REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORT FORMER UNOCAL BULK PLANT 0828 AND HULCO PROPERTY

Prepared for

City of Olympia Parks, Arts & Recreation

222 Columbia Street Northwest

Olympia, Washington 98501-8208

Prepared by

Anchor QEA, LLC

720 Olive Way, Suite 1900

Seattle, Washington 98101

August 2012

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degree Celsius
°F	degree Fahrenheit
Ag	silver
AGI	Applied Geotechnology, Inc.
Anchor QEA	Anchor QEA, LLC
Apex	Apex Laboratories, LLC
APH	air-phase petroleum hydrocarbon
ARAR	Applicable or Relevant and Appropriate Requirement
As	arsenic
AST	aboveground storage tank
ASTM	ASTM International
Ba	barium
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
Cd	cadmium
CFR	Code of Federal Regulations
City	City of Olympia
CLARC	Cleanup Levels and Risk Calculations
cm	centimeter
COC	contaminant of concern
CPT	cone penetration test
Cr	chromium
CSM	conceptual site model
cy	cubic yard
DCA	disproportionate cost analysis
DNR	Washington Department of Natural Resources
DRO	diesel range organic
Ecology	Washington State Department of Ecology
EDB	1,2-dibromoethane
EDC	1,2-dichloroethane
EPH	extractable petroleum hydrocarbon

FS	Feasibility Study
GRO	gasoline range organic
HCID	hydrocarbon identification
Hg	mercury
IDW	investigation derived waste
kg	kilogram
mg	milligram
MLLW	mean lower low water
MNR	monitored natural recovery
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl-tert-butyl ether
MTCA	Model Toxics Control Act
NFA	No Further Action
NOAA	National Oceanic and Atmospheric Administration
NTR	National Toxics Rule
NWTPH	Northwest Total Petroleum Hydrocarbon
NWTPH-Dx	Northwest Total Petroleum Hydrocarbon – diesel range (analytical method)
NWTPH-Gx	Northwest Total Petroleum Hydrocarbon – gasoline range (analytical method)
ORO	oil range organic
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
POC	point of compliance
PTL	Pacific Testing Laboratories
QA	quality assurance
QC	quality control
RAO	remedial action objective
RI	Remedial Investigation
RZA	Rittenhouse-Zenian & Associates, Inc.
Se	selenium

Site	Former Unocal Bulk Plant 0828 and Hulco Site
SVOC	semivolatile organic compound
TEE	terrestrial ecological evaluation
TPH	total petroleum hydrocarbon
Unocal	Union Oil Company of California
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
WAC	Washington Administrative Code
Work Plan	*Petroleum Contaminated Soil Assessment Workplan*

1 INTRODUCTION

This Remedial Investigation/Feasibility Study (RI/FS) has been prepared on behalf of the City of Olympia (City) for the Former Union Oil Company of California (Unocal) Bulk Plant 0828 and Hulco Site (Site) located in Olympia, Washington (Figure 1). RI activities define the nature and extent of contamination at the Site and support development of a conceptual site model (CSM) as put forth in this report. The FS evaluates a range of remedial alternatives consistent with Model Toxics Control Act (MTCA) requirements.

The RI/FS work is being conducted under the Voluntary Cleanup Program (VCP) in coordination with the Washington State Department of Ecology (Ecology) and consistent with MTCA requirements. The work described in this RI/FS Report incorporates investigation activities conducted pursuant to Ecology-approved work plans, including the *Petroleum Contaminated Soil Assessment Workplan* (Work Plan; Anchor QEA 2010a), the *Addendum to Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010b), and the *Addendum 2 to Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2011a). The *Upland Investigation Data Report* (Anchor QEA 2011b) was submitted to Ecology and provides a full description of the sampling and analysis conducted as part of the RI.

1.1 Purpose and Objectives

This RI/FS has been performed voluntarily to satisfy the RI requirements of MTCA, Chapter 70.105D in the Revised Code of Washington, administered by Ecology under the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC).

The overall objective of the RI/FS is to identify the hazardous substances that have been released to the uplands and adjacent aquatic environment; assess the nature, extent, and distribution of these substances; identify the potential migration pathways and receptors; assess potential risks to human health and the environment; and evaluate and compare protective remedial alternatives for the Site.

MTCA is the primary state law that governs the cleanup of contaminated sites. MTCA regulations (Chapter 173-340 WAC) define the process for the investigation and cleanup of contaminated sites. MTCA regulations specify criteria for the evaluation and conduct of a cleanup action in order to protect human health and the environment, meet state environmental standards and standards in other laws that apply, and provide for monitoring to confirm compliance with site cleanup standards. The RI assesses areas identified as potential environmental concerns based on historical activities to identify and quantify contaminants of concern (COCs) in soil and groundwater at the Site. The FS develops and evaluates remedial action alternatives to enable a final cleanup action to be approved by Ecology for the Site. In accordance with the MTCA Cleanup Regulation for those areas of the Site where concentrations of hazardous substances no longer exceed cleanup levels at the point of compliance (POC), an Ecology determination of no further remedial actions is appropriate.

1.2 Regulatory History

In August 1995, GeoEngineers prepared a Cleanup Action Plan (1995a) for the Unocal and Hulco properties. A voluntary cleanup was conducted between August and October 1995 to remove contaminated soil with total petroleum hydrocarbon (TPH) concentrations above the site-specific soil remediation level and remove former underground pipelines. The site-specific remediation level, which was based on a RI/FS completed by ICF Kaiser Engineers, Inc. in July 1995, was 5,000 milligrams per kilogram (mg/kg) TPH (as the sum of gasoline-, diesel-, and heavy oil-range hydrocarbons) in soil. This remediation level was later revised to 3,000 mg/kg after discussions with Ecology. A supplemental remedial excavation was conducted in November 2001 because monitoring wells, installed to evaluate groundwater quality at points of compliance at the property boundary, indicated that two areas exceeded cleanup levels or contained free product (GeoEngineers 2002). Following the supplemental excavation, some contaminated materials still remained in the west wall of the excavated area (under the boardwalk) in the northwest portion of the Site adjacent to a retaining wall and in the east wall of the supplemental excavation. Groundwater monitoring continued in these areas, with no cleanup level exceedances. Monitoring ended in November 2002, and the Site was removed from the Hazardous Site List on August 26, 2003. On October 10, 2003, Ecology issued a No Further Action (NFA) letter for the property (Ecology 2003).

During 2010 Percival Landing Park development activities, areas with TPH-contaminated soil were encountered. As a result, the City notified Ecology and submitted a Petroleum Contaminated Soil Management Plan to Ecology in September 2010. The City proceeded with cleanup actions in accordance with the Plan, as contaminated materials were encountered. The City applied to the VCP, which was accepted by Ecology on February 11, 2011 (Ecology 2011). RI activities, along with cleanup actions, were conducted simultaneously with the park development. The *Upland Investigation Data Report* summarizing all RI sample results was submitted to Ecology on August 15, 2011 (Anchor QEA 2011b).

1.3 Document Organization

The remainder of this RI/FS Report is organized as follows:

- **Section 2 – Site Background and Current Site Conditions**
  Provides an overview of historical uses and the environmental setting
- **Section 3 – Remedial Investigation Activities and Findings**
  Describes the RI studies completed at the Site
- **Section 4 – Summary of Conceptual Site Model**
  Provides a summary of the nature and extent of COCs along with a CSM
- **Section 5 –Development of Cleanup Levels:**
  Presents the development of cleanup levels, including points of compliance, and the terrestrial ecological evaluation (TEE)
- **Section 6 – Feasibility Study of Remediation Alternatives for Soil and Groundwater**
  Presents the development, screening, and evaluation of remedial alternatives for the Site
- **Section 7 – References**
  Lists references cited in development of this RI/FS Report
- **Tables and Figures**
  Provide data presentation and site mapping and graphics
- **Appendices**
  Contain the field data, laboratory data reports, data validation reports, and TPH calculation worksheet

2 SITE BACKGROUND AND CURRENT SITE CONDITIONS

This section provides background information related to the property features, historical operational history, and previous environmental cleanup actions and investigations. It also includes the environmental setting of the property location.

2.1 Current Land Use

Percival Landing Park is located adjacent to Budd Inlet in Thurston County, Olympia, Washington (Figure 1). This 3.38-acre park extends from the Olympia-Yashiro Friendship Bridge at the head of Budd Inlet and extends north to Port Plaza (Port of Olympia shoreline open space). The first phase of Percival Landing Park was completed in 1978 with the primary feature being the waterfront boardwalk. Further expansions of the boardwalk to the north and west occurred in 1985 and 1988. In 1996, the City acquired the former Unocal Tank Farm site (see Section 2.1.2.1) and converted it to a park. Percival Landing Park has been used mainly for active and passive recreation, outdoor movies, music, and festivals and includes a children's playground and picnic tables near the shoreline. This area is also the primary access for public transient boater moorage (Anchor 2008b). A major redevelopment of Percival Landing Park was completed in 2011. The portions of Percival Landing Park that comprise the Site are the large open space off of Columbia Street, the Harbor House, the Olympia Avenue paved walkway, including Pavilion No. 1, and the shoreline adjacent to these areas (Figure 2).

Percival Landing Park rehabilitation is currently underway. The first phase of the rehabilitation was completed in August 2011 and included park redevelopment, replacement of the creosote piles and treated timber boardwalk with a concrete structure, enhanced marine and shoreline habitats, and improved safety features. Installation of sheetpile walls have replaced failing rock and rubble revetments along the shoreline. A cove has been created to extend inland from Budd Inlet with a bridge over the cove. The existing bath house has been removed and replaced with a new facility (Harbor House) that, along with restrooms and showers, has a public gathering space and maintenance storage space. Olympia Avenue was converted to a pedestrian walkway. The open lawn was retained and improved for recreation and festivals. The contaminated soil under the playground area was excavated and backfilled with clean material, and new playground equipment was installed.

A replacement parking lot was created north of Olympia Avenue and adjacent to Columbia Street.

2.2 Historical Site Operations

The majority of the Site is currently owned by the City, with a portion of the shoreline area leased by the City from the State under management by the Washington Department of Natural Resources (DNR). A summary of property ownership and operational history is given in the following paragraph. Figure 2 shows current and historical property boundaries, along with former underground pipelines, former underground and aboveground fuel tanks, and the former Unocal dock.

