	pg/g	6.53	28.2 J	41.5	0.431 U	0.392 U	58.9	0.296 U	1.05 UJ
1,2,3,6,7,8-HxCDD	pg/g	22.9	104 J	170	1.25 J	0.463 U	204	0.608 J	1.27 UJ
1,2,3,7,8,9-HxCDD	pg/g	13.4	59.3	86.4	0.536 U	0.421 U	113	0.335 U	1.14 U
1,2,3,4,6,7,8-HpCDD	pg/g	728	3090	4720	28.9	6.36	6200	14.9	2.08 UJ
Total OCDD	pg/g	7540	26100	41000 J	232	49.3	53800	145	14.8 J
2,3,7,8-TCDF	pg/g	1.73	9.24 J	14.6	0.347 U	0.311 U	19.7	0.182 U	0.668 U
1,2,3,7,8-PeCDF	pg/g	1.39 J	7.81 J	12.1	0.349 U	0.342 U	15.5	0.21 U	0.835 U
2,3,4,7,8-PeCDF	pg/g	1.64 J	11.4	14.4	0.38 U	0.356 U	16.3	0.22 U	0.855 U
1,2,3,4,7,8-HxCDF	pg/g	11.6	50.3 J	82.9 J	1 J	0.513 J	102 J	0.197 U	0.812 UJ
1,2,3,6,7,8-HxCDF	pg/g	6.48	31.2 J	42.9	0.475 U	0.4 U	53.2	0.195 U	0.752 UJ
2,3,4,6,7,8-HxCDF	pg/g	7.58	34.3 J	53.3	0.491 U	0.425 U	68.6	0.213 U	0.82 UJ
1,2,3,7,8,9-HxCDF	pg/g	1.29 J	5.91 J	8.46	0.464 U	0.408 U	10.6	0.198 U	0.796 UJ
1,2,3,4,6,7,8-HpCDF	pg/g	176	693 J	1040	5.98 J	1.25 J	1320	2.8 J	1.13 UJ
1,2,3,4,7,8,9-HpCDF	pg/g	8.56	30.1	49	0.527 U	0.643 U	59.7	0.307 U	1.54 UJ
Total OCDF	pg/g	516	1780 J	2630 J	14.3	3.61 J	3280 J	7 J	3.08 UJ
Summed Dioxin/Furan TEQ[5,6]	pg/g	23.2 J	103 J	154 J	0.648 J	0.143 J	202 J	0.283 J	0.00444 J
Summed Dioxin/Furan TEQ with One-half of the Detection Limit[7,8]	pg/g	23.2 J	103 J	154 J	1.30 J	0.659 J	202 J	0.657 J	1.58 J

Notes:

1 Benzofluoranthenes (total) includes both benzo(b)fluoranthene and benzo(k)fluoranthene. Both analytes have a toxicity equivalency factor of 0.1, therefore the total of the two analytes is multiplied by 0.1 when calculating the cPAH TEQ.
2 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivancy Factors as presented in Table 708-2 of WAC 173-340-900 (WSDOE 2007).
3 Calculated using detected cPAH concentrations.
4 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.
5 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
6 Calculated using detected dioxin/furan concentrations.
7 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

Abbreviations:

- bgs Below ground surface
- cPAH Carcinogenic polycyclic aromatic hydrocarbon
- OCDD Octachlorodibenzo-p-dioxin
- OCDF Octachlorodibenzofuran
- NA Not analyzed
- TEQ Toxic equivalency quotient
- WAC Washington Administrative Code
- WSDOE Washington State Department of Ecology

Qualifiers:

- J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
- U Not detected at the given reporting limit.
- UJ Not detected, and the associated numerical value is an estimated reporting limit.

Table G.4
Lora Lake and Miller Creek Surface Sediment Analytical Results

	Location	LL-SED1		LL-SED2	LL-SED3	LL-SED4	LL-SED5	MC-SED1	MC-SED2	MC-SED3
	Sample ID	LL-SED1-0-15-032911	LL-SED1-0-15-032911-D	LL-SED2-0-15-032911	LL-SED3-0-15-032911	LL-SED4-0-15-032911	LL-SED5-0-15-032911	MC-SED1-0-10-032911	MC-SED2-0-10-032911	MC-SED3-0-10-032911
	Sample Date	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011
	Sample Depth (cm bgs)	0–15	0–15	0–15	0–15	0–15	0–15	0–10	0–10	0–10
Conventionals										
Total Organic Carbon	%	6.88	5.8	10.6	8.14	8.71	0.903	0.536	0.364	0.146
Total Solids	%	18.2	20.7	15.4	20.6	18.4	81.6	77.2	78.9	85.2
Total Solids (preserved)	%	18.5	18.1	14.5	20.6	17.3	77.3	78.3	77.7	83.6
Ammonia (total as nitrogen)	mg-N/kg	60.8	64.7	301	135	82.6	2.73	2.28	0.34	0.24
Sulfide	mg/kg	1190	1120	2670	1140	984	31.4	48.6	1.22 U	1.18 U
Grain Size										
Fines	%	52.3	50.7	72.2	84.7	75	1.9	2.6	2	0.1
GS <0.98 µm	%	4.8	4.8	17.4	12.8	9.1	1.9 U	2.6 U	2 U	0.1 U
GS 0.98–1.95 µm	%	5.3	3.1	10.6	10.8	7.4	1.9 U	2.6 U	2 U	0.1 U
GS 1.95–3.9 µm	%	6	6.4	12.2	14.2	11.4	1.9 U	2.6 U	2 U	0.1 U
GS 3.9–7.8 µm	%	8.9	8.3	12.8	16.5	13.2	1.9 U	2.6 U	2 U	0.1 U
GS 7.8–15.6 µm	%	10.9	10.9	9.6	15	13.8	1.9 U	2.6 U	2 U	0.1 U
GS 15.6–31.3 µm	%	11.8	11.1	7.4	11.3	14.1	1.9 U	2.6 U	2 U	0.1 U
GS 31.3–62.5 µm	%	4.7	6	2.3	4	6	1.9 U	2.6 U	2 U	0.1 U
GS 62.5–125 µm	%	7.9	8.8	4	2.8	5	0.4	0.7	0.3	0.1
GS 125–250 µm	%	10.8	13.5	3.4	2.1	3.2	4	1.8	1	1.3
GS 250–500 µm	%	8.9	10.2	3.6	1.8	2.7	19.5	7.1	10.1	7
GS 500–1000 µm	%	7.6	5.2	5.4	2.5	4.4	33.9	8.4	16.2	10
GS 1000–2000 µm	%	12.5	11.5	11.3	6.2	9.7	23.9	13.1	12.7	14
Gravel	%	0.1 U	0.1	0.1 U	0.1 U	0.1 U	16.4	66.3	57.8	67.5
Metals										
Arsenic	mg/kg	20	20	50	70	40	7	8	6 U	6 U
Lead	mg/kg	319	281	390	361	492	48	12	11	4
Semivolatile Organic Compounds										
Pentachlorophenol	µg/kg	50 J	20 U	330 U	24 U	25 U	33	7.5 U	7.3 U	6.5 U
Carcinogenic Polycyclic Aromatic Hydrocarbons										
Benzo(a)pyrene	µg/kg	130	130	80	43	30	34	4.6 UJ	4.9 U	4.9 U
Benzo(a)anthracene	µg/kg	97	76	55	30	20	25	4.6 UJ	4.9 U	4.9 U
Benzofluoranthenes (total)[1]	µg/kg	300	260	210	110	73	84	4.6 UJ	4.9 U	4.9 U
Chrysene	µg/kg	180	140	140	59	39	66	4.6 UJ	4.9 U	4.9 U
Dibenzo(a,h)anthracene	µg/kg	25	21	17	10	7	5.8	4.6 UJ	4.9 U	4.9 U
Indeno(1,2,3-cd)pyrene	µg/kg	100	73	67	32	22	19	4.6 UJ	4.9 U	4.9 U
Summed cPAH TEQ[2,3]	µg/kg	180	170	120	62	43	48	0 UJ	0 U	0 U
Summed cPAH TEQ with One-Half of the Reporting Limit[2,4]	µg/kg	180	170	120	62	43	48	3.2 UJ	3.5 U	3.5 U
Volatile Organic Compounds										
1,2-Dichloroethane	µg/kg	5.3 U	7.6 U	13 U	8.8 U	12 U	1.5 U	1.3 U	1.3 U	1.2 U
cis-1,2-Dichloroethene	µg/kg	5.3 U	7.6 U	13 U	8.8 U	12 U	1.5 U	1.3 U	1.3 U	1.2 U
trans-1,2-Dichloroethene	µg/kg	5.3 U	7.6 U	13 U	8.8 U	12 U	1.5 U	1.3 U	1.3 U	1.2 U
Tetrachloroethene	µg/kg	5.3 U	7.6 U	13 U	8.8 U	12 U	1.5 U	1.3 U	1.3 U	1.2 U
Trichloroethene	µg/kg	5.3 U	7.6 U	13 U	8.8 U	12 U	1.5 U	1.3 U	1.3 U	1.2 U
Dioxins/Furans										
2,3,7,8-TCDD	pg/g	4.31 J	4.28	4.8	10.4	5.23	0.269 U	0.158 U	0.209 U	0.159 UJ
1,2,3,7,8-PeCDD	pg/g	20.7 J	21.8	25.7	18.1	16.2	1.26 J	0.25 U	0.334 U	0.204 UJ
1,2,3,4,7,8-HxCDD	pg/g	53.8 J	51.3	60.3	45.5	40.1	2.03 J	0.308 U	0.282 U	0.336 U
1,2,3,6,7,8-HxCDD	pg/g	188 J	183	217	156	164	7.46	0.402 U	0.352 U	0.441 U
1,2,3,7,8,9-HxCDD	pg/g	113	111	135	81	93.4	3.88 J	0.345 U	0.31 U	0.378 U
1,2,3,4,6,7,8-HpCDD	pg/g	6770	6100	7500	4690	4980	202	7.83	2.83 J	1.03 J
Total OCDD	pg/g	68500	67000 J	67100	54600	51500	2110	52.6	15.4	5.93 J
2,3,7,8-TCDF	pg/g	8.37	7.09	10.7	14.3	9.95	0.185 U	0.152 U	0.132 U	0.0986 U
1,2,3,7,8-PeCDF	pg/g	10.5	10.1	11.3	10	12.2	0.518 J	0.18 U	0.215 U	0.152 U
2,3,4,7,8-PeCDF	pg/g	13	12.9	18.5	13.9	12.1	0.894 J	0.175 U	0.221 U	0.155 U
1,2,3,4,7,8-HxCDF	pg/g	130	137	139	60.9	78.5	8.09	0.197 U	0.178 U	0.208 U

Table G.4
Lora Lake and Miller Creek Surface Sediment Analytical Results

Location		LL-SED1		LL-SED2	LL-SED3	LL-SED4	LL-SED5	MC-SED1	MC-SED2	MC-SED3
Sample ID		LL-SED1-0-15-032911	LL-SED1-0-15-032911-D	LL-SED2-0-15-032911	LL-SED3-0-15-032911	LL-SED4-0-15-032911	LL-SED5-0-15-032911	MC-SED1-0-10-032911	MC-SED2-0-10-032911	MC-SED3-0-10-032911
Sample Date		3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011	3/29/2011
Sample Depth (cm bgs)		0–15	0–15	0–15	0–15	0–15	0–15	0–10	0–10	0–10
Dioxins/Furans (continued)										
1,2,3,6,7,8-HxCDF	pg/g	42.3 J	43.6	49	30.5	34.5	2.3 J	0.188 U	0.173 U	0.206 U
2,3,4,6,7,8-HxCDF	pg/g	56.4 J	57.7	64.4	44.9	44.3	2.75 J	0.2 U	0.177 U	0.22 U
1,2,3,7,8,9-HxCDF	pg/g	11.5	11.4	12.2	7.92 J	9.57	0.645 J	0.182 U	0.16 U	0.203 U
1,2,3,4,6,7,8-HpCDF	pg/g	1320	1350	1480	1050	979	41.9	1.37 J	0.536 J	0.301 U
1,2,3,4,7,8,9-HpCDF	pg/g	88.7	93.6	92.6	46.7	54.6	4.2 J	0.27 U	0.202 U	0.333 U
Total OCDF	pg/g	3830 J	4040	4050	2480	2470	114	3.22 J	0.868 U	0.646 UJ
Summed Dioxin/Furan TEQ[5,6]	pg/g	193 J	187 J	217	152 J	149	7.41 J	0.109 J	0.0383 J	0.0121 J
Summed Dioxin/Furan TEQ with One-half of the Detection Limit[5,7]	pg/g	193 J	187 J	217	152 J	149	7.55 J	0.442 J	0.435 J	0.327 J

Notes:

1 Benzofluoranthenes (total) includes both benzo(b)fluoranthene and benzo(k)fluoranthene. Both analytes have a toxicity equivalency factor of 0.1, therefore the total of the two analytes is multiplied by 0.1 when calculating the cPAH TEQ
2 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivancy Factors as presented in Table 708-2 of WAC 173-340-900 (WSDOE 2007).
3 Calculated using detected cPAH concentrations.
4 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.
5 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (Van den Berg et al. 2006).
6 Calculated using detected dioxin/furan concentrations.
7 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

Abbreviations:

bgs Below ground surface
cPAH Carcinogenic polycyclic aromatic hydrocarbon
OCDD Octachlorodibenzo-p-dioxin
OCDF Octachlorodibenzofuran
TEQ Toxic equivalency quotient
WAC Washington Administrative Code
WSDOE Washington State Department of Ecology

Qualifiers:

J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity
U Not detected at the given reporting limit.
UJ Not detected, and the associated numerical value is an estimated reporting limit.

Table G.5
Lora Lake and Miller Creek Sediment Bioassay Results[1]

Sample	20-day Chronic Midge *(Chironomus dilutus)* Test[2] for Mortality and Growth						10-day Acute Amphipod (*Hyalella azteca)* Test for Mortality[3]			15-minute 100% Porewater Microtox® Bacteria Bioluminescence Test[4]		Summary of Bioassay Testing Results
	Percent Mortality (Mean ± SD)	Mortality Percent Difference From Control	Significantly Different Relative to the Control	AFDW per Organism (mg) (Mean ± SD)	AFDW Percent of Control	Significantly Different Relative to the Control	Percent Mortality (Mean ± SD)	Mortality Percent Difference from Control	Significantly Different Relative to the Control	Mean Percent of Initial Light Output	Significantly Different Relative to the Control	
Control	7.3 ± 5.3	--	--	0.41 ± 0.06	--	--	3.8 ± 5.2	--	--	83 ± 3 / 89 ±5 [5]	--	--
LL-SED1	31.3 ± 33.6	24	No	1.02 ± 0.35	247	No	5.0 ± 7.6	1.3	No	83 ± 4	No	No failures
LL-SED2 (Initial Test)	**77.1 ± 18.2**	**69.8**	Yes	0.85 ± 0.46	206	No	3.8 ± 5.2	0	No	88 ± 2	No	Failed one-hit criterion for *Chironomus dilutus* survival
LL-SED3	30.2 ± 27.8	22.9	Yes	1.41 ± 0.29	341	No	3.8 ± 5.2	0	No	82 ± 3	No	Failed two-hit criterion for *Chironomus dilutus* survival
LL-SED4	31.3 ± 19.3	24	Yes	1.01 ± 0.53	245	No	0.0 ± 0.0	-3.8	No	83 ± 4	No	Failed two-hit criterion for *Chironomus dilutus* survival
MC-SED1	25.0 ± 12.6	17.7	Yes	1.19 ± 0.36	287	No	6.3 ± 7.4	2.5	No	87 ± 4	No	Failed two-hit criterion for *Chironomus dilutus* survival
MC-SED2	20.8 ± 10.9	13.5	Yes	1.22 ± 0.22	294	No	3.8 ± 5.2	0	No	90 ± 2	No	No failures
MC-SED3	30.2 ± 10.9	22.9	Yes	1.28 ± 0.21	310	No	8.8 ± 6.4	5	No	88 ± 2	No	Failed two-hit criterion for *Chironomus dilutus* survival
Control (Repeat Test)[6]	10.4 ± 9.7	--	--	0.81 ± 0.19	--	--	NT	NT	NT	NT	NT	--
LL-SED2 (Repeat Test)[6]	**51.0 ± 31.0**	**40.6**	Yes	0.75 ± 0.44	92.5	No	NT	NT	NT	NT	NT	Failed one-hit criterion for *Chironomus dilutus* survival

Notes:

Indicates sample results that failed the two-hit RSET criterion. (gray shading)

Bold sample results indicate failure of one-hit RSET criterion.

1 Sample results failing two-hit RSET criterion are shaded gray and sample results failing one-hit RSET criterion are bold.

2 For the mortality test, a two-hit failure is considered a mean mortality in test sediment of 15% over the mean control response **and** statistically different from the control (alpha = 0.05). A one-hit failure is considered a mean mortality in test sediment of 25% over the mean control response **and** statistically different from the control (alpha = 0.05). For the growth test, a two-hit failure is considered a mean reduction in biomass greater than 25% **and** statistically different from the control (alpha = 0.05). A one-hit failure is considered a mean reduction in biomass greater than 40% **and** statistically different from control (alpha = 0.05; RSET 2009).

3 A two-hit failure is considered a mean mortality in test sediment of 10% over the mean control response **and** statistically different from the control (alpha = 0.05). A one-hit failure is considered a mortality in test sediment of 25% over the mean control response **and** statistically different from the control (alpha = 0.05; RSET 2009).

4 A two-hit failure is considered a mean test output less than 90% of the control mean output and statistically significantly different (alpha = 0.05) from the control mean output. A one-hit failure is considered a mean test output less than 75% of the control mean output and statistically significantly different (alpha = 0.05) from the control mean output (RSET 2009).

5 Two microtox controls were run—the first for Lora Lake sediment samples, and the second for Miller Creek sediment samples.

6 The surface sediment sample from LL-SED2 was found to contain *Chaoborus sp.,* a carnivorous midge, that could have been responsible for the mortality of the *Chironomus dilutus* observed in this initial testing of this sample and possibly the reason the sediment was found to be toxic. Therefore, testing on this sample was repeated within the method holding time, following sieving of the sediment through a 0.5 mm sieve to remove any *Chaoborus sp.* larvae or eggs.

Abbreviations:

AFDW Ash-free dry weight
NT Not tested
RSET Regional Sediment Evaluation Team
SD Standard deviation

Table G.6
Lora Lake Parcel Shallow Soil Analytical Results

Location		LL-SB1				LL-SB2			LL-SB3		
Sample ID		LL-SB1-0-0.5-041911	LL-SB1-0-0.5-041911-D	LL-SB1-1.5-2-041911	LL-SB1-2-4-041911	LL-SB2-0-0.5-041911	LL-SB2-1.5-2-041911	LL-SB2-2-3.5-041911	LL-SB3-0-0.5-041911	LL-SB3-1.5-2-041911	LL-SB3-2-4-041911
Sample Date		4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011
Sample Depth (feet bgs)		0–0.5	0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–3.5	0–0.5	1.5–2	2–4
Conventionals											
Total Organic Carbon	%	0.714	0.654	0.666	1.03	1.6	0.08	0.072	2.61	0.737	1.04
Total Solids	%	92.8	92.9	91.6	90	88.1	91	90.1	84.9	89.5	87.9
Metals											
Arsenic	mg/kg	5 U	5 U	6	8	13	5 U	5 U	8	6	7
Lead	mg/kg	2	2 U	9	15	58	2	2	21	6	8
Semivolatile Organic Compounds											
Pentachlorophenol	µg/kg	6.6 U	6.7 U	6.6 U	6.7 U	6.8 U	6.5 U	6.5 U	7.2 U	6.9 U	6.7 U
Carcinogenic Polycyclic Aromatic Hydrocarbons											
Benzo(a)pyrene	µg/kg	4.7 U	4.7 U	4.9 U	4.7 U	4.7 U	4.9 U	4.5 U	8.7	4.5 UJ	4.6 U
Benzo(a)anthracene	µg/kg	4.7 U	4.7 U	4.9 U	4.7 U	4.7 U	4.9 U	4.5 U	7	4.5 UJ	4.6 U
Benzofluoranthenes (total)[1]	µg/kg	4.7 U	4.7 U	4.9 U	4.7 U	13	4.9 U	4.5 U	20	4.5 UJ	4.6 U
Chrysene	µg/kg	4.7 U	4.7 U	4.9 U	4.9	7.9	4.9 U	4.5 U	12	4.5 UJ	4.6 U
Dibenzo(a,h)anthracene	µg/kg	4.7 U	4.7 U	4.9 U	4.7 U	4.7 U	4.9 U	4.5 U	4.6 U	4.5 UJ	4.6 U
Indeno(1,2,3-cd)pyrene	µg/kg	4.7 U	4.7 U	4.9 U	4.7 U	4.7 U	4.9 U	4.5 U	6.9	4.5 UJ	4.6 U
Summed cPAH TEQ[2,3]	µg/kg	0 U	0 U	0 U	0.049	1.4	0 U	0 U	12	0 UJ	0 U
Summed cPAH TEQ with One-Half of the Reporting Limit[2,4]	µg/kg	3.3 U	3.3 U	3.5 U	3.3	4.4	3.5 U	3.2 U	12	3.2 UJ	3.2 U
Total Petroleum Hydrocarbons											
Gasoline Range Hydrocarbons	mg/kg	5.6 U	5.7 U	6.2 U	5.5 U	5.8 U	12	5.1 U	7 U	5.2 U	5.1 U
Diesel Range Hydrocarbons	mg/kg	5.4 U	5.4 U	5.4 U	5.5 U	5.7 U	5.4 U	5.6 U	5.7 U	5.6 U	5.6 U
Motor Oil Range Hydrocarbons	mg/kg	11 U	11 U	18	11 U	17	11 U	11 U	16	11 U	11 U
Volatile Organic Compounds											
1,2-Dichloroethane	µg/kg	1 U	1.1 U	1 U	1 U	1 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U
cis-1,2-Dichloroethene	µg/kg	1 U	1.1 U	1 U	1 U	1 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U
trans-1,2-Dichloroethene	µg/kg	1 U	1.1 U	1 U	1 U	1 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U
Tetrachloroethene	µg/kg	1 U	1.1 U	1 U	1 U	1 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U
Trichloroethene	µg/kg	1 U	1.1 U	1 U	1 U	1 U	0.9 U	0.9 U	0.9 U	1 U	0.9 U
Benzene, Toluene, Ethylbenzene, and Xylene Compounds											
Benzene	µg/kg	28 U	29 U	31 U	27 U	29 U	31 U	25 U	35 U	26 U	26 U
Ethylbenzene	µg/kg	28 U	29 U	31 U	27 U	29 U	31 U	25 U	35 U	26 U	26 U
Toluene	µg/kg	28 U	29 U	31 U	27 U	29 U	31 U	25 U	35 U	26 U	26 U
m,p-Xylene	µg/kg	56 U	57 U	62 U	55 U	58 U	62 U	51 U	70 U	52 U	51 U
o-Xylene	µg/kg	28 U	29 U	31 U	27 U	29 U	31 U	25 U	35 U	26 U	26 U
Dioxins/Furans											
2,3,7,8-TCDD	pg/g	0.193 U	0.185 U	0.611 J	0.671 J	7.82	0.208 U	0.157 U	2.11	0.567 J	0.888 J
1,2,3,7,8-PeCDD	pg/g	0.278 U	0.252 U	0.377 U	0.314 U	1.19 J	0.273 U	0.21 U	0.637 J	0.277 U	0.381 U
1,2,3,4,7,8-HxCDD	pg/g	0.291 U	0.261 U	0.32 U	0.524 J	1.72 J	0.286 U	0.245 U	0.941 J	0.258 U	0.364 U
1,2,3,6,7,8-HxCDD	pg/g	0.364 U	0.331 U	0.942 J	1.41 J	5.33	0.367 U	0.319 U	3.67 J	0.828 J	1.7 J
1,2,3,7,8,9-HxCDD	pg/g	0.32 U	0.289 U	0.653 J	0.908 J	2.63 J	0.319 U	0.275 U	1.91 J	0.679 J	0.902 J
1,2,3,4,6,7,8-HpCDD	pg/g	2.53 J	6.18	16.1	33.1	119	1.87 J	1.71 J	82.6	21.3	35.2
Total OCDD	pg/g	18.6 J	61.9 J	112 J	251 J	978 J	13.3 J	15.3 J	665	150 J	239 J
2,3,7,8-TCDF	pg/g	0.168 U	0.157 U	0.267 U	0.389 J	1.49	0.173 U	0.133 U	0.785 J	0.215 U	0.378 J
1,2,3,7,8-PeCDF	pg/g	0.231 U	0.166 U	0.246 U	0.204 U	0.785 J	0.202 U	0.157 U	0.333 U	0.235 U	0.26 U
2,3,4,7,8-PeCDF	pg/g	0.243 U	0.176 U	0.284 U	0.433 J	1.82 J	0.215 U	0.175 U	0.664 J	0.26 U	0.366 J
1,2,3,4,7,8-HxCDF	pg/g	0.177 U	0.155 U	0.26 U	0.586 J	2.22 J	0.212 U	0.168 U	1.04 J	0.225 U	0.496 J
1,2,3,6,7,8-HxCDF	pg/g	0.181 U	0.156 U	0.251 U	0.451 J	1.72 J	0.208 U	0.167 U	0.76 J	0.222 U	0.405 J
2,3,4,6,7,8-HxCDF	pg/g	0.192 U	0.172 U	0.49 J	0.688 J	2.72 J	0.234 U	0.183 U	1.11 J	0.411 J	0.506 J
1,2,3,7,8,9-HxCDF	pg/g	0.184 U	0.16 U	0.257 U	0.248 U	0.434 J	0.222 U	0.172 U	0.323 U	0.245 U	0.331 U
1,2,3,4,6,7,8-HpCDF	pg/g	0.483 J	0.562 J	3.2 J	6.32	27.4	0.497 J	0.365 J	15.6	3.58 J	5.52