2.2.1 Unocal/Hulco Property

The Unocal Bulk Plant (former address of 301 North Columbia Street) operated from about 1910 to 1993, and in addition to housing several underground and aboveground fuel tanks, Unocal operated a loading dock that extended from Olympia Avenue into Budd Inlet. The Hulco property (former address of 206/216 Olympia Avenue) was a bulk fuel storage facility operated by different companies including Shell Oil Company and Atlantic Richfield Company. The Shell/Atlantic Richfield bulk plant was in operation from at least 1924 to about 1980 (GeoEngineers 1995a). A voluntary cleanup was conducted in 1995 to remove contaminated soil with TPH concentrations above site-specific soil remediation level negotiated between Unocal and Ecology. Figure 3 presents the excavations conducted for this voluntary cleanup. This area has since been converted into the open lawn and play area that currently form the central open space of Percival Landing Park (Anchor 2008b). Several areas with TPH concentrations exceeding the remediation level were known to have been left in areas adjacent to Olympia Avenue to the south, under the boardwalk to the west, under the old restroom building, and under the utility corridor running north and south down the center of the Former Unocal Hulco Bulk Plant site.

2.2.2 Department of Natural Resources Property

DNR is the primary leasing authority for tideland areas occupied along Percival Landing Park, including the Harbor House. The boardwalk area is located on lands that involve a mix

of DNR leases and subleases from other primary DNR leaseholders. Within this cleanup site, the City leases the tidelands and the northeast triangle of uplands directly from DNR.

2.3 Previous Environmental Investigations

GeoEngineers, Pacific Testing Laboratories (PTL), Applied Geotechnology, Inc. (AGI), and Rittenhouse-Zenian & Associates, Inc. (RZA), performed site assessment and site decommissioning and excavation activities beginning in 1987.

The following environmental assessment reports were prepared for the former Hulco Property:

- *Subsurface Investigation: Columbia Street, Thurston County, Olympia, Washington*, prepared by PTL for the City and dated January 26, 1989
- *Preliminary Contamination Assessment, West Olympia Avenue Property*, prepared by AGI for Mr. Albert Hulbert and dated September 30, 1989
- *Environmental Site Assessment, Unocal Hulco Site*, prepared by RZA for the City and dated October 1989
- *Site History Study: Unocal Bulk Plant 0548 (301/307 Columbia Street North); Hulco Property (206/216 Olympia Avenue West) and General Petroleum Property (209/223 Olympia Avenue West)*, prepared by SAFE Research, Inc., for Unocal and dated March 22, 1993
- *Report of Environmental Services, Subsurface Contamination Assessment and Ground Water Monitoring, Hulco Property and Unocal Bulk Plant 0828*, prepared by GeoEngineers and dated May 16, 1995
- *Remedial Excavation Monitoring Former Unocal Bulk Plant 0828 and Hulco Property*, prepared by GeoEngineers and dated December 19, 1995

Soil and groundwater samples collected as part of these studies were submitted for various analytical chemistry testing including volatile organic compounds (VOCs), TPH, polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and metals. Some VOCs, SVOCs, and metals were detected at relatively low concentrations. TPH was detected in all soil samples at relatively high concentrations, with the highest concentrations from samples taken 5 to 7.5 feet below ground surface (bgs).

The following environmental assessment reports were prepared for the former Unocal Property:

- *Site Reconnaissance and Remediation, Harrington Distributing Plant*, dated April 1, 1987
- *Interim Report of Site Characterization Services, Subsurface Contamination Study*, dated April 16, 1993
- *August 1993 Ground Water Monitoring*, dated September 17, 1993
- *Report of Environmental Services, Underground Storage Tank (UST) Removal Monitoring*, dated August 9, 1994
- *Report of Environmental Services, Subsurface Contamination Assessment and Ground Water Monitoring, Hulco Property and Unocal Bulk Plant 0828*, prepared by GeoEngineers and dated May 16, 1995
- *Remedial Excavation Monitoring Former Unocal Bulk Plant 0828 and Hulco Property*, prepared by GeoEngineers and dated December 19, 1995

The groundwater monitoring study conducted in 1993 included the installation of seven monitoring wells. Both soil and groundwater were tested as part of this study from each of the monitoring wells. TPH and petroleum-related compounds (VOCs and lead) were detected in most samples at elevated concentrations. In 1994, GeoEngineers removed four USTs and other bulk plant facilities and 100 cubic yards (cy) of surrounding contaminated soil.

As described in Section 1.2, a voluntary cleanup was conducted at the Site in 1995 to address most areas with soil concentrations greater than the remediation level (3,000 mg/kg). Several areas were not excavated because of property boundaries or the presence of underground utilities (GeoEngineers 1995b). Detailed information regarding the remediation activities and supplemental remediation activities can be found in the *Remedial Investigation Monitoring* report and *Final Cleanup Report Supplemental Remedial Excavation* (GeoEngineers 1995b, 2002).

2.4 Previous Cleanup Actions

The voluntary cleanup conducted in 1995 resulted in the removal of approximately 9,438 tons of contaminated soil. Some soil with TPH concentrations above the remediation goal of 3,000 mg/kg was left at the Site due to property boundaries or the presence of underground utilities (GeoEngineers 1995b). Groundwater monitoring wells were installed and tested quarterly to assess cleanup compliance. One monitoring well yielded groundwater quality results that were out of compliance, and another occasionally indicated the presence of free product. A supplemental excavation was performed in November 2001 to remove approximately 890 tons of contaminated soil from these two areas. Figure 3 presents the 1995 and 2001 excavation extents.

During the recent Percival Landing Park Phase 1 construction work, the contractor encountered petroleum product contamination during shoreline excavations, which resulted in visible sheens on the waterway. These releases occurred when the contractor encountered and removed a timber cribwall that was buried in the shoreline embankment. In response, the City voluntarily created the Work Plan (Anchor QEA 2010a) and accompanying Addenda (Anchor QEA 2010b, 2011a). Under the Work Plan and Addenda, an RI was conducted consisting of soil borings and test pits to collect soil, groundwater, and soil vapor samples to define the nature and extent of soil and groundwater contamination in shoreline and upland areas and to provide data to evaluate potential vapor pathway to indoor air in buildings adjacent to the Site.

The investigations were conducted during construction activities (i.e., utility installation, building construction, and shoreline regrading) in several phases, between September 2010 and July 2011, with ongoing discussions and coordination with Ecology. Confirmation samples were collected in areas of concern to determine if further excavations were necessary prior to completion of park construction. Approximately 11,000 tons of contaminated soil was removed from the shoreline, cove, substation, and playground areas on the former Hulco property. As part of Percival Landing Park design, deep sheetpile walls (60 feet in length) have been installed along the entire length of the Site (except the cove area) to approximately -43 feet mean lower low water (MLLW). Short sheetpile walls (15 to 20 feet in length) were installed in the cove area to approximately 0 feet MLLW for bank stabilization.

2.5 Environmental Setting

This section describes the topography, geology, climate, and hydrogeology of the Site.

2.5.1 Climate

The climate of Olympia is a Marine West Coast climate (Koppen climate classification). Most of western Washington's weather is brought in by weather systems that form near the Aleutian Islands in Alaska. These weather systems contain cold, moist air, which brings western Washington cold rain, cloudiness, and fog. The average daily high temperature is 59.8 degrees Fahrenheit (°F) and the average daily low temperature is 39.5 °F. November and December are Olympia's rainiest months. Olympia averages 50.8 inches (1,290 millimeters) of precipitation per year and has a year-round average of 75 percent cloud cover. Snow for the 1971 to 2000 period averaged 14.7 inches, with a median of 4.3 inches (NOAA 2010).

2.5.2 Topography

The Site is located on an area of fill that is bounded by Budd Inlet to the west. The Site is relatively flat, with a maximum elevation of approximately 19 feet above mean sea level. The western edge of the Site is bounded by sheetpile walls and slopes moderately inward to the east. A cove has been created to extend inland from Budd Inlet near the Harbor House building.

2.5.3 Geology and Hydrogeology

From 1909 through 1911, a major dredging and filling operation (also known as Carlyon Fill) resulted in approximately 2.3 million cy of sediment (from mudflats) removed from Budd Inlet and redeposited to create 29 city blocks, including the Site (The Olympian 2010).

Recent onshore and offshore subsurface explorations (performed for the 30-percent design) were conducted using three different geotechnical methods: hollow stem auger borings, cone penetration tests (CPTs), and excavated test pit explorations.

Test pits excavated around the playground and lawn indicate that a 6-inch to 1-foot-thick layer of sod and topsoil covers the surface of the excavation area. A 1.5-foot-thick layer of brick and concrete rubble underlying the sod was encountered in two test pits, and the other

test pits encountered well-graded material at a depth of 2 to 6 feet, further indicating a layer of fill. Under this fill layer, and continuing down to the bottom of the test pits, was a layer of poorly graded fine sand with some shells. This sand material appears to be native deposit.

The CPTs and boring logs on land indicate a soil profile composed of three very distinct strata of varying densities. The three layers mainly consisted of sand mixed with gravel and silt. Offshore, the general soil sequence was similar to what was observed on land, except for the absence of near-surface fill soils. The loose sand material was detected at depths of up to 7 to 18 feet below the mudline from elevations -20 to -40 feet MLLW. This layer likely represents an unconsolidated alluvial soil. Medium dense sand and silt were encountered below the loose sand layer. This was the last material encountered before CPTs were terminated at between -32 and -42 feet MLLW (Anchor 2008a).

Depths to groundwater range from 6 to 9 feet below grade and fluctuate seasonally and with tides. The general direction of groundwater flow is to the west toward Budd Inlet; however, some short-term reversal of the gradient caused by tidal action has been observed in close proximity to Budd Inlet (GeoEngineers 1995b).

3 REMEDIAL INVESTIGATION ACTIVITIES AND FINDINGS

This section describes the methods used for completion of the RI field activities, as developed through consultation with Ecology. The RI methods were developed to supplement previously available investigation data and to define the nature and extent of contamination within the Site. RI activities included soil, groundwater, and soil vapor sampling.

3.1 Remedial Investigation Activities

RI activities were performed consistent with the Work Plan and accompanying Addenda, as described in the following points, to assess current Site conditions. The RI included testing for COCs known to be present at the Site from historical operations and as verified by previous testing. These COCs included petroleum hydrocarbons; benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds; and lead. The RI work also included select testing for polycyclic aromatic hydrocarbon (PAH) compounds and heavy metals. A total of 19 Geoprobe borings, eight test pits, and 16 confirmation samples were conducted at the Site, as shown on Figure 4. The following is a brief summary of the Work Plan and Addenda:

- *Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010a). This document was prepared to characterize the extent of petroleum related contaminants at the Site, so appropriate cleanup and source control actions could be conducted during construction activities.
- *Addendum to the Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2010b). This document was prepared to provide modifications to sampling and testing procedures, as well as present additional sampling locations based on historical features and uses.
- *Addendum 2 to the Petroleum Contaminated Soil Assessment Workplan* (Anchor QEA 2011a). This document was prepared to provide information on additional sampling locations to further characterize the Site, including groundwater and soil vapor sampling locations and procedures.

Following completion of the RI activities in 2011, methods and testing results were reported to Ecology in the *Upland Investigation Data Report* (Anchor QEA 2011b). This report included tabular and graphical summaries of the RI field work and analytical data. This report also included data from the property to the south—The City Sewer Pump Station and

General Petroleum Corporation site. Sampling locations on this property are not included in this present RI/FS, which is why the sample nomenclature is nonconsecutive (i.e., starting with BH-11).

Testing of soil boring, test pit, and several confirmation samples was performed using a tiered approach, with Tier 1 being the results of a qualitative hydrocarbon identification (HCID) scan. Tier 2 testing was conducted on select samples based on the results of Tier 1 testing. Tier 2 testing included a quantitative analysis of TPHs, including gasoline range organics (GROs), diesel range organics (DROs), and oil range organics (OROs); VOCs; metals; and/or PAHs. Two of the Tier 2 samples were analyzed for volatile petroleum hydrocarbons (VPHs), and three of the Tier 2 samples were analyzed for extractable petroleum hydrocarbons (EPHs). Due to field observations at the time of sample collection, some confirmation samples were tested for TPH (GRO, DRO, and ORO), VOCs, and lead without an HCID scan. Four groundwater samples were collected and submitted for Tier 2 analyses. Two soil vapor samples were collected and submitted for VOCs, VPH, and air-phase petroleum hydrocarbons (APH). Table 1 presents a summary of the RI sample collection and testing details.

3.1.1 Soil Boring Sampling and Processing

Soil boring samples were collected using a direct push Geoprobe sampling system operated by Pacific Soil & Water, LLC. The soil samples were collected to obtain chemical data and define the vertical nature and extent of contamination in subsurface soil. Figure 4 presents the soil boring locations, which are denoted by "BH-No."

Soil boring samples were collected during three events at 5 locations along the shoreline and 14 locations on the upland portion of the property. The first event, conducted in September 2010, consisted of five shoreline locations (BH-11 through BH-15) that were selected to characterize the shoreline and investigate suspected historical sources based on historical information or visual observations during park construction. The results of the first event triggered the exploration of seven subsequent borings (BH-22 through BH-28) that were collected in November 2010 to provide additional information regarding residual contamination in the upland portion of the Site. In June 2011, following informal consultation with Ecology, seven additional soil borings were collected (BH-33 through

BH-39) to delineate the nature and extent of historical petroleum contamination (borings were spaced approximately every 50 to 100 feet).

Each soil boring was advanced 20 feet bgs or until refusal. All soil borings were fully logged and sampled from discrete 5-foot depth intervals. Soil boring logs are provided in Appendix A. The soil near shoreline locations (BH-11, BH-12, and BH-13) were excavated during park construction to approximately 10 feet bgs and backfilled with clean material (from approximately elevation +8 feet MLLW) sloping back at a 1:1 slope behind the sheetpile wall). The results at these locations may still be representative of soils outside of this backfill upland of the sheetpile wall.

A direct push Geoprobe collected a continuous soil profile starting at the ground surface with a 5-foot-long, 1.5-inch inside-diameter core sampler. The piston tip was loosened and the sampler advanced into the ground, thereby collecting the soil into the inside of the sampler's clean, disposable, single-use plastic liner. The sampler was withdrawn to retrieve the liner and the soil sample. This step was repeated to a depth of 20 feet bgs. Prior to deployment at each new location, the drill rig was decontaminated with potable water.

The soil cores were processed and sampled at the time of collection. All sampling equipment was decontaminated, as described in the Work Plan. The core liner was cut longitudinally using a scoring knife and was split with decontaminated stainless steel spoons into two halves for sampling.

Immediately upon opening, aliquots of soil sample were collected for volatile constituents analysis from each 5-foot interval using an SW-846 5035 sampling device. The material collected in this device was placed directly into a container with methanol preservative for VOC and GRO analysis. The sample intervals represented in each sample were included in each sample's name. For instance, BH-15-5-10 is a sample collected from location BH-15 at a depth of 5 to 10 feet.

After VOC and GRO collection, photographs were taken, and a soil description of each core was recorded on an exploratory boring log. Final boring logs are provided in Appendix A. The following parameters were noted:

- Sample recovery
- Physical soil description in accordance with ASTM International (ASTM) D-2488 – Unified Soil Classification System including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide and petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris with quantitative estimate (e.g., wood debris)
- Presence of sheen

Following sampling for volatile constituents and logging of the core, each 5-foot interval soil sample was homogenized in a decontaminated stainless steel bowl until it was uniform in color and texture. The sample was then spooned into laboratory-supplied jars for analyses. Soil samples collected for chemical analysis were packed on ice and either shipped via express delivery (FedEx or UPS) or driven by the laboratory courier to Apex Laboratories, LLC (Apex), in Tigard, Oregon. Archived samples were frozen at the laboratory.

3.1.2 Test Pit Sampling and Processing

Test pit soil samples were collected using a small backhoe operated by Quigg Brothers, Inc., the Percival Landing Park Phase 1 construction contractor. The soil removed from the test pit was temporarily stockpiled on site and disposed of off site as part of managing investigation derived waste (IDW; see Section 3.1.7). The test pits were backfilled with clean, imported materials. The chemical data collected from the test pits were used to determine the vertical extent of contamination in subsurface soil. Figure 4 presents the test pit locations, which are denoted by "TP-No."

Eight test pits were excavated between September 2010 and June 2011. One location was on the shoreline (TP-2), four locations were in the footprint of the future Harbor House Building (TP-6 through TP-9), one location was on Olympia Avenue (TP-5), and two locations were above the sewer line between the former Hulco and Unocal properties (TP-10 and TP-11). TP-2 was sampled prior to the completion of construction activities and has since been fully excavated to remove all contaminated soil at the time of the cove development.

Test pit soil sample intervals were determined by visual observations. After each backhoe scoop, the test pit was inspected by the Anchor QEA, LLC (Anchor QEA) field coordinator to determine if a distinct contaminated layer was present. This layer was typically characterized by a bluish color and/or a strong petroleum odor. If petroleum observations were identified, soil samples with no observed petroleum impacts were collected above and below this layer (except TP-10 and TP-11). Samples were collected by taking several discrete aliquots from representative areas within the selected backhoe bucket, being careful not to collect material that had been exposed to the walls of the bucket. At location TP-2, samples were taken by scraping the side wall after the test pit was dug to depth. The sample intervals represented in each sample were included in the sample name. For instance, TP-8-6-9 represents a sample taken at Test Pit 8 from 6 to 9 feet bgs.

Prior to homogenization, aliquots of sample were collected for volatile constituents from a representative bucket using an SW-846 5035 sampling device. The material collected with this device was directly placed into a container with methanol preservative for VOC and GRO analysis. After VOC and GRO sample collection, representative soil collected from each bucket was mixed using the approved mixing procedure until homogenous in color and texture and then spooned into laboratory-supplied jars and couriered to Apex for analysis.

3.1.3 Confirmation Sampling and Processing

Confirmation soil samples were collected during park construction activities and soil excavations to confirm the limits of excavation. Soil samples were collected from the final excavated surface prior to placing any shore protection materials or completing park construction activities. They were collected in the vicinity of excavated shoreline locations and in the playground area to confirm that petroleum impacted soils were removed. The chemical data collected from the confirmation samples were used to document the concentrations of soils remaining on site after the completion of park construction. Figure 4 shows the confirmation sample locations, which are denoted by "CS-No." As shown in Table 1, some confirmation soil samples were subsequently excavated to remove all contaminated soils above cleanup level. In these areas, a subsequent confirmation soil sample was collected to confirm all the contaminated soil was removed.

Five confirmation samples (CS-11 to CS-15) were collected in November 2010 near or along the shoreline, and nine confirmation samples (CS-22 to CS-30) were collected in April and June 2011 in the playground area after excavation activities were completed. Figure 4 presents the locations of confirmation soil samples. The locations of the shoreline confirmation samples were generally based on the locations of soil boring samples collected during the first round of investigation to allow for comparison of data between the two samples. Samples CS-20 and CS-21 were collected in January 2011 in the cove near TP-2 on top of the shelf that was excavated in front of the short, buried sheets. All shoreline confirmation samples were collected from the surface interval (approximately 0 to 10 centimeters [cm]).

The locations of the upland playground confirmation soil samples were based on visual observations during excavation activities. Excavation continued until a clean sidewall was encountered. A clean sidewall was determined by visual and olfactory observation and confirmed with a photoionization detector. The sidewalls were sampled to confirm removal of contaminated soils in the playground area. In the event a confirmation soil sample had elevated petroleum results, additional excavation was completed, and a subsequent confirmation soil sample was collected. Confirmation soil samples were collected at the bottom of the excavation (depth of 10 to 12 feet bgs) to confirm that all contaminated soil was removed.

Prior to homogenization, aliquots of soil sample were collected using an SW-846 5035 sampling device. The material collected with this device was directly placed into a container with methanol preservative for VOC and GRO analysis. After VOC and GRO sample collection, soil from 0 to 10 cm was collected and mixed using the approved mixing procedure until homogenous in color and texture and then spooned into laboratory-supplied jars and couriered to Apex for analysis.

3.1.4 Groundwater Sampling and Processing

Groundwater sampling was performed during the RI to characterize site-related COCs in groundwater and confirm the results of groundwater monitoring during 2003 as part of the NFA determination by Ecology. In addition, groundwater testing provides an empirical demonstration that low-level residual petroleum concentrations in soil are protective of

groundwater. Temporary wells were installed during June 2011 using a direct push Geoprobe sampling system. Groundwater was collected using a peristaltic pump and low-flow sampling methodology, as described in Work Plan Addendum 2 (Anchor QEA 2011a).

Groundwater was collected at four locations (BH-33, BH-34, BH-37, and BH-38), as shown in Figure 4. A stainless steel temporary well screen was placed at the observed water table at the time of sampling; the 5-foot screen interval was typically 6 to 11 feet bgs, except at location BH-34, which was at 5 to 10 feet bgs. Groundwater samples were taken just below the water table at each location. After the tubing was purged and the groundwater quality measurements were stabilized, VOC, GRO, DRO, ORO, and total and dissolved lead samples were collected. Sampling for dissolved lead was performed using a 0.45-micron filter in the field. New tubing was used at each sample location. Samples were packed on ice and picked up by an Apex courier.

3.1.5 Soil Vapor Sampling and Processing

Soil vapor samples were collected to provide data for evaluating the vapor intrusion pathway to nearby buildings. Temporary borings were completed using a direct push Geoprobe sampling system. A Post-Run Tubing system was used to drive the probe rods to the desired sampling depth. Grab samples were collected using a 1-liter summa canister with a soil manifold, as described in Work Plan Addendum 2 (Anchor QEA 2011a).