Table G.6
Lora Lake Parcel Shallow Soil Analytical Results

Location		LL-SB1				LL-SB2			LL-SB3		
Sample ID		LL-SB1-0-0.5-041911	LL-SB1-0-0.5-041911-D	LL-SB1-1.5-2-041911	LL-SB1-2-4-041911	LL-SB2-0-0.5-041911	LL-SB2-1.5-2-041911	LL-SB2-2-3.5-041911	LL-SB3-0-0.5-041911	LL-SB3-1.5-2-041911	LL-SB3-2-4-041911
Sample Date		4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011	4/19/2011
Sample Depth (feet bgs)		0–0.5	0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–3.5	0–0.5	1.5–2	2–4
Dioxins/Furans (continued)											
1,2,3,4,7,8,9-HpCDF	pg/g	0.379 U	0.322 U	0.388 U	0.49 U	2.11 J	0.396 U	0.29 U	1.11 J	0.429 U	0.488 U
Total OCDF	pg/g	1.18 UJ	1.31 UJ	7.18 J	15.2 J	72.6 J	1.51 UJ	1.07 U	47.8	9.58 J	14.8 J
Summed Dioxin/Furan TEQ[5,6]	pg/g	0.0357 J	0.086 J	1.05 J	1.77 J	13.2 J	0.0277 J	0.0253 J	5.17 J	1.06 J	1.92 J
Summed Dioxin/Furan TEQ with One-half of the Detection Limit[5,7]	pg/g	0.407 J	0.419 J	1.35 J	1.95 J	13.2 J	0.407 J	0.322 J	5.20 J	1.30 J	2.15 J

Notes:
1 Benzofluoranthenes (total) includes both benzo(b)fluoranthene and benzo(k)fluoranthene. Both analytes have a toxicity equivalency factor of 0.1, therefore the total of the two analytes is multiplied by 0.1 when calculating the cPAH TEQ.
2 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivancy Factors as presented in Table 708-2 of WAC 173-340-900 (WSDOE 2007).
3 Calculated using detected cPAH concentrations.
4 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.
5 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (van den Berg et al. 2006).
6 Calculated using detected dioxin/furan concentrations.
7 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

Abbreviations:
bgs Below ground surface
cPAH Carcinogenic polycyclic aromatic hydrocarbon
OCDD Octachlorodibenzo-p-dioxin
OCDF Octachlorodibenzofuran
TEQ Toxic equivalency quotient
WAC Washington Administrative Code
WSDOE Washington State Department of Ecology

Qualifiers:
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
U Not detected at the given reporting limit.
UJ Not detected, and the associated numerical value is an estimated reporting limit.

Table G.6
Lora Lake Parcel Shallow Soil Analytical Results

Location		LL-SB4			LL-SB5			LL-SB6		
Sample ID		LL-SB4-0-0.5-041911	LL-SB4-1.5-2-041911	LL-SB4-2-4-041911	LL-SB5-0-0.5-041811	LL-SB5-1.5-2-041811	LL-SB5-2-4-041811	LL-SB6-0-0.5-041811	LL-SB6-1.5-2-041811	LL-SB6-2-4-041811
Sample Date		4/19/2011	4/19/2011	4/19/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Sample Depth (feet bgs)		0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–4
Conventionals										
Total Organic Carbon	%	6.13	0.547	0.248	8.78	3.86	4.75	5.09	2.9	1.77
Total Solids	%	84.2	89.1	85.8	74	85.1	82.2	83.4	88	88.4
Metals										
Arsenic	mg/kg	13	5 U	6 U	12	12	10	9	10	7
Lead	mg/kg	26	2	3	64	14	14	17	13	13
Semivolatile Organic Compounds										
Pentachlorophenol	µg/kg	7.5 U	7 U	7.1 U	8.7 U	7 U	7.6 U	24	7.1 U	7 U
Carcinogenic Polycyclic Aromatic Hydrocarbons										
Benzo(a)pyrene	µg/kg	12	4.6 U	4.6 U	17 J	5.6	4.7 U	8.9	4.6 U	5.3
Benzo(a)anthracene	µg/kg	9.1	4.6 U	4.6 U	12 J	4.7 U	4.7 U	5.9	4.6 U	4.5 U
Benzofluoranthenes (total)[1]	µg/kg	29	4.6 U	4.6 U	61 J	13	4.7 U	23	4.6 U	4.5 U
Chrysene	µg/kg	18	4.6 U	4.6 U	37 J	7.6	6	15	4.6 U	4.9
Dibenzo(a,h)anthracene	µg/kg	4.5 U	4.6 U	4.6 U	4.5 UJ	4.7 U	4.7 U	4.6 U	4.6 U	4.5 U
Indeno(1,2,3-cd)pyrene	µg/kg	7.9	4.6 U	4.6 U	7.2 J	4.7 U	4.7 U	8	4.6 U	4.5 U
Summed cPAH TEQ[2,3]	µg/kg	17	0 U	0 U	25 J	7.0	0.06	13	0 U	5.3
Summed cPAH TEQ with One-Half of the Detection Limit[2,4]	µg/kg	17	3.2 U	3.2 U	26 J	7.7	3.4	13	3.2 U	6.2
Total Petroleum Hydrocarbons										
Gasoline Range Hydrocarbons	mg/kg	7.2 U	5.6 U	5.9 U	9.5 U	5.8 U	6.9 U	7.2 U	6.5 U	6.2 U
Diesel Range Hydrocarbons	mg/kg	6.1	5.6 U	5.8 U	13	5.7 U	6.1 U	6 U	5.7 U	5.6 U
Motor Oil Range Hydrocarbons	mg/kg	28	11 U	12 U	150	22	17	49	11 U	11 U
Volatile Organic Compounds										
1,2-Dichloroethane	µg/kg	1.2 U	1 U	0.9 U	1.5 U	1.1 U	1.1 U	1.3 U	1.1 U	1.1 U
cis-1,2-Dichloroethene	µg/kg	1.2 U	1 U	0.9 U	1.5 U	1.1 U	1.1 U	1.3 U	1.1 U	1.1 U
trans-1,2-Dichloroethene	µg/kg	1.2 U	1 U	0.9 U	1.5 U	1.1 U	1.1 U	1.3 U	1.1 U	1.1 U
Tetrachloroethene	µg/kg	1.2 U	1 U	0.9 U	1.5 U	1.1 U	1.1 U	1.3 U	1.1 U	1.1 U
Trichloroethene	µg/kg	1.2 U	1 U	0.9 U	1.5 U	1.1 U	1.1 U	1.3 U	1.1 U	1.1 U
Benzene, Toluene, Ethylbenzene, and Xylene Compounds										
Benzene	µg/kg	36 U	28 U	29 U	47 U	29 U	35 U	36 U	32 U	31 U
Ethylbenzene	µg/kg	36 U	28 U	29 U	47 U	29 U	35 U	36 U	32 U	31 U
Toluene	µg/kg	36 U	28 U	29 U	47 U	29 U	35 U	36 U	32 U	31 U
m,p-Xylene	µg/kg	72 U	56 U	59 U	95 U	58 U	69 U	72 U	65 U	62 U
o-Xylene	µg/kg	36 U	28 U	29 U	47 U	29 U	35 U	36 U	32 U	31 U
Dioxins/Furans										
2,3,7,8-TCDD	pg/g	1.35	0.119 U	0.134 U	1.39	1.13	7.35	0.89 J	0.317 J	0.193 U
1,2,3,7,8-PeCDD	pg/g	0.768 J	0.198 U	0.23 U	1.19 J	1.44 J	2.32 J	7.97	1.21 J	0.767 J
1,2,3,4,7,8-HxCDD	pg/g	1.15 J	0.214 U	0.226 U	1.85 J	2.28 J	3.56 J	15.9	2.04 J	1.19 J
1,2,3,6,7,8-HxCDD	pg/g	4.76 J	0.28 U	0.287 U	8.17	11.2	18	46.6	8.56	5.5
1,2,3,7,8,9-HxCDD	pg/g	2.48 J	0.241 U	0.25 U	4.23 J	5.11	8.08	30.3	4.05 J	2.29 J
1,2,3,4,6,7,8-HpCDD	pg/g	128	3.08 J	1.17 J	217	331	521	1330	238	154
Total OCDD	pg/g	1150	26.4	10.3 J	2140	3390	5170	10700	2440	1710
2,3,7,8-TCDF	pg/g	1.09	0.108 U	0.105 U	1.32	0.671 J	1.13	0.477 J	0.625 J	0.286 J
1,2,3,7,8-PeCDF	pg/g	0.471 J	0.129 U	0.147 U	0.772 J	0.381 J	0.569 J	0.617 J	0.33 J	0.202 U
2,3,4,7,8-PeCDF	pg/g	0.772 J	0.135 U	0.156 U	1.29 J	1.15 J	2 J	2.02 J	0.825 J	0.465 J
1,2,3,4,7,8-HxCDF	pg/g	1.29 J	0.181 U	0.207 U	3.2 J	4.63 J	7.23	17.2	2.91 J	2 J
1,2,3,6,7,8-HxCDF	pg/g	0.836 J	0.186 U	0.202 U	2.1 J	1.55 J	2.53 J	5.74	1.29 J	0.792 J
2,3,4,6,7,8-HxCDF	pg/g	1.4 J	0.204 U	0.218 U	3.61 J	2.48 J	3.77 J	7.35	2.09 J	1.11 J
1,2,3,7,8,9-HxCDF	pg/g	0.258 J	0.187 U	0.203 U	0.5 J	0.334 J	0.474 J	1.55 J	0.247 J	0.277 U
1,2,3,4,6,7,8-HpCDF	pg/g	24.3	0.635 J	0.22 U	41	61.2	101	173	43	26.6

Table G.6
Lora Lake Parcel Shallow Soil Analytical Results

Location		LL-SB4			LL-SB5			LL-SB6		
Sample ID		LL-SB4-0-0.5-041911	LL-SB4-1.5-2-041911	LL-SB4-2-4-041911	LL-SB5-0-0.5-041811	LL-SB5-1.5-2-041811	LL-SB5-2-4-041811	LL-SB6-0-0.5-041811	LL-SB6-1.5-2-041811	LL-SB6-2-4-041811
Sample Date		4/19/2011	4/19/2011	4/19/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011	4/18/2011
Sample Depth (feet bgs)		0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–4	0–0.5	1.5–2	2–4
Dioxins/Furans (continued)										
1,2,3,4,7,8,9-HpCDF	pg/g	1.27 J	0.218 U	0.255 U	2.03 J	2.64 J	4.11 J	8.16	2.06 J	1.37 J
Total OCDF	pg/g	76	1.71 J	0.527 U	111	217	364	405	137	94.3
Summed Dioxin/Furan TEQ[5,6]	pg/g	5.59 J	0.0456 J	0.0148 J	8.76 J	10.8 J	22.7 J	40.4 J	7.57 J	4.58 J
Summed Dioxin/Furan TEQ with One-half of the Detection Limit[5,7]	pg/g	5.59 J	0.307 J	0.310 J	8.76 J	10.8 J	22.7 J	40.4 J	7.57 J	4.70 J

Notes:
1 Benzofluoranthenes (total) includes both benzo(b)fluoranthene and benzo(k)fluoranthene. Both analytes have a toxicity equivalency factor of 0.1, therefore the total of the two analytes is multiplied by 0.1 when calculating the cPAH TEQ.
2 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivancy Factors as presented in Table 708-2 of WAC 173-340-900 (WSDOE 2007).
3 Calculated using detected cPAH concentrations.
4 Calculated using detected cPAH concentrations plus one-half the reporting limit for cPAHs that were not detected.
5 World Health Organization 2005 Toxic Equivalency Factors used for calculation of dioxin/furan TEQ (van den Berg et al. 2006).
6 Calculated using detected dioxin/furan concentrations.
7 Calculated using detected dioxin/furan concentrations plus one-half the detection limit for dioxins/furans that were not detected.