Soil vapor was collected at two locations between 4 and 5 feet bgs. Figure 4 presents the soil vapor sampling locations. Air samples were submitted for VOC, VPH, and APH analysis. Summa canisters were kept out of the sun and shipped to Air Toxics Laboratory in Folsom, California, for analysis.

3.1.6 Chemical Testing

Sample containers, holding times, and preservation methods are discussed in the Work Plan and Addenda for each sampling event. A chain-of-custody form was logged by the processing staff and relinquished to the laboratory. Analytical methods and laboratory reporting limits are defined in the Work Plan and Addenda.

For soil samples, all but a few confirmation samples (as discussed previously) were analyzed by Northwest Total Petroleum Hydrocarbon-Hydrocarbon Identification (NWTPH-HCID) analysis to determine if TPH (GRO, DRO, or ORO) was detected. If GRO was detected, a quantitative gasoline range method (Northwest Total Petroleum Hydrocarbon – gasoline range [NWTPH-Gx])[1], was triggered along with VOC analysis and total lead. If DRO or ORO were detected, a quantitative diesel and oil range method (Northwest Total Petroleum Hydrocarbon – diesel range [NWTPH-Dx])[2] was triggered. PAHs and total metals were analyzed for soil sample BH-11-5-10. Based on initial testing results and historical information, which indicate that Diesel No. 1 and/or 2 and home heating oil were present on the property, these analyses were not requested on all samples. The MTCA regulations specify that if adequate information exists to identify the type of diesel used and this diesel falls within a specific category, this test is not required (Ecology 2007). The following analytical methods were used for soil testing:

- GRO by method NWTPH-Gx
- DRO and ORO by method NWTPH-Dx
- VOC analysis (BTEX; 1,2-dibromoethane [EDB]; 1,2-dichloroethane [EDC]; and methyl-tert-butyl ether [MTBE]) by Method 8260B
- Total lead by Method 6010C
- Total metals by Method 6020 (arsenic [As], barium [Ba], cadmium [Cd], chromium [Cr], mercury [Hg], selenium [Se], silver [Ag]) and 6010C (lead [Pb])
- PAHs by Method 8260D-SIM
- EPHs and VPHs by NWTPH-EPH and NWTPH-VPH analysis, respectively.

The following analytical methods were used for groundwater testing:

- GRO by method NWTPH-Gx
- DRO and ORO by method NWTPH-Dx
- VOC analysis (BTEX, EDB, EDC, and MTBE) by Method 8260B-SIM
- Total lead and dissolved lead by Method 6020

[1] NWTPH-Gx is an analytical method for volatile petroleum products, such as aviation and automotive gasolines, mineral spirits, Stoddard solvent, and naphtha.
[2] NWTPH-Dx is an analytical method for semi-volatile petroleum products, such as jet fuels, kerosene, diesel oils, hydraulic fluids, mineral oils, lubricating oils, and fuel oils.

The following analytical methods were used for soil vapor testing:

- VOC analysis (BTEX, EDB, EDC, and MTBE) by Method TO-15
- VPH and APH analysis (Washington State protocols) by Method TO-15

3.1.7 Investigative Waste Management

All IDW and wash water were stockpiled on site or disposed in labeled 55-gallon waste drums that were temporarily stored on site. The test pit stockpiles were hauled to an authorized disposal facility, the Weyerhaeuser landfill in Castle Rock, Washington, on October 14, 2010. The drums were hauled to the same location on December 1, 2010, and August 1, 2011. Wastes from test pits excavated after December 2010 and from the playground area excavated in April 2011 were also hauled and disposed at the Weyerhaeuser landfill on the same day they were excavated.

3.2 Remedial Investigation Chemical Data Quality Summary

Chemical testing was performed by Apex in Tigard, Oregon, a laboratory certified by Ecology and the Oregon Environmental Laboratory Accreditation Program. All analyses conformed to procedures described in the approved Work Plan. Chemical testing adhered to one or more of the following quality assurance/quality control (QA/QC) procedures and analysis protocols: SW-846 (USEPA 1986) and Ecology.

Field QA/QC procedures used for this project included collecting additional containers for matrix spike/matrix spike duplicate (MS/MSD) samples at a frequency of 1 per 20 samples and adequate equipment decontamination. Because separate jars were collected for MS/MSD samples, these analyses can also be used to measure sample homogenization precision. The precision (calculated relative percent difference) between the MS/MSD samples was within project data quality objectives for all MS/MSD samples, indicating that samples were thoroughly homogenized.

Chain-of-custody forms were used to track sample custody and document the proper handling and integrity of the samples. After preparation, all sample containers were delivered to the analytical laboratory according to appropriate sample handling procedures (i.e., transported at 4 degrees Celsius [°C]). All samples were shipped via express delivery

(FedEx or UPS) or picked up by Apex and relinquished under signature by Anchor QEA staff. At the laboratory, samples were logged in and then immediately placed in refrigerated storage; some samples were placed in frozen storage for archiving. The chain-of-custody forms are included with the corresponding laboratory reports in Appendix B.

All chemical data submitted in this report were checked for completeness (correct method, hold times met, and results reported for each sample) and validated by Anchor QEA personnel using U.S. Environmental Protection Agency (USEPA) guidelines and the National Functional Guidelines for Data Review (USEPA 2004, 2008). Project-specific control limits (Anchor QEA 2010a) were used to assess the precision and accuracy of method blanks, laboratory control samples, MS/MSD, and replicate samples. Any QC results that exceeded these criteria were qualified in the validation process. Data validation reports are provided in Appendix C.

Data validation verified the accuracy and precision of chemical determinations performed during this investigation. Data qualifiers assigned because of the data validation and their definitions are shown on each of the respective analytical results tables. Data may have been qualified as biased or estimated for a particular analysis based on method or technical criteria. Data qualified with a "J" indicates that the associated numerical value is the approximate concentration of the analyte. Data qualified with a "UJ" indicates the approximate reporting limit below which the analyte was not detected. Consequently, these data qualifications are not expected to impact the data quality objectives. All RI data were determined to be useable as reported from the laboratory or as qualified for the purposes of soil, groundwater, and soil vapor characterization.

3.3 Remedial Investigation Results

This section describes the results of soil, groundwater, and soil vapor sampling performed in support of the RI/FS. RI methods are summarized in Sections 3.1 and 3.2 and were performed consistent with the Ecology-reviewed Work Plan and accompanying Addenda. RI data were screened consistent with MTCA cleanup levels for each media and incorporated cross-media protection in evaluating the potential for affects to human health or the environment and were evaluated based on their applicability to existing site conditions and

potential exposure pathways. A discussion of cleanup standards for developing FS alternatives is provided in Section 5.

3.3.1 Soil Quality

RI soil sampling stations were selected based on previous investigations and cleanup actions, as well as historical uses. Additional samples were collected to confirm the limit of excavations for removal of contaminated soils during park construction. A summary of the soil chemistry results is presented in Tables 2a, 2b, and 2c for petroleum, petroleum-related constituents, and supplemental testing, respectively. Soil data were screened against MTCA Method A Soil Cleanup Levels for Unrestricted Land Use (Ecology 2007). DRO and ORO were also screened in accordance with Ecology Memorandum No. 4 (Ecology 2004) by using the sum of DRO and ORO results. The locations of soil samples exceeding MTCA Method A cleanup levels for GRO, DRO, ORO, and VOCs are presented in Figure 5.

3.3.1.1 Petroleum Hydrocarbons

Soil TPH testing was performed site-wide for the purposes of determining the limits of soil excavation during park construction and to determine the presence of residual petroleum concentrations in other areas of the Site. Soil sampling was performed in phases—first, for exploratory purposes and, second, to confirm the limits of soil excavation (confirmation sampling). Some soil sampling locations were subsequently excavated after collection; these locations are identified in Table 1. Soil sampling results are presented in Table 2a and include those soil sampling locations excavated after sample collection.

Figure 5 presents a summary of soil sampling locations where petroleum concentrations exceeded the MTCA Method A cleanup level for unrestricted use. Soil sampling results indicate that low-level residual petroleum concentrations are present in isolated areas of the Site. Two locations, BH-36 and TP-5, exhibited GRO concentrations just above the MTCA Method A cleanup level of 100 mg/kg, with concentrations of 120 mg/kg and 116 mg/kg, respectively. Only one location showed a DRO and ORO concentration greater than the MTCA Method A cleanup level of 2,000 mg/kg—BH-24 had a combined DRO/ORO result of 2,159 mg/kg. However, the individual DRO and ORO concentrations were below the MTCA Method A cleanup level for these petroleum ranges. Both the GRO and DRO/ORO

exceedances were detected at depth intervals below at least 4 feet bgs, and neither non-detect concentrations nor field observations showed indications of petroleum impacts above and below the impacted depth interval.

Other soil sampling locations showing petroleum concentrations greater than MTCA Method A cleanup levels were excavated during the 2011 park construction activities. These soil sampling locations are presented in Table 2a and on Figure 5. Figure 5 also presents the limits of soil excavation during park construction in relation to RI soil sampling locations.

Based on soil sampling in the southwest area of the Site, soil upland of the sheetpile wall may contain some residual petroleum contamination associated with BH-11. Shoreline soil boring BH-11 had a DRO concentration of 5,320 mg/kg at a depth of 5 to 10 feet bgs, exceeding the MTCA Method A cleanup level. The area (including BH-11) waterward of the sheetpile wall was excavated to approximately -6 feet MLLW, and the subsequent confirmation sample (CS-11) showed petroleum concentrations well below the cleanup level. A confirmation samples was not taken landside of the sheetpile wall to confirm TPH concentrations in this area.

3.3.1.2 Petroleum-related Constituents (VOCs and Lead)

Soil samples were tested for petroleum-related constituents, including VOCs and lead, when the petroleum HCID scan or TPH analysis showed detection for either GRO or DRO. VOC testing included BTEX compounds, MTBE, EDB, and EDC. Analytical results for VOCs and lead are presented in Table 2b. Of those soil sampling locations not excavated during park construction, two of the eight soil samples had VOC detections; all VOC detections were below the MTCA Method A cleanup levels. Soil sampling location BH-36 had a VOC detection for benzene (0.0097 mg/kg) and total xylenes (0.046 mg/kg), and soil sampling location TP-5 had a detection of ethylbenzene (0.035 mg/kg). These two samples are the locations in which GRO was detected just above the GRO MTCA Method A cleanup level. The maximum lead concentration was 13.2 mg/kg, which is well below the MTCA Method A cleanup level of 250 mg/kg.

3.3.1.3 Other Supplemental Testing

Due to the elevated DRO concentration at soil sampling location BH-11, PAHs and metals were analyzed for the 5- to 10-foot depth interval. These data were also collected to characterize excavated soil for disposal purposes, as this area was subsequently excavated during park construction. PAH and metals analytical results are presented in Table 2c. PAH testing results showed all non-detect concentrations. The reporting limit for benzo(a)pyrene (less than 0.0592 mg/kg) was below the MTCA Method A cleanup level of 0.1 mg/kg. All metals results were also below the MTCA Method A cleanup level.

Three soil samples were analyzed for petroleum fractionation to provide information for developing site-specific TPH cleanup levels. Petroleum fractionation results are presented in Table 2c. Results of VPH/EPH testing were used along with Ecology's TPH Workbook to develop a site-specific cleanup level (Appendix D). Results indicated that the TPH concentrations tested were below levels anticipated to pose a direct contact risk or to pose a risk to groundwater quality.

3.3.2 Groundwater Quality

RI groundwater sampling was performed in select areas to determine the potential for leaching of residual low-level petroleum concentrations in soil. Groundwater sampling provides a direct empirical demonstration that current soil conditions are protective of groundwater and surface water quality. In addition to RI groundwater sampling, previous groundwater monitoring data from 2002 are summarized, as these data supported the decision by Ecology to issue a NFA for the Site. One year of quarterly groundwater monitoring from the historical compliance monitoring well MW-13A, and two quarters of groundwater monitoring data from MW-15 are presented in Table 3a.

A summary of the RI groundwater chemistry results is presented in Table 3b. Groundwater results are screened to the most stringent marine surface water criteria because groundwater beneath the Site is non-potable, as defined in WAC 173-340-720(2). Petroleum hydrocarbons results were screened to MTCA Method A groundwater cleanup levels because surface water criteria were not available. A discussion of groundwater cleanup standards is provided in Section 5.2.2. Figure 6 presents the historical compliance monitoring wells,

groundwater RI sample locations, and results of site-related COCs. All RI groundwater results were below the groundwater cleanup levels.

3.3.3 Soil Vapor Results

A summary of the soil vapor testing results is presented in Table 4. Figure 7 presents soil vapor sample locations with a summary of VOC detections. BTEX analytes were detected in all soil vapor samples. Soil vapor results were screened against draft vapor intrusion guidance (Ecology 2009). Only benzene exceeded the screening level value (at location BH-36).

4 SUMMARY OF CONCEPTUAL SITE MODEL

This section presents a summary of the CSM developed for the Site based on the findings of the RI. A CSM incorporates physical and chemical information to understand potential fate and transport mechanisms at the Site. The CSM considers contaminant sources, nature and extent of contamination remaining on site, release mechanisms, transport and exposure pathways, and potential receptors. The development of the CSM supports the assessment of remedial alternatives in the FS consistent with MTCA requirements. The CSM is illustrated in Figure 8.

The CSM developed for the Site is based on available historical information and site-specific information gathered during sampling activities and includes the potential transport and exposure pathways and the potential receptors for the Site COCs. This model reflects current conditions and possible future development in assessing exposure pathways. The future use of the Site is anticipated to be maintained as a public park.

4.1 Nature and Extent of Contamination

The nature and extent of contamination has been evaluated at the Site since the late 1980s and included multiple investigations and cleanup actions, as described in Section 2. The RI activities described in this report were completed after consultation with Ecology to complete the assessment of current site conditions consistent with current and future land use.

As discussed in Section 2, the Site was historically used as a bulk fuel storage facility, which housed several aboveground storage tanks (ASTs), USTs, and underground pipelines that transported fuel from a loading dock in Budd Inlet. Multiple previous investigations and cleanup actions were completed at the Site from the late 1980s to 2003 when Ecology issued a NFA for the cleanup. The RI was performed to supplement previous information and focus on residual petroleum-related contamination discovered during the City Percival Landing Park development. The RI findings indicated low-level residual TPH constituents (GROs, DROs, and OROs) and benzene in isolated areas of the site. The nature and extent of each of the Site COCs are explained in the following points:

- **TPH – Gasoline Range.** Low-level residual GRO concentrations were identified during the RI in isolated areas of the Site. Concentrations of GRO greater than MTCA Method A were identified in 6 of the 113 subsurface soil samples (at locations BH-28, BH-36, TP-2, TP-5, CS-28, and CS-29) submitted for TPH analysis. The concentrations of these six samples ranged from 116 mg/kg to 1,980 mg/kg, above the cleanup level 100 mg/kg. Four of these locations were excavated during park construction. Existing soil sample locations with GRO exceeding the MTCA Method A cleanup level are depicted on Figure 5. All GRO groundwater concentrations were below the MTCA Method A cleanup level.
- **TPH – Diesel and Oil Range.** Low-level residual DRO and ORO concentrations were identified during the RI in an isolated area of the Site. Concentrations of DRO and ORO greater than MTCA Method A were identified in 4 of the 113 soil samples (at locations BH-11, BH-24, TP-2, and CS-28) submitted for TPH analysis. DRO and ORO were screened in accordance with Ecology Memorandum No. 4 (Ecology 2004) by using the sum of DRO/ORO results. The concentrations of these four samples ranged from 2,159 mg/kg to 8,260 mg/kg, above the cleanup level of 2,000 mg/kg. Two of these locations were excavated and one location (BH-11) was partially excavated during park construction. Existing soil sample locations with DRO/ORO exceeding the MTCA Method A cleanup level are depicted on Figure 5. All DRO/ORO groundwater concentrations were below the MTCA Method A cleanup level.
- **Benzene.** Benzene was detected in 2 of 14 soil samples, at locations where residual GRO was also identified. One detection was well below the MTCA Method A cleanup level of 0.030 mg/kg and the other detection was above it (CS-28 at a concentration of 0.0647 mg/kg). Location CS-28 was excavated during park construction. Benzene was also detected in a soil vapor sample above the draft guidance for Evaluating Soil Vapor Intrusion in Washington State (Ecology 2009). Benzene concentrations in groundwater were well below the groundwater cleanup level for protection of surface water.

4.2 Transport and Exposure Pathways

Findings of the RI indicated that residual petroleum-related constituents remain in the soil in isolated areas of the Site. Petroleum-related constituents were not present in groundwater.

Potential transport pathways that could result in transport of petroleum-related constituents in the soil include the following:

- Direct contact—human and terrestrial
- Soil leaching to groundwater
- Groundwater migration to surface water
- Soil vapor migration

Petroleum impacts are limited to subsurface soils. Exposure of these soils is limited in some cases by pavement or boardwalk overlying the contaminated soil; however, due to its proximity to the surface (less than 15 bgs), the potential exists for historical subsurface soil in unpaved areas to be exposed during future construction (excavation) or maintenance activities. Additionally, contaminated soil exists in close proximity to groundwater and the potential exists for residual petroleum impacts in soil to leach to groundwater.

Groundwater at the Site does not meet the definition of potable water, as outlined in WAC 173-340-720(2) based on the following factors: 1) the groundwater does not serve as a current source of drinking water; and 2) the groundwater is not a potential future source of drinking water given the Site's proximity to surface water that is not suitable as a domestic water supply. Therefore, ingestion of groundwater beneath the Site is not an exposure pathway. As a result, the potential exposure pathways for Site groundwater are human ingestion of marine organisms and effects to aquatic organisms exposed to groundwater migrating to adjacent marine surface water.

Vapor migration of VOCs could impact buildings within 100 feet of contaminated soil or groundwater. The Site consists of an open space with one building (Harbor House), which was constructed with a vapor barrier to prevent vapor intrusion. Neighboring structures include the Wine Loft (near the northern portion of the Site) and several businesses on the eastern side of Columbia Street. All soil boring samples and the one soil vapor sample collected near the Wine Loft are below MTCA Method A cleanup levels and Washington State indoor soil vapor draft screening levels (Ecology 2009), respectively. Soil vapor collected at location BH-36 exceeded the soil vapor draft screening level and contained detections of GRO and benzene; however, this sample location is surrounded by locations that yielded low or no detections of GRO or benzene in soil, and thus, it is an isolated area

more than 100 feet from the adjacent buildings. Additionally, groundwater at the Site is below MTCA Method A cleanup levels, which means that potential future migration of contaminants through groundwater flow is unlikely. Thus, soil vapor is not a complete exposure pathway.

4.3 Site Receptors

The Site is part of the City of Olympia Percival Landing Park. The Site is located in an urban setting surrounded by commercial properties and marine surface water (Budd Inlet) along the shoreline. Relevant exposure pathways and receptors at the Site include the following:

- **Protection of Site Workers.** The main potential on-site receptor is a future industrial worker. Direct contact risks for industrial workers can be assessed using MTCA industrial soil cleanup levels.
- **Protection of Budd Inlet Surface Water.** Aquatic receptors in Budd Inlet include fish and shellfish potentially exposed to surface water contaminants. Protection of these receptors can be ensured by preventing adverse impacts of groundwater on surface water quality.

5 DEVELOPMENT OF CLEANUP LEVELS

The final cleanup action for the Site must be protective of human health and the environment by complying with cleanup levels. This section discusses the development of site-specific cleanup levels to be used for identifying remedial action objectives (RAOs) and evaluating remedial alternatives discussed in Section 6. The site-specific cleanup levels consider the POC and concentration of a hazardous substance in media above which the impacted media may pose a risk to human health or the environment through the exposure pathway. The following discussion presents the cleanup levels and POC that have been developed for the Site.

5.1 Method for Determining Cleanup Levels

The MTCA Cleanup Regulations (Sections 173-340-720, -730, and -740 WAC) establish procedures to develop cleanup levels for soil, groundwater, and surface water. The MTCA Method A procedure is applicable to sites with relatively few hazardous substances. Cleanup levels based on this method are derived through selection of the most stringent concentration as available in the following sources:

- Concentrations listed in WAC Tables 173-720-1, -740-1, and -745-1 (for groundwater and soil)
- Concentrations established under Applicable or Relevant and Appropriate Requirements (ARAR; e.g., National Toxics Rule [NTR])
- Concentrations protective of the environment and surface water beneficial uses

Where numeric values were not available in the aforementioned sources, Method B procedures were used to develop cleanup levels for unrestricted site use. MTCA Method B procedures employ a risk-based evaluation of potential human health and environmental exposures to site COCs.

The Method B procedure also requires that a cleanup level for one media must also be protective of the beneficial uses of other potentially affected media. For example, site groundwater discharges into the marine surface waters of Budd Inlet. Therefore, site-specific groundwater cleanup levels consider surface water protection requirements. Included in these sections are the specific rules for evaluating cross-media protectiveness.