Abbreviations:
bgs Below ground surface
cPAH Carcinogenic polycyclic aromatic hydrocarbon
OCDD Octachlorodibenzo-p-dioxin
OCDF Octachlorodibenzofuran
TEQ Toxic equivalency quotient
WAC Washington Administrative Code
WSDOE Washington State Department of Ecology

Qualifiers:
J The analyte was analyzed for and positively identified, but the associated numerical value is an estimated quantity.
U Not detected at the given reporting limit.
UJ Not detected, and the associated numerical value is an estimated reporting limit.

Port of Seattle
Lora Lake Apartments Site

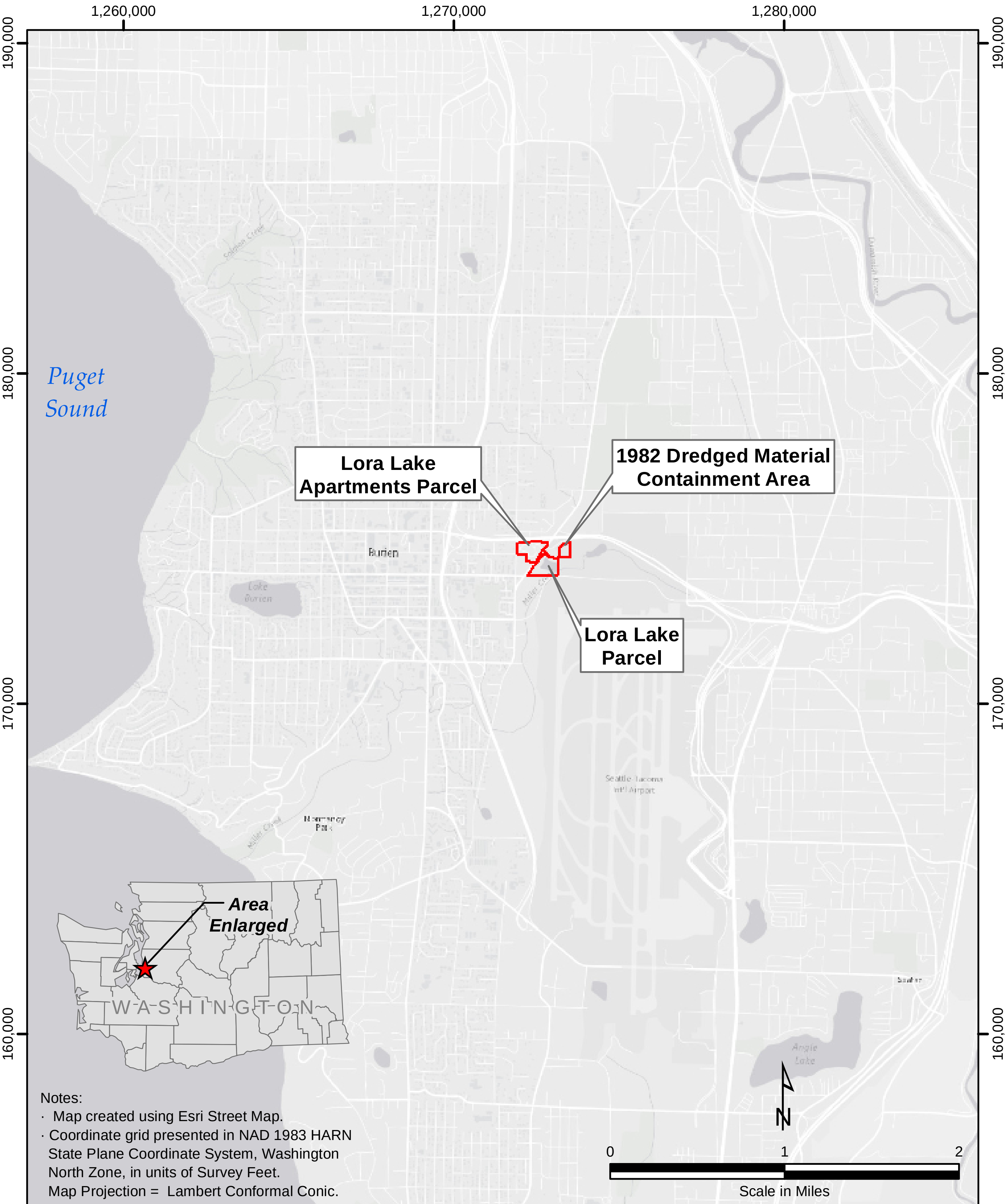
Remedial Investigation/ Feasibility Study

Volume II

Appendix G
Lora Lake Parcel
Remedial Investigation Data Report

Figures

FINAL

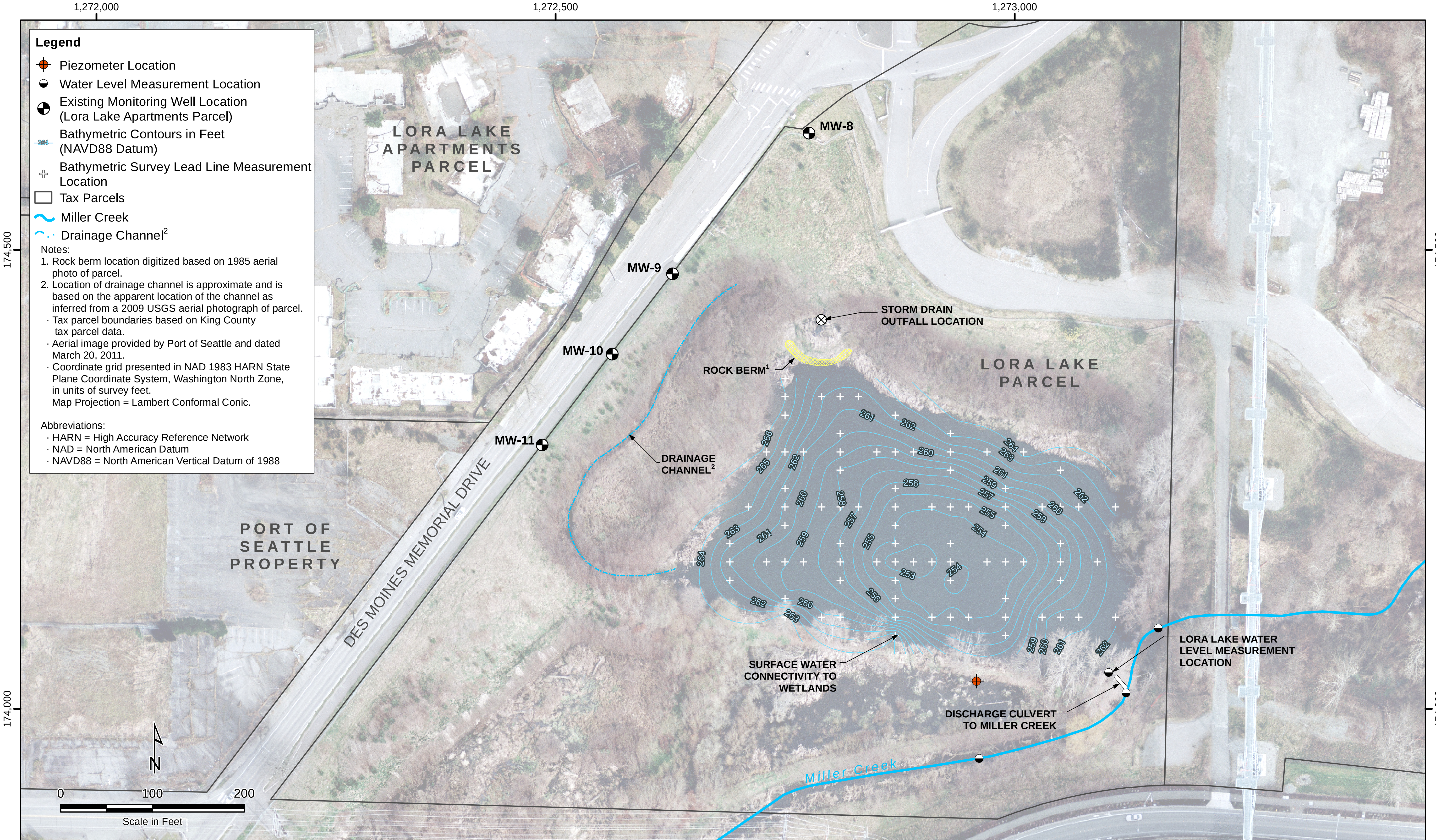


FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.1
Vicinity Map

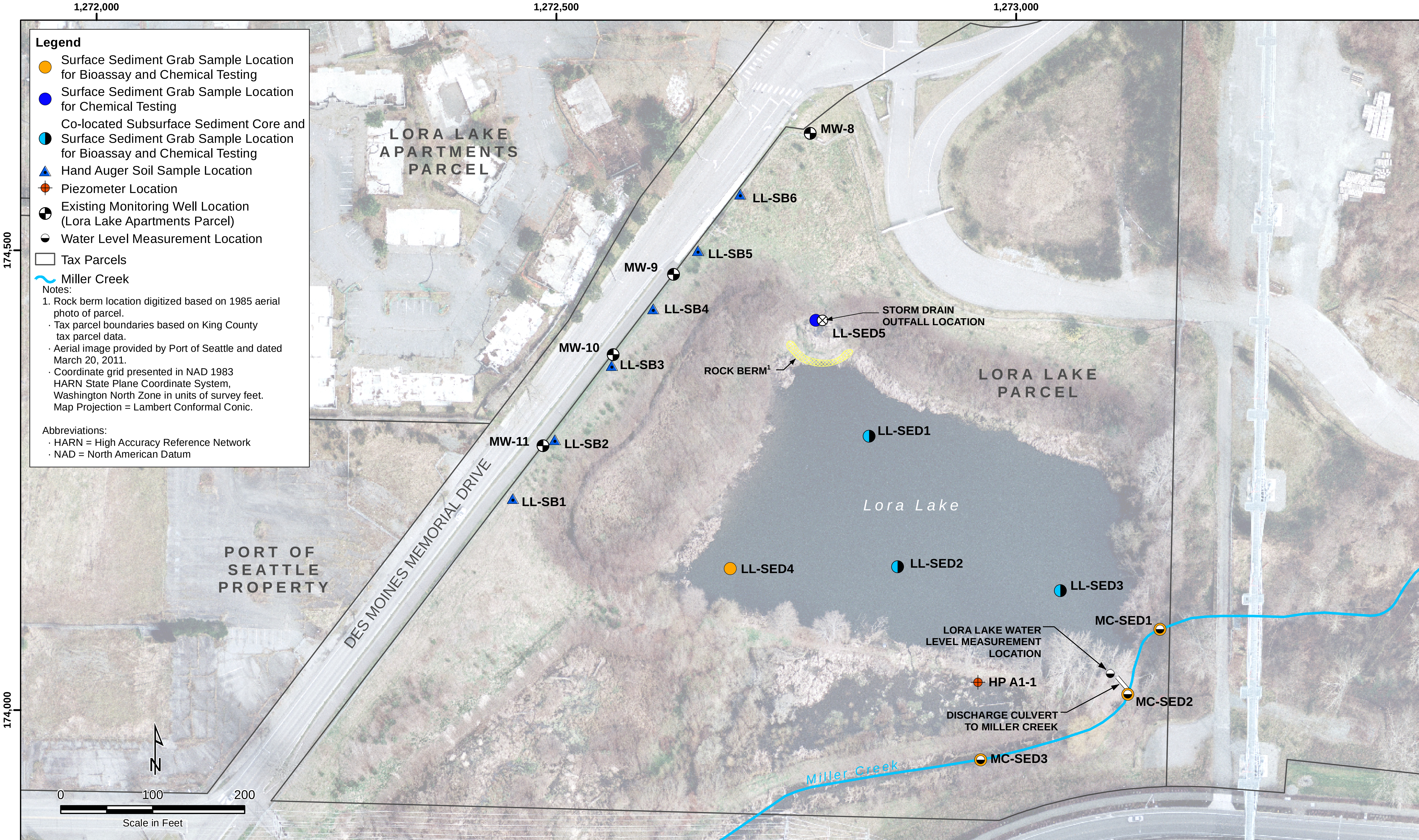
I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.1 Vicinity Map.mxd
9/9/2014



Remedial Investigation/Feasibility Study	Figure G.2
Port of Seattle	Bathymetric Contours and Visual
Lora Lake Apartments Site	Observations of Lora Lake
Burien, Washington	

FLOYD | SNIDER
strategy ▪ science ▪ engineering

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.2 Bathymetric Contours and Visual Observations of Lora Lake.mxd
9/9/2014

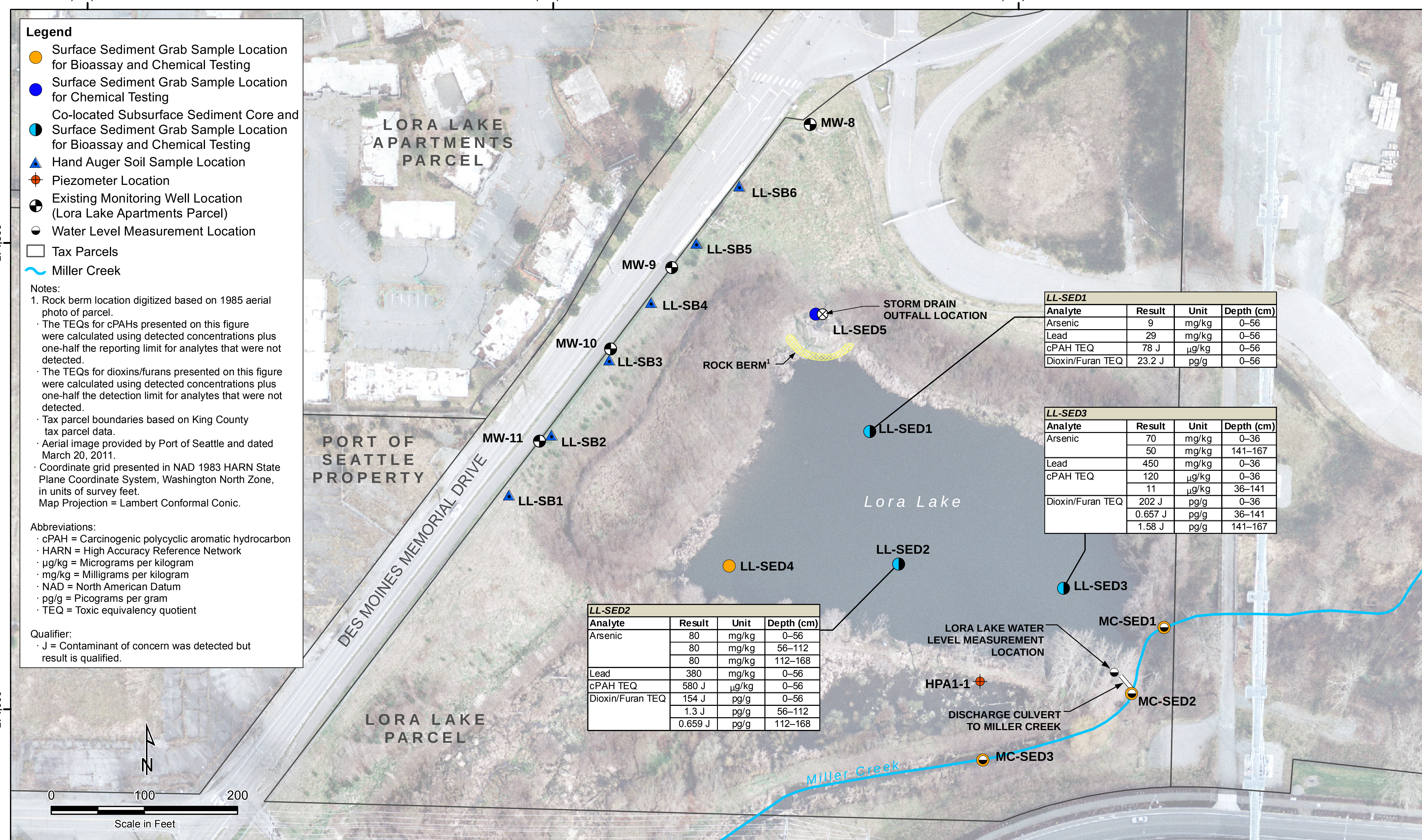


FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.3
Lora Lake Parcel Sampling Locations

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.3 Lora Lake Parcel Sampling Locations.mxd
9/9/2014



LL-SED1

Analyte	Result	Unit	Depth (cm)
Arsenic	9	mg/kg	0–56
Lead	29	mg/kg	0–56
cPAH TEQ	78 J	µg/kg	0–56
Dioxin/Furan TEQ	23.2 J	pg/g	0–56

LL-SED3

Analyte	Result	Unit	Depth (cm)
Arsenic	70	mg/kg	0–36
	50	mg/kg	141–167
Lead	450	mg/kg	0–36
cPAH TEQ	120	µg/kg	0–36
	11	µg/kg	36–141
Dioxin/Furan TEQ	202 J	pg/g	0–36
	0.657 J	pg/g	36–141
	1.58 J	pg/g	141–167

LL-SED2

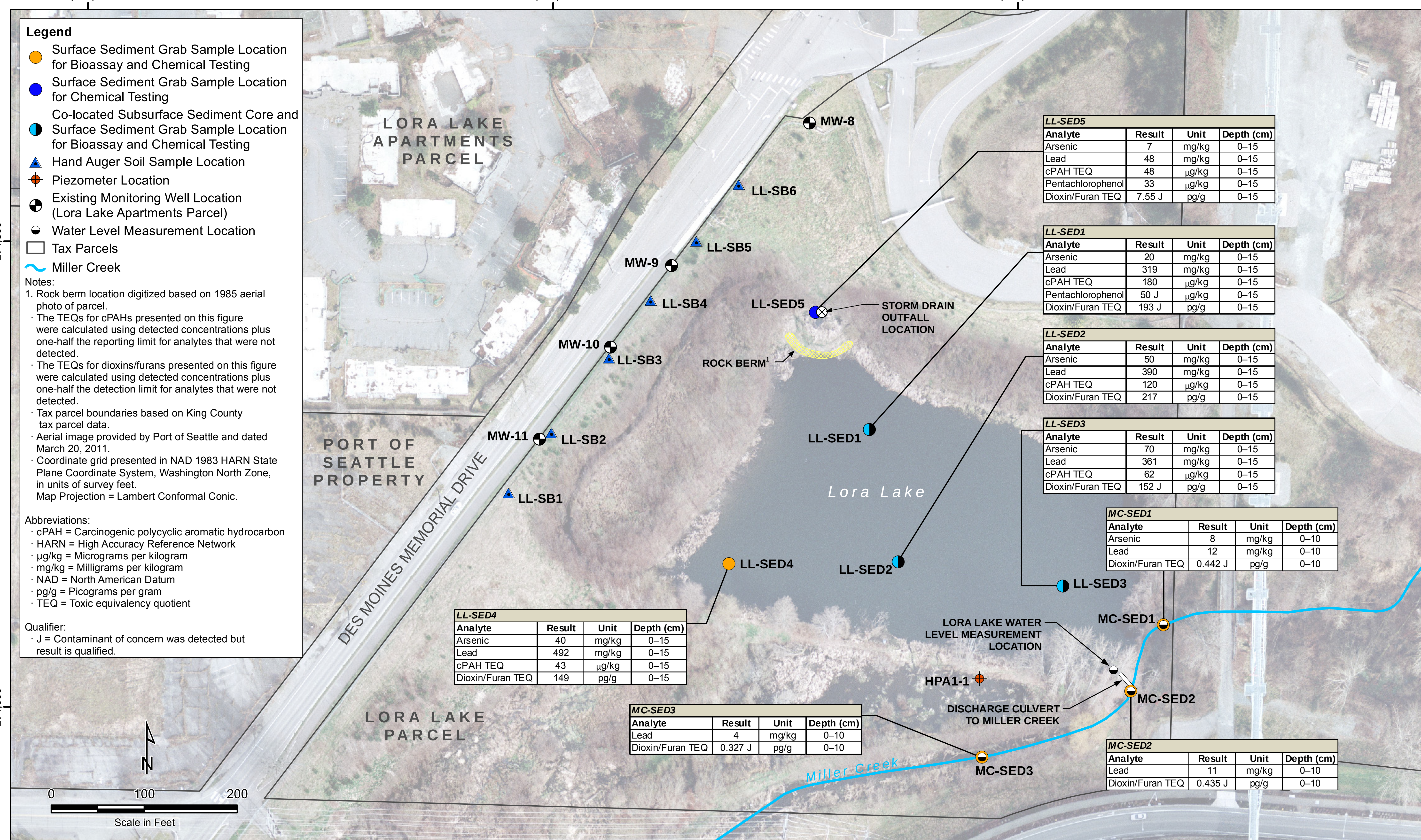
Analyte	Result	Unit	Depth (cm)
Arsenic	80	mg/kg	0–56
	80	mg/kg	56–112
	80	mg/kg	112–168
Lead	380	mg/kg	0–56
cPAH TEQ	580 J	µg/kg	0–56
Dioxin/Furan TEQ	154 J	pg/g	0–56
	1.3 J	pg/g	56–112
	0.659 J	pg/g	112–168

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.4
Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake Subsurface Sediments

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.4 Detected PCOC Conc in Subsurface Sediments.mxd
9/9/2014



LL-SED5

Analyte	Result	Unit	Depth (cm)
Arsenic	7	mg/kg	0–15
Lead	48	mg/kg	0–15
cPAH TEQ	48	µg/kg	0–15
Pentachlorophenol	33	µg/kg	0–15
Dioxin/Furan TEQ	7.55 J	pg/g	0–15

LL-SED1

Analyte	Result	Unit	Depth (cm)
Arsenic	20	mg/kg	0–15
Lead	319	mg/kg	0–15
cPAH TEQ	180	µg/kg	0–15
Pentachlorophenol	50 J	µg/kg	0–15
Dioxin/Furan TEQ	193 J	pg/g	0–15

LL-SED2

Analyte	Result	Unit	Depth (cm)
Arsenic	50	mg/kg	0–15
Lead	390	mg/kg	0–15
cPAH TEQ	120	µg/kg	0–15
Dioxin/Furan TEQ	217	pg/g	0–15

LL-SED3

Analyte	Result	Unit	Depth (cm)
Arsenic	70	mg/kg	0–15
Lead	361	mg/kg	0–15
cPAH TEQ	62	µg/kg	0–15
Dioxin/Furan TEQ	152 J	pg/g	0–15

MC-SED1

Analyte	Result	Unit	Depth (cm)
Arsenic	8	mg/kg	0–10
Lead	12	mg/kg	0–10
Dioxin/Furan TEQ	0.442 J	pg/g	0–10

LL-SED4

Analyte	Result	Unit	Depth (cm)
Arsenic	40	mg/kg	0–15
Lead	492	mg/kg	0–15
cPAH TEQ	43	µg/kg	0–15
Dioxin/Furan TEQ	149	pg/g	0–15

MC-SED3

Analyte	Result	Unit	Depth (cm)
Lead	4	mg/kg	0–10
Dioxin/Furan TEQ	0.327 J	pg/g	0–10

MC-SED2

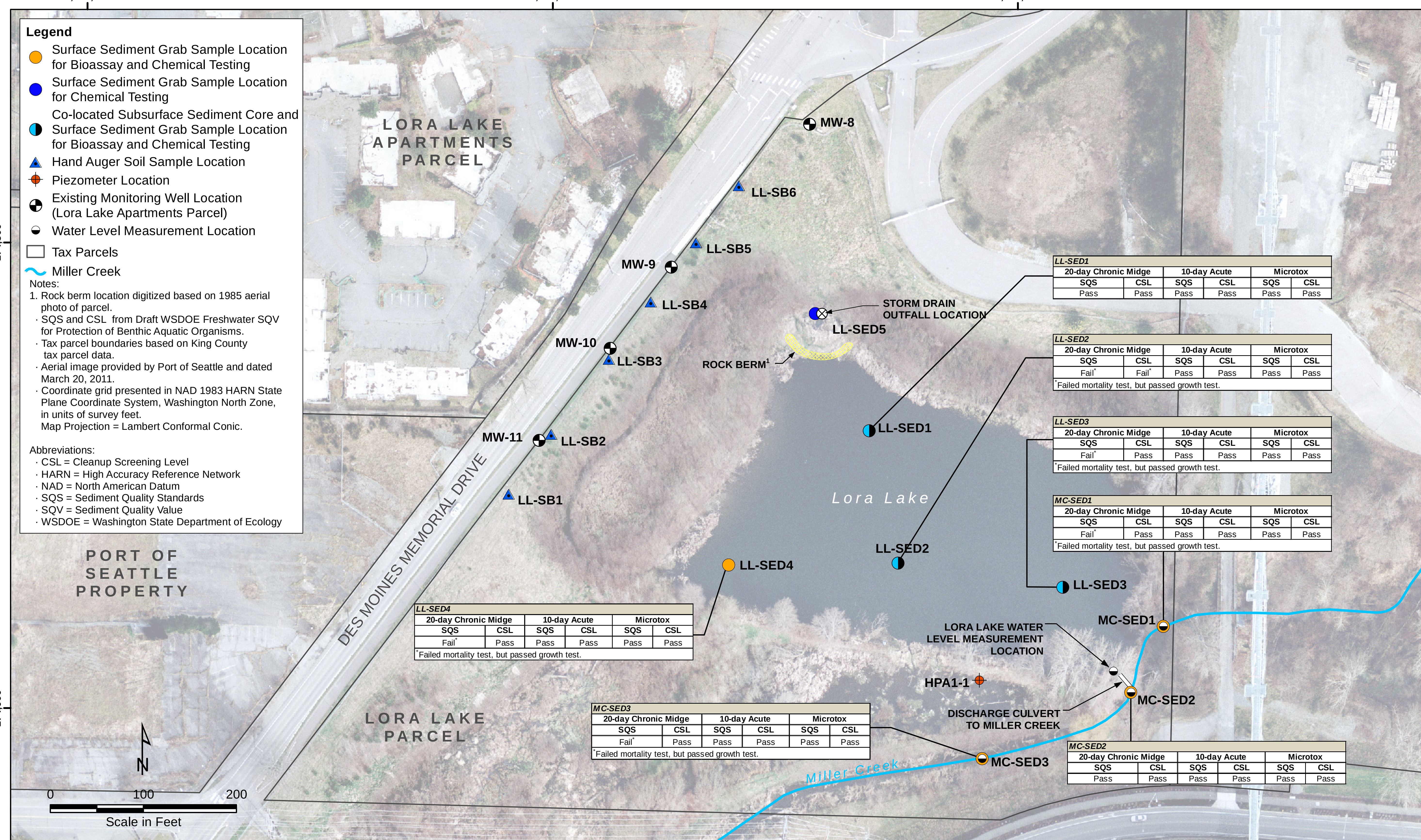
Analyte	Result	Unit	Depth (cm)
Lead	11	mg/kg	0–10
Dioxin/Furan TEQ	0.435 J	pg/g	0–10