5.2 Site Cleanup Levels

This section describes the determination of site cleanup levels for soil and groundwater. The POC for meeting cleanup levels in each media is described in Section 5.3.

5.2.1 Soil Cleanup Levels

The current and future site use is planned to be maintained as a public park and will meet the requirement of "unrestricted use" under the MTCA regulations (WAC 173-340-740). Unrestricted use is the appropriate basis for development of site-specific soil cleanup levels using MTCA Method A and B procedures. Soil cleanup levels were developed for petroleum and petroleum-related constituents including BTEX compounds and lead. A summary of soil cleanup levels is presented in Table 5. As described in the CSM, cleanup levels are determined by considering the following complete exposure pathways:

- Human health protection from direct soil contact
- Human health protection from soil-to-groundwater pathway exposure
- Terrestrial ecological protection

5.2.1.1 Soil Direct Contact Pathway Exposure

Previous cleanup actions and the recent park construction activities included excavation of petroleum impacted soil and backfill/grading. These activities effectively minimized direct contact exposures to soil and RI results confirm that residual petroleum impacts are at depth. The potential pathway for direct contact would occur during earthwork operations and other activities required for future site development. Cleanup levels for direct contact were derived using WAC Equations 173-340-740-1 and -740-2 for non-carcinogenic and carcinogenic COCs, respectively. No modifications were made to the standard parameters for these equations.

As described in WAC 173-340-740, a direct contact TPH cleanup level was calculated taking into account the additive effects of petroleum fractions (VPH and EPH) and VOCs. Calculations were performed using Ecology's Cleanup Levels and Risk Calculations (CLARC) database TPH Workbook *MTCATPH11.1.xls*, along with data input from the RI soil sample with the highest concentrations of VPH and EPH fractions (BH-36-SO-5-10). The results of the workbook calculations also determined that these concentrations are protective of

groundwater. Table 5 presents the site-specific cleanup levels, and Appendix D contains the site-specific TPH calculation worksheet.

5.2.1.2 Soil-to-Groundwater Pathway Exposure

Cleanup levels based on Method B direct contact must also consider the protection of groundwater resources. As described in the CSM, groundwater beneath the Site is not potable; however, groundwater quality must be protective of surface water resources. In addition to deriving soil concentrations that are protective of surface water, empirical groundwater data can be used to indicate that current groundwater impacts are not occurring and sufficient time has elapsed to perform this demonstration.

As described in WAC 173-340-747, a fixed parameter, three-phase partitioning model (equation 747-1) was used to calculate soil concentrations that are protective of groundwater for petroleum-related COCs detected in Site soil samples (presented in Table 5). The evaluation was based on the protection of marine surface waters; surface water cleanup levels are described in Section 5.2.2. Petroleum-related COCs—benzene, toluene, ethylbenzene, and lead—soil concentrations were calculated using equation 747-1 and the most stringent marine surface water criteria (presented in Table 6). There is no marine surface water criterion for xylenes or TPH. No modifications were made to the standard parameters for these equations. All existing soil concentrations of petroleum-related COCs are protective of groundwater.

5.2.2 Groundwater Cleanup Levels

As previously discussed, groundwater beneath the Site is not considered to be a potable source; however, groundwater quality must be protective of surface water quality in Budd Inlet. In accordance with WAC 173-340-730, surface water cleanup levels must be at least as stringent as the criteria established under WAC 173-201A, Section 304 of the Federal Clean Water Act, and the NTR (40 Code of Federal Regulations [CFR] Part 131). Groundwater cleanup levels were determined by selecting the most stringent surface water ARARs. These consist of the following:

- State Surface Water Quality Standards [WAC 173-201A]. Standards based on marine, chronic exposure for the protection of aquatic life.

- **National Recommended Water Quality Criteria** [Clean Water Act § 304(a)]. USEPA's national recommended water quality criteria for the protection of human health and aquatic life (marine, chronic).
- **NTR** [40 CFR 131]. Provides chemical-specific, numeric criteria for priority toxic pollutants protective of human health and aquatic life; WAC 173-201A provides for use of NTR water quality criteria for protection of human health.

Table 6 presents the summary of groundwater cleanup levels.

5.2.3 Terrestrial Ecological Evaluation

The TEE is required by Ecology under WAC 173-340-7490 unless a site qualifies for a TEE exclusion using the criteria in WAC 173-340-7491.

This first step of the TEE is conducted to determine if there is a potential for concentrations of chemicals in site soils to pose a risk to soil biota, plants, or wildlife. The site may be excluded from the TEE process if there is an incomplete exposure pathway from contaminants in soil to terrestrial ecological receptors (based on current or future site use), no habitat for terrestrial ecological receptors in the area(s) of the site where contaminants are located, or if concentrations of site contaminants are at or lower than natural background levels. If site conditions meet any one of these primary exclusions, the TEE process is complete. If site conditions do not meet any of the four primary exclusions, the TEE process continues to determine whether a simplified or site-specific TEE assessment is warranted.

Approximately half of the Site consists of paved parking areas and walkways. The other half consists of open park space and landscaped planting strips. Three of the four primary exclusions listed in Figure 9 (Primary Exclusions Documentation Form) were met, thus excluding the Site from the TEE. The following is a summary of the TEE exclusions applicable to the Site:

- Based on soil boring logs, field observations, and analytical chemistry results, contaminated soil (that is not covered) is located deeper than 6 feet bgs and shallower than 15 feet bgs. Because all soil contamination is located below the TEE conditional

POC (Ecology-defined biologically active zone of 6 feet bgs), the implementation of institutional controls completes the TEE process.

- All soil contamination shallower than 6 feet bgs is covered by pavement or other physical barriers that prevent plants or wildlife from being exposed.
- There is less than 1.5 acres of contiguous undeveloped land on and within 500 feet of the Site.
- The exclusion involving comparison with natural background data is not applicable to the Site, as background data were not collected.

5.3 Points of Compliance

Under MTCA, a POC is the point or location on a site where a cleanup level must be attained. The points of compliance will be used to develop and evaluate the effectiveness of the remedial action alternatives for the Site. The points of compliance for the cleanup levels established in Section 5.2 are as follows:

- For soil cleanup levels based on human exposure via direct contact, the POC is 15 feet bgs throughout the Site. Based on the results of TPH data and analysis, all remaining on-site soil concentrations are below the site-specific TPH cleanup level of 2,724 mg/kg, except for an area in the southwest portion of the Site (upland of boring BH-11), which was identified as potentially containing soil concentrations greater than the site-specific TPH cleanup level.
- All soils throughout the Site are predicted to meet the soil cleanup levels for protection of groundwater, based on the calculations discussed in Section 5.2. In addition, empirical groundwater data were used to determine whether soil concentrations are protective of groundwater (soil to groundwater pathway), and ultimately protective of surface water quality following discharge of groundwater to Budd Inlet. Evaluation of the soil-to-groundwater pathway indicates that current soil concentrations are protective of the proposed groundwater cleanup levels.
- For groundwater, the standard POC is site-wide. RI groundwater results indicate that current groundwater quality meets the groundwater cleanup levels, which also provide protection of surface water quality criteria.

6 FEASIBILITY STUDY OF REMEDIATION ALTERNATIVES FOR SOIL AND GROUNDWATER

Development of an acceptable remedial action for a site is multi-step process. The first step involves establishing RAOs for the site. Next, remedial action technologies are developed and screened to determine which technologies are capable of achieving the RAOs. The remedial technologies are then assembled into alternatives that achieve all RAOs, and the alternatives are compared against criteria established under MTCA to select the most practicable cleanup action for the site. This alternatives development, evaluation, and selection process is typically accomplished by conducting an FS, per WAC 173-340-350(8). The FS develops alternatives that achieve the RAOs, compares the alternatives against criteria established under MTCA (WAC 173-340-360), and selects the alternative that is permanent to the maximum extent practicable.

The Site was remediated as the park was developed, and several discussions with Ecology occurred during the RI sampling and excavations. Therefore, based on the one area of isolated residual contamination, a focused FS was prepared to evaluate a select set of remedial alternatives. The remedial alternatives (composed of acceptable remedial technologies) identified as being reasonable options for the Site are described, screened, and compared against MTCA requirements to demonstrate compliance with required criteria.

6.1 Remedial Action Objectives

Based on evaluation of data collected as part of the RI and discussions with Ecology, the RAOs for the Site are as follows:

- Prevent human contact with the isolated TPH contaminated soil identified at BH-11
- Prevent terrestrial and aquatic ecological exposure to the isolated impacted soils
- Maintain current site use as a public park

6.2 Development of Remedial Technologies

Complying with MTCA cleanup standards can be accomplished by various methods including removing or containing contaminated media. The development of remedial

alternatives includes researching remedial technologies and identifying potentially viable technologies that are applicable and implementable at the Site.

Potentially viable remedial technologies for the contaminants at the Site include the following:

- No action
- Institutional controls
- Monitored natural recovery (MNR)
- Biological remediation of soil
- Soil removal

For the purposes of this focused FS, the proposed remedial technologies are also considered as the remedial alternatives for the Site. The following sections provide an initial screening of the remedial alternatives and then evaluate those alternatives that are retained for further consideration.

6.3 Screening of Remedial Alternatives

Remedial alternatives are screened to comply with cleanup standards (WAC 173-340-700 through 173-340-760) and applicable state and federal laws. Additionally, the remedial alternatives are screened to be protective of human health and the environment and to take into account current and proposed future land uses. Remedial alternatives that are selected must fulfill the threshold requirements, which include the following:

- The selected action uses permanent solutions (as outlined in WAC 173-340-360[3]) to the maximum extent practicable
- The action provides for a reasonable restoration timeframe (as outlined in WAC 173-340-360[4])
- The remedial alternative considers public concerns (as outlined in WAC 173-340-600)

The following sections provide screening of the proposed remedial alternatives for the Site.

6.3.1.1 No Action

Because the contaminated soils are at depth and generally covered by pavement, the remaining contamination is inaccessible for human contact without the occurrence of construction and excavation activities. The no action alternative proposed that no additional remedial actions be completed at the Site. There is no anticipated change of Site use or planned redevelopment of this specific area; however, this alternative is not considered feasible at this Site because contaminated soils shallower than 15 feet bgs would remain at the Site with no method of institutional controls and, thus, would not meet the RAO of human protection.

Because the no action alternative does not meet the RAOs identified for the Site, it is not retained for further evaluation as part of this focused FS.