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.5
Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake and Miller Creek Surface Sediments

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.5 Detected PCOC Conc in Surface Sediments.mxd
9/9/2014



LL-SED1

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Pass	Pass	Pass	Pass	Pass	Pass

LL-SED2

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Fail*	Fail*	Pass	Pass	Pass	Pass

*Failed mortality test, but passed growth test.

LL-SED3

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Fail*	Pass	Pass	Pass	Pass	Pass

*Failed mortality test, but passed growth test.

MC-SED1

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Fail*	Pass	Pass	Pass	Pass	Pass

*Failed mortality test, but passed growth test.

LL-SED4

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Fail*	Pass	Pass	Pass	Pass	Pass

*Failed mortality test, but passed growth test.

MC-SED3

20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Fail*	Pass	Pass	Pass	Pass	Pass

*Failed mortality test, but passed growth test.

MC-SED2

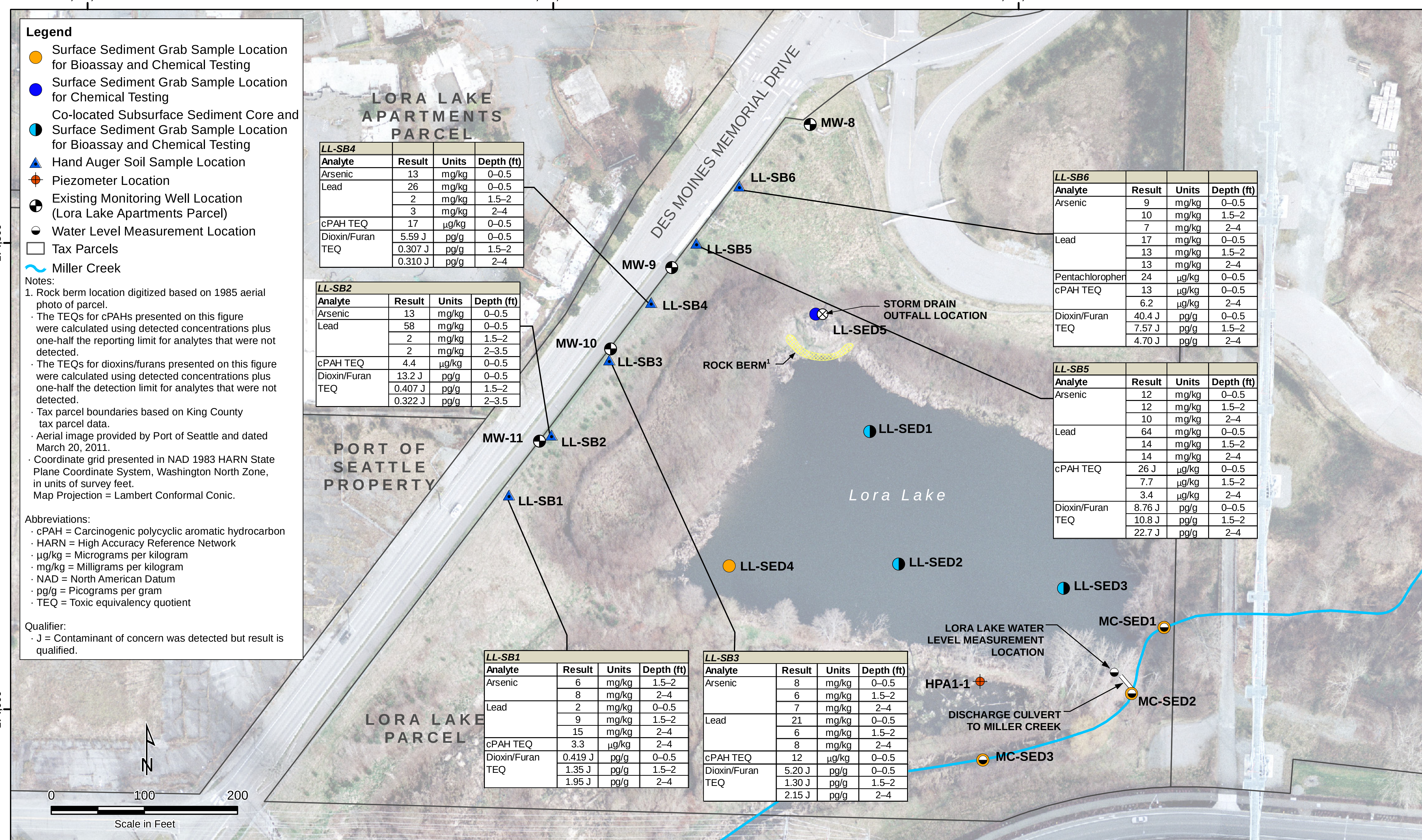
20-day Chronic Midge		10-day Acute		Microtox	
SQS	CSL	SQS	CSL	SQS	CSL
Pass	Pass	Pass	Pass	Pass	Pass

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.6
Bioassay Results in Lora Lake and Miller Creek Surface Sediments

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.6 Bioassay Results in Surface Sediments.mxd
9/9/2014



Legend

- Surface Sediment Grab Sample Location for Bioassay and Chemical Testing
- Surface Sediment Grab Sample Location for Chemical Testing
- Co-located Subsurface Sediment Core and Surface Sediment Grab Sample Location for Bioassay and Chemical Testing
- Hand Auger Soil Sample Location
- Piezometer Location
- Existing Monitoring Well Location (Lora Lake Apartments Parcel)
- Water Level Measurement Location
- Tax Parcels
- Miller Creek

Notes:

1. Rock berm location digitized based on 1985 aerial photo of parcel.
- The TEQs for cPAHs presented on this figure were calculated using detected concentrations plus one-half the reporting limit for analytes that were not detected.
- The TEQs for dioxins/furans presented on this figure were calculated using detected concentrations plus one-half the detection limit for analytes that were not detected.
- Tax parcel boundaries based on King County tax parcel data.
- Aerial image provided by Port of Seattle and dated March 20, 2011.
- Coordinate grid presented in NAD 1983 HARN State Plane Coordinate System, Washington North Zone, in units of survey feet. Map Projection = Lambert Conformal Conic.

Abbreviations:

- cPAH = Carcinogenic polycyclic aromatic hydrocarbon
- HARN = High Accuracy Reference Network
- µg/kg = Micrograms per kilogram
- mg/kg = Milligrams per kilogram
- NAD = North American Datum
- pg/g = Picograms per gram
- TEQ = Toxic equivalency quotient

Qualifier:

- J = Contaminant of concern was detected but result is qualified.

LL-SB4

Analyte	Result	Units	Depth (ft)
Arsenic	13	mg/kg	0–0.5
Lead	26	mg/kg	0–0.5
	2	mg/kg	1.5–2
	3	mg/kg	2–4
cPAH TEQ	17	µg/kg	0–0.5
Dioxin/Furan TEQ	5.59 J	pg/g	0–0.5
	0.307 J	pg/g	1.5–2
	0.310 J	pg/g	2–4

LL-SB2

Analyte	Result	Units	Depth (ft)
Arsenic	13	mg/kg	0–0.5
Lead	58	mg/kg	0–0.5
	2	mg/kg	1.5–2
	2	mg/kg	2–3.5
cPAH TEQ	4.4	µg/kg	0–0.5
Dioxin/Furan TEQ	13.2 J	pg/g	0–0.5
	0.407 J	pg/g	1.5–2
	0.322 J	pg/g	2–3.5

LL-SB6

Analyte	Result	Units	Depth (ft)
Arsenic	9	mg/kg	0–0.5
	10	mg/kg	1.5–2
	7	mg/kg	2–4
Lead	17	mg/kg	0–0.5
	13	mg/kg	1.5–2
	13	mg/kg	2–4
Pentachloropher	24	µg/kg	0–0.5
cPAH TEQ	13	µg/kg	0–0.5
	6.2	µg/kg	2–4
Dioxin/Furan TEQ	40.4 J	pg/g	0–0.5
	7.57 J	pg/g	1.5–2
	4.70 J	pg/g	2–4

LL-SB5

Analyte	Result	Units	Depth (ft)
Arsenic	12	mg/kg	0–0.5
	12	mg/kg	1.5–2
	10	mg/kg	2–4
Lead	64	mg/kg	0–0.5
	14	mg/kg	1.5–2
	14	mg/kg	2–4
cPAH TEQ	26 J	µg/kg	0–0.5
	7.7	µg/kg	1.5–2
	3.4	µg/kg	2–4
Dioxin/Furan TEQ	8.76 J	pg/g	0–0.5
	10.8 J	pg/g	1.5–2
	22.7 J	pg/g	2–4

LL-SB1

Analyte	Result	Units	Depth (ft)
Arsenic	6	mg/kg	1.5–2
	8	mg/kg	2–4
Lead	2	mg/kg	0–0.5
	9	mg/kg	1.5–2
	15	mg/kg	2–4
cPAH TEQ	3.3	µg/kg	2–4
Dioxin/Furan TEQ	0.419 J	pg/g	0–0.5
	1.35 J	pg/g	1.5–2
	1.95 J	pg/g	2–4

LL-SB3

Analyte	Result	Units	Depth (ft)
Arsenic	8	mg/kg	0–0.5
	6	mg/kg	1.5–2
	7	mg/kg	2–4
Lead	21	mg/kg	0–0.5
	6	mg/kg	1.5–2
	8	mg/kg	2–4
cPAH TEQ	12	µg/kg	0–0.5
Dioxin/Furan TEQ	5.20 J	pg/g	0–0.5
	1.30 J	pg/g	1.5–2
	2.15 J	pg/g	2–4

FLOYD | SNIDER
strategy • science • engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Apartments Site
Burien, Washington

Figure G.7
Detected Concentrations of Preliminary Contaminants of Concern in Lora Lake Parcel Shallow Soil Samples

I:\GIS\Projects\POS_LLA\MXD\T6030\Appendix G\Figure G.7 Detected PCOC Conc in Shallow Soil Samples.mxd
9/9/2014

Port of Seattle
Lora Lake Apartments Site

Remedial Investigation/ Feasibility Study

Volume II

Appendix G
Lora Lake Parcel
Remedial Investigation Data Report

Attachment G.1
Field Photographs

FINAL

Photograph 1: Surface water connection from wetlands to Lora Lake. This wetland area is located to the south of Lora Lake.

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Remedial Investigation/Feasibility Study** **Port of Seattle** **Lora Lake Parcel** **SeaTac, Washington**	Attachment G.1 Photograph 1

Photograph 2: Drainage channel discharge point to Lora Lake, located near the southwest corner of Lora Lake.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Parcel
SeaTac, Washington

Attachment G.1
Photograph 2

Photograph 3: Drainage channel upstream of the Lora Lake discharge point.