6.3.1.2 Institutional Controls

Institutional controls (e.g., deed restrictions to restrict excavation) can be highly effective, implementable, and cost-effective provided that they are consistent with future Site use. The area (BH-11) potentially containing contaminated soil above the proposed cleanup level in soil is currently covered by new pavement, which was installed during the recent park construction. Restricting excavation activities at this location would be less expensive than demolishing the pavement walkway and excavating the contaminated soils and would provide an equal level of protection as the area is currently capped with pavement (i.e., no risk of direct contact). The deed restrictions should include procedures to assure future excavations (if necessary), follow applicable health and safety procedures for the protection of the Site, and identify the need for disposal of contaminated materials at an acceptable and permitted landfill facility.

Advantages:

- This remedial alternative has a low cost to implement.
- This remedial alternative is more environmentally sustainable in that it does not involve the destruction and removal of newly constructed materials, which would need to be replaced.

Disadvantages:

- With this remedial alternative, contaminated soil will still remain at the Site.

This alternative achieves the three RAOs and is considered an acceptable and applicable remedial alternative. Thus, the institutional controls alternative is retained for further evaluation as part of this focused FS.

6.3.1.3 Monitored Natural Recovery

MNR is the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives and cleanup levels within a reasonable time frame. MNR may be applied following source removal and potentially requires institutional controls to limit exposure during the attenuation period. Source removal has been performed at the Site through AST, UST, and pipeline removal and removal of a substantial volume of contaminated soil as part of the previous shoreline cleanup and park construction activities. This alterative assumes that remaining petroleum hydrocarbon contamination will be attenuated through aerobic and anaerobic biological degradation and through physical processes, including dispersion, dilution, sorption, and volatilization.

Comparisons of historical data from the 1995 excavation to the 2011 RI data indicate that there is little or no attenuation of TPH at the Site.

Advantages:

- This remedial alternative provides treatment through natural processes rather than relocation of contamination and, thus, has more permanence.

Disadvantages:

- Because of the location of the potentially impacted soils, there is no long-term (ongoing) access to this area without modifications to the Percival Landing Park boardwalk.
- This remedial alternative may not be conducted under a reasonable restoration time frame.

Based on the historical and current data comparisons, the timeframe predicted for TPH to attenuate to concentrations that are below cleanup levels would not be reasonable; therefore, the MNR remedial alternative is not evaluated further as part of this focused FS.

6.3.1.4 In Situ or Ex Situ Treatment of Soil

The use of in situ or ex situ biological remediation consists of periodically injecting the contaminated area (or remediation cell) with additives that stimulate aerobic or anaerobic treatment of contaminated soil. Stimulation of aerobic bioremediation involves the addition of an oxygen-releasing compound that would ultimately degrade the TPH contamination identified in subsurface soils located near BH-11. Stimulation of anaerobic bioremediation involves the addition of nitrate or sulfate in the form of readily available salts (i.e., ammonium nitrate fertilizer). The decision regarding whether to stimulate aerobic or anaerobic biological activity at a given site depends on whether natural aquifer conditions are aerobic or anaerobic (in situ treatment). Ex situ treatment consists of removing the impacted soil and treating it in a soil remediation cell on site.

Advantages:

- This remedial alternative provides treatment through natural processes rather than relocation of contamination and, thus, has more permanence.

Disadvantages:

- Reduction-oxidation parameters (e.g., redox potential, dissolved oxygen, or nitrate) were not collected at the Site during RI sampling efforts, so further site characterization, including installation of groundwater monitoring wells, would be necessary in order to conduct in situ treatment.
- This remedial alternative involves the destruction and removal of the newly constructed boardwalk, pavement, and landscaping to access the impacted area.
- It might not be possible for this remedial alternative to be conducted under a reasonable restoration timeframe.

In order to have periodic access to the impacted soil (near BH-11), a portion of the Percival Landing Park boardwalk/walkway would have to be temporarily removed and closed down.

The amount of time necessary to evaluate and perform bioremediation to achieve cleanup levels at the Site is unknown but could potentially be extensive. Because excavation or institutional controls provide the same level of protection from direct contact to soil in a more reasonable timeframe, the in situ or ex situ treatment of soils alternative is not evaluated further as part of this focused FS.

6.3.1.5 Soil Removal

For the removal alternative, soil containing TPH above the cleanup standards would be excavated and taken to an approved and permitted off-site location (i.e., landfill) for disposal. The excavation would also include demolition of a portion of the newly constructed concrete walkway in order to access the contaminated soils at depth. Excavation activities would be performed during low-tide periods to avoid the need for dewatering and management of excavation water. The off-site disposal facility would have to be suitable for Subtitle D soils, with the exception of the concrete demolition debris, which could be disposed of as non-contaminated material. Clean material would be imported and used to backfill the excavation area, and a new concrete walkway would be placed following completion of backfilling activities to restore the Site. Figure 10 presents the excavation preliminary design.

Advantages:

- This remedial alternative provides a permanent solution, which includes removal and disposal of all remaining soil material that exceeds the proposed cleanup levels for the Site.
- This remedial alternative can be implemented in a short period of time.

Disadvantages:

- Due to the depth of contaminated soil, this remedial alternative is costly (as described in Section 6.4.1.3).
- Because the potentially contaminated soil is below new park structures, removing the soils would involve destroying and removing portions of a newly constructed walkway (boardwalk) and landscaping.

- The removal action would involve temporarily shutting down portions of Percival Landing Park.
- The work would generate significant construction water (requiring management) if not completed during periods of low tide.

This alternative achieves the three RAOs and is considered an acceptable and applicable remedial alternative. The soil removal alternative is retained for further evaluation as part of this focused FS.

6.4 Evaluation of Alternatives

Given results of the alternative screening process described in Section 6.3, the following two remedial alternatives are retained for further evaluation:

- **Alternative 1.** Institutional Controls
- **Alternative 2.** Soil Removal

Consistent with MTCA regulations and Ecology guidance, the two remedial alternatives are evaluated for the seven evaluation criteria (listed in WAC 173-340-360[3][f]), as described in Section 6.4.1.

6.4.1 Disproportionate Cost Analysis

MTCA requires that when selecting from remedial action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable (WAC 173-340-360[2][b][i]).

MTCA specifies that the permanence of qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a disproportionate cost analysis (DCA) in accordance with WAC 173-340-360(3)(e). The most practical permanent solution evaluated is the baseline remedial alternative to which other remedial alternatives are compared. The evaluation criteria for the DCA, as defined by WAC 173-340-360(3)(f), are summarized in the following subsections.

6.4.1.1 Protectiveness

The protectiveness criteria measures the overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.

Alternative 2 has on-site and off-site risks associated with excavation, load, and transporting the impacted soil from the excavation. Alternative 1 has a shorter risk reduction timeframe and achieves a similar level of protectiveness to Alternative 2 via implementation of institutional controls that restrict future redevelopment and construction actions.

6.4.1.2 Permanence

Permanence is defined as the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment of residuals generated.

Neither alternative reduces the toxicity or volume of the hazardous substances. Alternative 2 removes the hazardous substances from the Site, providing remedy permanence for the Site by transferring the waste to a permitted landfill facility, and thus, Alternative 2 is more permanent than Alternative 1.

6.4.1.3 Cost

The cost for implementation of Alternative 1 is approximately $5,000, and the cost for implementation of Alternative 2 is approximately$205,000. Alternative cost estimate summary sheets are provided in Table 7.

6.4.1.4 Effectiveness over the Long Term

Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time that hazardous substances are expected to remain on site at concentrations that exceed cleanup levels, the

magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. There are six types of remedial action components listed in WAC 173-340-360(1)(f)(iv): reuse or recycling, destruction or detoxification, immobilization, on- and off-site disposal in an engineered facility, containment, and institutional controls and monitoring.

Alternative 2 is considered to have a slightly higher level of effectiveness over the long term based on consideration of the six types of remedial action components as listed previously.

6.4.1.5 Management of Short-term Risks

Short-term risks are those risks to human health and the environment associated with the construction and implementation of an alternative with consideration of the measures that will be taken to manage such risks.

Alternative 2 would require construction demolition and soil disruption (excavation, loading, and hauling) to implement. There are no short-term risks for Alternative 1.

6.4.1.6 Technical and Administrative Implementability

This criterion considers if an alternative is technically possible; the availability of necessary off-site facilities, services, and material; and the administrative and regulatory requirements. This criterion also considers scheduling, size, and complexity for construction operations and monitoring.

Alternatives 1 and 2 are both considered to be implementable from technical and administrative standpoints.

6.4.1.7 Consideration of Public Concerns

This criterion considers the extent to which the community has concerns regarding an alternative based on those individual, community groups, local governments, tribes, federal and state agencies, or any other organization that may have interest in or knowledge of the Site.

Alternative 2 would remove the impacted soil from the Site; however, this removal and off-site disposal of soil would temporarily shut down Percival Landing Park, and it would increase construction noise and truck traffic.

6.4.2 Reasonable Restoration Timeframe

WAC 173-340-360(4)(b) specifies that eight factors be considered to determine whether a remedial action provides for a reasonable restoration timeframe. For each remedial alternative, these factors are considered in the following points:

- **Potential risks to human health and the environment.** Both alternatives eliminate the exposure pathway for direct contact with contaminated soil.
- **Practicability of achieving shorter restoration timeframe.** Each remedial action alternative can achieve site cleanup within a reasonable restoration timeframe.
- **Current use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site.** Migration of contaminants to surrounding areas is not expected.
- **Availability of alternate water supplies.** The availability of alternate water supplies is not applicable to this site.
- **Likely effectiveness and reliability of institutional controls.** Institutional controls that would be included in Alternative 1 are expected to be effective at preventing future direct contact with contaminated soil because they would restrict future Site development (via deed restrictions) in the contaminated area.
- **Ability to control and monitor migration of hazardous substances from the site.** RI investigations indicate that the Site is bound on all sides by clean soil. Groundwater flow is toward Budd Inlet and restricted by the sheetpile wall; therefore, migration of hazardous substances is unlikely.
- **Toxicity of hazardous substances at the site.** The main COC within the cleanup action area following actions taken to date is DRO. The toxicity of this constituent is low.
- **Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.** Based on historical data comparisons, there is little evidence of natural attenuation occurring at the Site.

In summary, each remedial alternative is likely to achieve site cleanup within a reasonable timeframe.

6.5 Conclusion and Preferred Alternative

In conclusion, the Former Unocal and Hulco property had residual TPH-contaminated soil after a cleanup action (1995) and a supplemental cleanup action (2001). To address this unexpected residual contamination during Percival Landing Park development, the City conducted extensive soil investigations and excavations and entered into the VCP. Site-specific cleanup-levels have been developed for groundwater and soils. Existing soil and groundwater concentrations are below the site-specific cleanup levels with the exception of an isolated area on the southwest portion of the property (near BH-11), where a confirmation sample was not taken inland of the sheetpile wall, after excavation, to assess the existing concentration. Based on the excavation limits, it was determined that this area could potentially have residual TPH contamination above the site-specific TPH cleanup level (2,724 mg/kg). This area has since been covered by concrete and boardwalk.