Photograph 4: City of Burien storm drain outfall and adjacent concrete outfall.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Remedial Investigation/Feasibility Study
Port of Seattle
Lora Lake Parcel
SeaTac, Washington

Attachment G.1
Photograph 4

Photograph 5: No discharge was observed from the partially submerged concrete outfall.

FLOYD | SNIDER strategy ▪ science ▪ engineering	**Remedial Investigation/Feasibility Study** **Port of Seattle** **Lora Lake Parcel** **SeaTac, Washington**	Attachment G.1 Photograph 5

Port of Seattle
Lora Lake Apartments Site

Remedial Investigation/ Feasibility Study

Volume II

Appendix G
Lora Lake Parcel
Remedial Investigation Data Report

Attachment G.2
Sediment Collection Forms and Bore Logs

FINAL

SUBSURFACE SEDIMENT COLLECTION FORM AND LOG

Lora Lake Parcel Remedial Investigation
Date: 3/15/11 Time: 17:22 ☐ am ☒ pm
Field Personnel: E. Breckel, A. McKay
Weather: light rain, overcast, ~55°F

Sampling Location: LL-SED31

Datum Horizontal: Washington State Plane N, NAD 83

Datum Vertical:

Lat/Northing: 174306 } 1st attempt 174299 } 2nd attempt – used for sample

Long/Easting: 1272838 1272840

Drive Method: Hand ☐ Slide Hammer ☒ Photograph: ☒ Yes ☐ No

Leadline Water Depth: 8.0 ft ~~cm~~ Core Tube Length: 7 ft cm

Drive Length: 3.5 ft ~~cm~~ Recovered Length: 26 inches (*) cm

% Recovery (D/C x 100): 100%

(*) Bottom portion of core driven into sediment did not have any sample when recovered. Likely not enough water present in sediment at this depth to freeze sediment to core tube.

In Tube (ft): 0; 22"; 26"

Corrected (cm): 0; 22" 56; 26"; 112; 168

Drive Length (C)	Sample ID	Analytes*	Sediment Description Density, Moisture, Minor Constituents, Major Constituents, Odor, Organics, Sheen, Etc
	LL-SED31-0-56-031511 (18:00)	TOC, Dioxins, cPAHs, PCP, Metals	0-5 in – brown and black mottled silt with trace sand 5 – ~~10~~ 10.5" – brown sandy silt 10.5" – 18" brown sandy grey silt with sand clasts and ~~trace~~ occ. fragments of wood
			18"-26" – grey medium sand with occ. piece of gravel.

*Note: See Table B.1 for Required Analytes

ATTACHMENT B.3

SUBSURFACE SEDIMENT COLLECTION FORM AND LOG

Lora Lake Parcel Remedial Investigation
Date: 3/15/11 Time: 13:25 ☐ am ☒ pm
Field Personnel: E. Breckel, A. McKay
Weather: overcast, ~55°F

Sampling Location: LL-SED2
Datum Horizontal: Washington State Plane N, NAD 83
Datum Vertical:
Lat/Northing: 174156
Long/Easting: 1272871

Drive Method: Hand ☒ Slide Hammer ☐ Photograph: ☒ Yes ☐ No

Leadline Water Depth: 13.7 feet ~~cm~~ Core Tube Length: 7 ft cm
Drive Length: 67" ~~cm~~ Recovered Length: 67" cm
% Recovery (D/C x 100): 100 %

In Tube (ft)	Corrected (cm)	Drive Length (C)	Sample ID	Analytes*	Sediment Description (Density, Moisture, Minor Constituents, Major Constituents, Odor, Organics, Sheen, Etc)
0 – (22")	56		LL-SED2-0-56-031511 + field dup LL-SED2-0-56-031511-D (14:15)	TOC, Dioxins, cPAHs, PCP, Metals	0-6" Dark brown w/ black mottling silt; 6-14.25" Reddish brown silty organic soil ~~with~~ (peat ?); 14.25"-22" Greyish brown silt
(44")	112		LL-SED2-56-112-031511 + volume for MS/MSD (14:25)	↓	22"-27" Greyish brown silt; 27"-44" stratified layers of lighter and darker greyish brown silt. Distinct darker band ~1 cm thick at 34"
(66")	168		LL-SED2-112-168-031511 (14:55)	↓	44"-47" see description for 27"-44" above. 47"-66" brown silt.

*Note: See Table B.1 for Required Analytes

SUBSURFACE SEDIMENT COLLECTION FORM AND LOG

Lora Lake Parcel Remedial Investigation
Date: 3/15/11 Time: 11:45 [X] am [ ] pm
Field Personnel: E. Brecker / A. McKay
Weather: Overcast, ~55°F

Sampling Location: LL-SED3
Datum Horizontal: Washington State Plane N, NAD 83
Datum Vertical:
Lat/Northing: 174130
Long/Easting: 1273048

Drive Method: Hand [X] Slide Hammer [X] Photograph: [X] Yes [ ] No
For last drive interval (~last ~~12~~ in)

Leadline Water Depth: 7.4 feet ~~cm~~ Core Tube Length: 7 ft cm
Drive Length: 65 3/4" 167 cm cm Recovered Length: 65 3/4" cm
% Recovery (D/C x 100): 100%

In Tube (ft)	Corrected in (~~cm~~)	Drive Length (C)	Sample ID	Analytes*	Sediment Description Density, Moisture, Minor Constituents, Major Constituents, Odor, Organics, Sheen, Etc
0	0 – 14.25" ~~10.00~~ ~~56~~ (36 cm)		LL-SED3-0-36-031511 (12:30)	TOC, Dioxins, cPAHs, PCP, Metals,	Greyish-Brown silt
	55.75" ~~112~~ (141 cm)		LL-SED3-~~35~~-141-031511 (12:40)	TOC, Dioxins, cPAHs, PCP, Metals.	Reddish brown, ~~significant~~ soft organic material (peat) with some silt. Organic soil with some silt
	65.75" ~~168~~ (167 cm)		LL-SED3-141-167-031511 (12:50)	TOC, Dioxins, cPAHs, PCP, Metals.	~~Reddish~~ Brown silty ~~or~~ organic soil (peat). ~~with~~

*Note: See Table B.1 for Required Analytes

AMEC Freezecore Bore Log

Collection Information

Date: 3-15-11 **Initials:** GSM

Project: Lora Lake **Project #:** LY1160070

Station Name: LL SED 01

Position Information

Water Depth (ft): ~~5.6~~ ~~5.5~~ **Time:** ~~1421~~ 1449

Coordinate Datum:

Est. Penetration: ~~6.8~~ ~~7.8~~ 8.0

Northing ~~174342~~ ~~174332~~

Easting ~~1272791~~ 1272804

lbs CO2 Used: 40 **Freezing Time**

On Deck Diameter of Sediment **On Deck Length of Sediment**

Comments:

	start		stop	
cylinder 1	1540	1705	1554	1715
cylinder 2	1555	1716	1611	1722

R2 very firm bottom - moved ~16 ft SW

R3 " " " - moved ~10 SE 174327 / 1272810

R4 " " " ~10 SE 174321 1272833

R5 174306 1272838

some nozzels plugged up near bottom of manifold - poor recovery

R6 174299 / 1272840

AMEC Freezecore Bore Log

Collection Information

Date: 3-15-11 Initials: GSM

Project: Lora Lake Project #: LY1160070

Station Name: LL SED 02

Water Depth (ft): 13.7 Time: 1243

Est. Penetration: 8

Position Information

Coordinate Datum:

Northing 174156

Easting 1272871

lbs CO2 Used: 40 lb

Freezing Time

On Deck Diameter of Sediment

On Deck Length of Sediment

Comments:

	start	stop
cylinder 1	1300	1313
cylinder 2	1314	1329

hand push

AMEC Freezecore Bore Log

Collection Information

Date: 3-15-2010 Initials: GSN

Project: Lora Lake Project #: LY1160070

Station Name: LL-SED-03

Water Depth (ft): 7.4 Time: 1037

Est. Penetration: 6.0

Position Information

Coordinate Datum: WA N NAD 83 Survey ft

Northing 174129

Easting 1273048

lbs CO2 Used: 40 Freezing Time

On Deck Diameter of Sediment

On Deck Length of Sediment

Comments: start stop

bottle #1 1107 1119

bottle #2 1120 1131

drove with slide hammer ~ 1 ft

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11 14:05
Weather: Raining
Field Personnel: JS EB AM

Sample Type:

☒ 1. Surface Sample (0-~~10 cm~~) 0 - 15 cm
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. LL-SED1-0-15-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) CAB core tube (~15 cm)

Datum (Horizontal/Vertical) WA State Plane N, NAD 83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 8.35' (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	1405	174301.	1272840						Y	0-15cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other):

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):
Top 0-10cm brown silt w/ black streaks, bottom 10-15cm sandy SILT - Sand is very fine grain little peat or organic material

Sample containers filled (number and type):
20 for chemistry (10 for parent sample and 10 for field dup sample)
3 for bioassay (no duplicate for bioassay)

Laboratory analysis:
Refer to SAP/QAPP

Diver Comments etc:
18 core tubes collected. Volume collected for field duplicate —
LL-SED1-0-15-032911-D

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/24/11, 12:00 pm
Weather: overcast, ~50°
Field Personnel: EB/AM/TS

Sample Type:

☑ 1. Surface Sample ~~(0-10 cm)~~ (0-15 cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. LL-SED2-0-15-03-2911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) CAB core tube (~15 cm)

Datum (Horizontal/Vertical) WA State Plane N, NAD 83

Sample Types 1, 2, 3, 4; 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 14'10" (A)
Predicted Tide Elevation ________ (B)
Mudline Elevation ________ (B-A)
Actual Tide Elevation ________

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	12:00	174159	1272875						Y	15 cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other): ________

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):

wet dark grey silt. occasionally see some mottling with brown silt throughout depth of core (15 cm). Several worms. Organic sheen on surface.

Sample containers filled (number and type):

20 for chemistry (10 for sample / 10 for MS/MSD analysis)
3 for bioassay

Laboratory analysis:

Refer to SAP/QAPP

Diver Comments etc:

18 dive cores collected. Volume collected for MS/MSD analysis.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11 . 11:10
Weather: overcast, ~50°
Field Personnel: EB/AM/TS

Sample Type:

☑ 1. Surface Sample ~~(0-10 cm)~~ (0-15 cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. LL-SED3-0-15-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) CAB core tube (~15cm)

Datum (Horizontal/Vertical) WA State Plane N, NAD 83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 7.9 feet (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	11:10	174128	1273050						Y	0-15cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other): ______

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):
Wet brown silt. A few of the core tubes (3) had reddish-brown organic soil (peat) layer at the bottom. Occ. leaf present, Streaks of black silt, Dense, medium plasticity (CL), fine grain, chunks of organic material, organic odor, organics sheen,

Sample containers filled (number and type):
10 for chemistry
3 for bioassay

Laboratory analysis:
Refer to SAP/QAPP

Diver Comments etc:
15 core tubes collected.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11, 13:10
Weather: Cloudy
Field Personnel: TS AM EB

Sample Type:

☒ 1. Surface Sample ~~(0-10 cm)~~ (0-15cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. LL-SED4-0-15-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) CAB Core Tube (~15cm)

Datum (Horizontal/Vertical) WA State Plane N, NAD83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 7' (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	1310	174154.215	1272688.698	x	x	x		x	Y	0-15cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other):

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):

brown silt w/ streaks of black, some organic material, peat layer present.
slight biological sheen on surface.

Sample containers filled (number and type):

10 ~~sample~~ for chemistry
3 for bioassay

Laboratory analysis:

Refer to SAP/QAPP

Diver Comments etc:

15 core tubes collected.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11 15:10
Weather: Raining
Field Personnel: TS EB AM

Sample Type:

☒ 1. Surface Sample (~~0-10~~ cm) 0-15cm
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. LL-~~[illegible]~~ SED5-0-15-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) — 14" depth cookie cutter

Datum (Horizontal/Vertical) WA State Plan N, NAD 83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 2.4' (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	1510	174424	1272782						Y	0-15cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other): ______

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):
Sand w/ some silt and small round gravels, large grain size, slight organic odor, little organic material. Brown with some white, red, grey grains.

Sample containers filled (number and type):
10 for chemistry. No bioassay sample collected per SAP/QAPP.

Laboratory analysis:
Refer to SAP/QAPP

Diver Comments etc: Collected in sediment settling basin, near mouth of outfall. Used cookie cutter to collect sample. Taped outside of sampler to mark 15cm depth so diver knew how deep to push cookie cutter into sediment. Remaining overlying water was decanted off surface of sample once it was placed in the bowl — loss of some fines in overlying water.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 03/29/11 16:50
Weather: Rain, 50°
Field Personnel: EB/AM/TS

Sample Type:

☒ 1. Surface Sample (0-10 cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. MC-SED1-0-10-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) Trowel / Stainless Steel Bowl

Datum (Horizontal/Vertical) Washington State Plane N, NAD83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 18.5" (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	1650	collected at rebar stake							Y	0-10 cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other): ______

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):

Some twigs, worms, black sandy gravels, bark, some silt, angular gravel to 2" round gravel up to 1", angular gravels = brown to black, round gravels = all colors (red, white, green) no odor, no sheen

Sample containers filled (number and type):

10 for chemistry
1 for bioassay

Laboratory analysis:

Refer to SAP/QAPP

Diver Comments etc:

Having to move quarry spalls to collect interstitial sediment. Removing cobbles/large gravel from sampling bowl. Collecting sediment just upstream of rebar stake (~0-2 feet upstream). Collected to depth of ~10 cm by diver in dry suit with bowl and trowel.

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11, 16:35
Weather: Overcast, ~50°
Field Personnel: EB/AM/TS

Sample Type:

☒ 1. Surface Sample (0-10 cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. MC-SED2-0-10-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) Trowel / stainless steel bowl

Datum (Horizontal/Vertical) Washington State Plane N NAD 83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 12.25" (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	16:35	Collected at rebar stake							Y	0 – 10 cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other): ______

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):

2 pieces broken glass, porcelain, gravel w/ medium grain sand, primarily gray angular gravel up to 2", small round gravel up to 1", little silt, no odor or sheen, no visible organics. Sandy gravel.

Sample containers filled (number and type):
10 for chemistry
1 for bioassay

Laboratory analysis:
Refer to SAP/QAPP

Diver Comments etc:
Remove cobbles, large pieces of gravel from sampling bowl. 0-10 cm collected by diver in dry suit, with bowl and trowel. Sample collected just upstream of rebar stake (0-1 ~~[illegible]~~ feet).

ATTACHMENT B.4

SURFACE SEDIMENT SAMPLE COLLECTION FORM

Date/Time Collected: 3/29/11 16:15

Weather: Light rain, ~50°

Field Personnel: EB / AM / TS

Sample Type:

☒ 1. Surface Sample (0-10 cm)
☐ 2. Next Surface Sample (10- 20 cm)

Sample ID/Design. MC-SED3-0-10-032911

Sample Method (Van Veen Surface Grab/Diver Core-Cookie Cutter) Trowel/Stainless steel bowl

Datum (Horizontal/Vertical) Washington State Plane N, NAD 83

Sample Types 1, 2, 3, 4, 5:
*If sample type 4, were reference samples collected? ☐ Yes ☐ No

Leadline Water Dept: 15.5" (A)
Predicted Tide Elevation ______ (B)
Mudline Elevation ______ (B-A)
Actual Tide Elevation ______

Run # or Composite Pt	Time	Latitude (Northing)	Longitude (Easting	Sample Criteria (Surface Grab Only) 1	2	3	4	5	Accept Sample Y/N	Comments (Include depth of sample)
	16:15	collected at rebar stake							Y	0-10cm

Acceptance criteria: 1 Overlying water is present, 2 Water has low turbidity, 3 Sampler is not over filled, 4 Sample surface is flat, 5 Desired sample depth is reached

Decon Procedure (Alconox Wash, DI water rinse, other):______

Sediment Sample Description

Sediment Sample Description (density, moisture, color, minor constituents, major constituents, other observations - *see field ref cards):

Sandy gravel, round gravel up to 1-3" gray Sand, w/ some silt, multi color gravel no odor, no sheen, wet, no visable organic material.

Sample containers filled (number and type):

10 for chemistry
1 for bioassay

Laboratory analysis:

Refer to SAP/QAPP

Diver Comments etc:

Removed large rocks (cobble) from sampler bowl, 0-10 cm. Collected just upstream of rebar stake. (~2 ft upstream). Collected in dry suit, kneeling on bottom, working w/ bowl and trowel.

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Boring ID: LL-SB1

Drill Date: April 19, 2011
Logged By: Dean Brame
Drilled By: Floyd|Snider

Coordinate System: NAD83/NGVD29
Ground Surface Elevation: 283.6
Latitude/Northing: 174230.0
Longitude/Easting: 1272451.8
Boring Location: D.M.D. Right-of-Way

Drill Type: 3" x 18" Hand auger
Sample Method: Composite grab
Boring Diameter: 3 inches
Boring Depth (ft bgs): 4 ft
Groundwater ATD (ft bgs): NA

Client: Port of Seattle
Project: POS-LL
Task: T 4010
Address: Lora Lake Parcel
15001 Des Moines Memorial Dr.

Remarks:

PID (ppm)	SHEEN	SAMPLE ID	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS (color, texture, moisture, MAJOR CONSITIUENT, odor, staining, sheen, debris, etc.)
0.2	no sheen	LL-SB1-0-0.5-041911		0	SM	dark grayish-brown, moist fine SILTY SAND, some small roots, minor mottles, no odor.
0.4	no sheen			1	SP	dark gray-brown, moist, fine SAND, minor mottles, 1% small gravel, trace large gravel, few light gray reduced small peds, no odor.
0.4	no sheen	LL-SB1-1.5-2-041911		2		dark brown with oxidized streaks, 5% small gravel, 1% large gravel at 1.5 ft, no odor.
						very dark gray and wet with very few oxidized flecks at 2.5 ft, 10% small gravel, 3% large gravel, no odor.
0.1	no sheen	LL-SB1-2-4-041911		3		
				4		

Notes:
FT BGS = feet below ground surface
ppm = parts per million
--- Dashed contact line in soil description indicates a gradational contact
USCS = Unified Soil Classification System
▼ = denotes groundwater table

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Boring ID: LL-SB2

Drill Date: April 19, 2011
Logged By: Dean Brame
Drilled By: Floyd|Snider

Coordinate System: NAD83/NGVD29
Ground Surface Elevation: 284.1
Latitude/Northing: 174294.1
Longitude/Easting: 1272497.7
Boring Location: D.M.D. Right-of-Way

Drill Type: 3" x 18" Hand auger
Sample Method: Composite grab
Boring Diameter: 3 inches
Boring Depth (ft bgs): 3.5 ft
Groundwater ATD (ft bgs): NA

Client: Port of Seattle
Project: POS-LL
Task: T 4010
Address: Lora Lake Parcel
15001 Des Moines Memorial Dr.

Remarks:

PID (ppm)	SHEEN	SAMPLE ID	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS (color, texture, moisture, MAJOR CONSITIUENT, odor, staining, sheen, debris, etc.)
0.2	no sheen	LL-SB2-0-0.5-041911		0	SM	dark brown, moist, fine SILTY SAND, mottled, small roots, 2% small gravels, few light gray reduced peds, no odor.
0.3	no sheen			1	SP	light grayish-brown, moist, fine SAND, few oxidation streaks, 5% small gravel, trace large gravel, no odor.
0.3	no sheen	LL-SB2-1.5-2-041911		2		minor mottling at 1.5 ft., 5% small gravel, 2% large gravel, no odor.
0.1	no sheen	LL-SB2-2-3.5-041911		3		wet and mottled at 2.5 ft., 5% small gravel, 4% large gravel, no odor.
				4		no recovery 3.5-4 ft due to large cobbles blocking sampler

Notes:
FT BGS = feet below ground surface
ppm = parts per million
--- Dashed contact line in soil description indicates a gradational contact
USCS = Unified Soil Classification System
▼ = denotes groundwater table

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Boring ID: LL-SB3

Drill Date: April 19, 2011
Logged By: Dean Brame
Drilled By: Floyd|Snider

Coordinate System: NAD83/NGVD29
Ground Surface Elevation: 283.1
Latitude/Northing: 174374.7
Longitude/Easting: 1272559.8
Boring Location: D.M.D. Right-of-Way

Drill Type: 3" x 18" Hand auger
Sample Method: Composite grab
Boring Diameter: 3 inches
Boring Depth (ft bgs): 4 ft
Groundwater ATD (ft bgs): NA

Client: Port of Seattle
Project: POS-LL
Task: T 4010
Address: Lora Lake Parcel
15001 Des Moines Memorial Dr.

Remarks:

PID (ppm)	SHEEN	SAMPLE ID	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS (color, texture, moisture, MAJOR CONSITIUENT, odor, staining, sheen, debris, etc.)
0.1	no sheen	LL-SB3-0-0.5-041911		0	SM	very dark brown, moist, fine SILTY SAND, 2% small gravel, fine roots, oxidized after 0.3 ft bgs, no odor.
0.2	no sheen			1	SP	medium orange brown, miost, fine SAND, mottled, 2% small gravel, trace large rounded gravel, no odor.
0.2	no sheen	LL-SB3-1.5-2-041911		2		wet with 15% small rounded gravel, trace large rounded gravel at 2 ft. no odor.
0.2	no sheen	LL-SB3-2-4-041911		3		
				4		

Notes:
FT BGS = feet below ground surface
ppm = parts per million
--- Dashed contact line in soil description indicates a gradational contact
USCS = Unified Soil Classification System
▼ = denotes groundwater table

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Boring ID: LL-SB4

Drill Date: April 19, 2011
Logged By: Dean Brame
Drilled By: Floys|Snider
Drill Type: 3" x 18" Hand auger
Sample Method: Composite grab
Boring Diameter: 3 inches
Boring Depth (ft bgs): 4 ft
Groundwater ATD (ft bgs): NA

Coordinate System: NAD83/NGVD29
Ground Surface Elevation: 283.8
Latitude/Northing: 174436.5
Longitude/Easting: 1272604.5
Boring Location: D.M.D. Right-of-Way

Client: Port of Seattle
Project: POS-LL
Task: T 4010
Address: Lora Lake Parcel 15001 Des Moines Memorial Dr.

Remarks:

PID (ppm)	SHEEN	SAMPLE ID	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS (color, texture, moisture, MAJOR CONSITIUENT, odor, staining, sheen, debris, etc.)
				0	SM	dark brown, moist, fine SILTY SAND. few small roots, trace large gravel, no odor.
0.1	no sheen	LL-SB4-0-0.5-041911			SP	medium brown, moist, fine SAND. oxidized, few small roots, trace large gravel, no odor.
						medium brown-yellow with1% large rounded gravel a 1-2 inch light gray reduced layer with mottling at 0.5 ft, no odor.
0.1	no sheen			1		
0.0	no sheen	LL-SB4-1.5-2-041911				light gray and orange, mottled, with trace large rounded gravel at 1.5 ft, no odor.
				2		medium brown, very moist, oxidized and very mottled at 2 ft. no gravel.
0.0	no sheen	LL-SB4-2-4-041911		3		at 3 ft, turning more gray with mottling.
						at 3.5 ft, ~1 inch layer light gray reduced silty lense
				4		light brown, moist and mottled at 3.6 ft , no odor.

Notes:
FT BGS = feet below ground surface
ppm = parts per million
--- Dashed contact line in soil description indicates a gradational contact
USCS = Unified Soil Classification System
▼ = denotes groundwater table

FLOYD | SNIDER
strategy ▪ science ▪ engineering

Boring ID: LL-SB5

Drill Date: April 18, 2011
Logged By: Dean Brame
Drilled By: Dean Brame
Drill Type: Hand auger
Sample Method: Composite grab
Boring Diameter: 3 inches
Boring Depth (ft bgs): 4 ft
Groundwater ATD (ft bgs): NA

Coordinate System: NAD83/NGVD29
Ground Surface Elevation: 282.8
Latitude/Northing: 174499.8
Longitude/Easting: 1272653.4
Boring Location: adjacent to roadway

Client: Port of Seattle
Project: POS-LL
Task: T 4010
Address: Lora Lake Parcel
15001 Des Moines Memorial Dr.

Remarks:

PID (ppm)	SHEEN	SAMPLE ID	DRIVEN / RECOVERED	DEPTH FT BGS	USCS SYMBOL	SOIL DESCRIPTION AND OBSERVATIONS (color, texture, moisture, MAJOR CONSITIUENT, odor, staining, sheen, debris, etc.)
0.0	no sheen	LL-SB5 -0-0.5		0	SM	very dark brown very fine SILTY SAND, major organic matter, small roots, trace fine gravel, moist, organic earthy odor.
0.0	no sheen			0.5–1	SP	dark brown fine SAND, few fine roots, dry, no odor
0.0	no sheen	LL-SB5 -1.5-2		1.5		mottled with 2% fine gravel and trace large gravel at 1.5 ft no odor
				2		moist, mottled and oxidized with trace large rounded gravel at 2 ft. no odor
0.0	no sheen	LL-SB5 -2-4		3		
				4		

Notes:
FT BGS = feet below ground surface
ppm = parts per million
--- Dashed contact line in soil description indicates a gradational contact
USCS = Unified Soil Classification System
▼ = denotes groundwater table