Two remedial alternatives were evaluated to address the potential contamination remaining at this Site: 1) institutional controls; and 2) soil removal. Both alternatives would prevent direct human and ecological contact with contaminated soil. Alternative 2 has the greatest permanence but includes demolition of portions of the newly constructed boardwalk, a costly excavation, and transport and disposal of contaminated soil. The high cost and short-term risks required to implement this alternative are disproportionate to the incremental benefits gained when compared to Alternative 1, which offers a similar level of human and ecological protectiveness. Therefore, excavation can be considered disproportionate from the standpoint of this DCA.

Based on the comparative evaluation of the two alternatives, the preferred remedial action is Alternative 1, the implementation of institutional controls near area BH-11. This alternative meets the threshold requirements, uses permanent solutions to the maximum extent practicable, and provides for a reasonable restoration timeframe. It is recommended that Ecology issue an NFA determination for work already completed at this Site, provided that an acceptable level of institutional controls is implemented to provide protection from direct contact with soils during excavations on site and proper testing and disposal of excavated soils.

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TABLES

Table 1
Summary of RI Sample Collection and Testing

Station ID	Sample ID	Sample Date	Start Depth (ft) bgs	End Depth (ft) bgs	Tier 1 Testing	Tier 2 Testing	Excavated Post-Sampling[3]
BH-11	BH-11-0-5	9/27/2010	0	5	TPH-HCID	--	Yes
	BH-11-5-10	9/27/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Metals, PAHs	Partially
	BH-11-10-15	9/27/2010	10	15	TPH-HCID	--	No
	BH-11-15-20	9/27/2010	15	20	TPH-HCID	--	No
BH-12	BH-12-0-5	9/28/2010	0	5	TPH-HCID	--	Yes
	BH-12-5-10	9/28/2010	5	10	TPH-HCID	--	Partially
	BH-12-10-15	9/28/2010	10	15	TPH-HCID	--	No
	BH-12-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-13	BH-13-0-5	9/28/2010	0	5	TPH-HCID	TPH-G, TPH-Dx	Yes
	BH-13-5-10	9/28/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	Partially
	BH-13-10-15	9/28/2010	10	15	TPH-HCID	--	No
	BH-13-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-14	BH-14-0-5	9/28/2010	0	5	TPH-HCID	--	Yes
	BH-14-5-10	9/28/2010	5	10	TPH-HCID	--	Partially
	BH-14-10-15	9/28/2010	10	15	TPH-HCID	--	No
	BH-14-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-15	BH-15-0-5	9/28/2010	0	5	TPH-HCID	--	Yes
	BH-15-5-10	9/28/2010	5	10	TPH-HCID	--	Partially
	BH-15-10-15	9/28/2010	10	15	TPH-HCID	--	No
	BH-15-15-20	9/28/2010	15	20	TPH-HCID	--	No
BH-22	BH-22-0-5	11/8/2010	0	5	TPH-HCID	TPH-Dx	No
	BH-22-5-10	11/8/2010	5	10	TPH-HCID	TPH-Dx	No
	BH-22-10-15	11/8/2010	10	15	TPH-HCID	--	No
	BH-22-15-20	11/8/2010	15	20	TPH-HCID	--	No
BH-23	BH-23-0-5	11/8/2010	0	5	TPH-HCID	--	No
	BH-23-5-10	11/8/2010	5	10	TPH-HCID	--	No
	BH-23-10-15	11/8/2010	10	15	TPH-HCID	--	No
	BH-23-15-20	11/8/2010	15	20	TPH-HCID	--	No
BH-24	BH-24-0-5	11/9/2010	0	5	TPH-HCID	--	No
	BH-24-5-10	11/9/2010	5	10	TPH-HCID	--	No
	BH-24-10-15	11/9/2010	10	15	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	No
	BH-24-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-25	BH-25-0-5	11/9/2010	0	5	TPH-HCID	--	No
	BH-25-5-10	11/9/2010	5	10	TPH-HCID	--	No
	BH-25-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-25-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-26	BH-26-0-5	11/9/2010	0	5	TPH-HCID	--	No
	BH-26-5-10	11/9/2010	5	10	TPH-HCID	--	No
	BH-26-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-26-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-27	BH-27-0-5	11/9/2010	0	5	TPH-HCID	--	No
	BH-27-5-10	11/9/2010	5	10	TPH-HCID	--	No
	BH-27-10-15	11/9/2010	10	15	TPH-HCID	--	No
	BH-27-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-28	BH-28-0-5	11/9/2010	0	5	TPH-HCID	--	Yes
	BH-28-5-10	11/9/2010	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	Yes
	BH-28-10-15	11/9/2010	10	15	TPH-HCID	--	Yes
	BH-28-15-20	11/9/2010	15	20	TPH-HCID	--	No
BH-33	BH-33-GW	6/17/2011	6	11	GW Tests[1]	--	No
	BH-33-SO-0-5	6/17/2011	0	5	TPH-HCID	--	No
	BH-33-SO-5-10	6/17/2011	5	10	TPH-HCID	--	No
	BH-33-SO-10-15	6/17/2011	10	15	TPH-HCID	--	No
	BH-33-SO-15-20	6/17/2011	15	20	TPH-HCID	--	No
BH-34	BH-34-GW	6/17/2011	5	10	GW Tests[1]	--	No
	BH-34-SO-0-5	6/17/2011	0	5	TPH-HCID	--	No
	BH-34-SO-5-10	6/17/2011	5	10	TPH-HCID	--	No
	BH-34-SO-10-15	6/17/2011	10	15	TPH-HCID	--	No
	BH-34-SO-15-20	6/17/2011	15	20	TPH-HCID	--	No
BH-35	BH-35-SO-0-5	6/17/2011	0	5	TPH-HCID	--	No
	BH-35-SO-5-10	6/17/2011	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead, VPH, EPH	No
	BH-35-SO-10-15	6/17/2011	10	15	TPH-HCID	--	No
	BH-35-SO-15-20	6/17/2011	15	20	TPH-HCID	--	No
BH-36	BH-36-SO-0-5	6/16/2011	0	5	TPH-HCID	--	No
	BH-36-SO-5-10	6/16/2011	5	10	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead, VPH, EPH	No
	BH-36-SO-10-15	6/16/2011	10	15	TPH-HCID	--	No
	BH-36-SO-15-20	6/16/2011	15	20	TPH-HCID	--	No
	BH-36-SV	6/16/2011	4.5	4.5	Air Tests[2]	--	No

Table 1
Summary of RI Sample Collection and Testing

Station ID	Sample ID	Sample Date	Start Depth (ft) bgs	End Depth (ft) bgs	Tier 1 Testing	Tier 2 Testing	Excavated Post-Sampling[3]
BH-37	BH-37-GW	6/16/2011	6	11	GW Tests[1]	--	No
	BH-37-SO-0-5	6/16/2011	0	5	TPH-HCID	--	No
	BH-37-SO-5-10	6/16/2011	5	10	TPH-HCID	--	No
	BH-37-SO-10-15	6/16/2011	10	15	TPH-HCID	--	No
	BH-37-SO-15-20	6/16/2011	15	20	TPH-HCID	--	No
BH-38	BH-38-GW	6/16/2011	6	11	GW Tests[1]	--	No
	BH-38-SO-0-5	6/16/2011	0	5	TPH-HCID	--	No
	BH-38-SO-5-10	6/16/2011	5	10	TPH-HCID	--	No
	BH-38-SO-10-15	6/16/2011	10	15	TPH-HCID	--	No
	BH-38-SO-15-20	6/16/2011	15	20	TPH-HCID	--	No
BH-39	BH-39-SO-0-5	6/16/2011	0	5	TPH-HCID	--	No
	BH-39-SO-5-10	6/16/2011	5	10	TPH-HCID	--	No
	BH-39-SO-10-15	6/16/2011	10	15	TPH-HCID	--	No
	BH-39-SO-15-20	6/16/2011	15	20	TPH-HCID	--	No
	BH-39-SV	6/16/2011	5	5	Air Tests[2]	--	No
TP-2	TP-2-4-6E	9/28/2010	4	6	TPH-HCID	--	Yes
	TP-2-4-6W	9/28/2010	4	6	TPH-HCID	--	Yes
	TP-2-6-8W	9/28/2010	6	8	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	Yes
	TP-2-8-9E	9/28/2010	8	9	TPH-HCID	--	Yes
TP-5	TP-5-4-5	2/16/2011	4	5	--	TPH-G, TPH-Dx, VOCs, total Lead	No
TP-6	TP-6-1-4	10/29/2010	1	4	TPH-HCID	--	No
	TP-6-4-10	10/29/2010	4	10	TPH-HCID	--	No
TP-7	TP-7-1-5	10/28/2010	1	5	TPH-HCID	--	No
	TP-7-6-10	10/28/2010	6	10	TPH-HCID	--	No
TP-8	TP-8-1-6	10/29/2010	1	6	TPH-HCID	--	No
	TP-8-6-9	10/29/2010	6	9	TPH-HCID	--	No
TP-9	TP-9-1-5	10/28/2010	1	5	TPH-HCID	--	No
	TP-9-8-10	10/28/2010	8	10	TPH-HCID	--	No
TP-10	TP-10	6/15/2011	4.5	5	TPH-HCID	--	No
TP-11	TP-11	6/15/2011	6	6.5	TPH-HCID	TPH-Dx, EPH	No
CS-11	CS-11	11/5/2010	0 cm	10 cm	TPH-HCID	TPH-Dx	No
CS-12	CS-12	11/4/2010	0 cm	10 cm	TPH-HCID	--	No
CS-13	CS-13	11/4/2010	0 cm	10 cm	TPH-HCID	--	No
CS-14	CS-14	11/2/2010	0 cm	10 cm	TPH-HCID	TPH-G, TPH-Dx, VOCs	No
CS-15	CS-15	11/2/2010	0 cm	10 cm	TPH-HCID	TPH-Dx	No
CS-20	CS-20	1/26/2011	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	No
CS-21	CS-21	1/28/2011	0 cm	10 cm	--	TPH-G, TPH-Dx, VOCs, total Lead	No
CS-22	CS-22	4/18/2011	10	12	TPH-HCID	--	No
CS-23	CS-23	4/19/2011	10	12	TPH-HCID	--	No
CS-24	CS-24	4/19/2011	10	12	TPH-HCID	--	No
CS-25	CS-25	4/19/2011	10	12	TPH-HCID	--	No
CS-26	CS-26	4/19/2011	10	12	TPH-HCID	--	No
CS-27	CS-27	4/26/2011	10	12	TPH-HCID	TPH-G, TPH-Dx, VOCs	No
CS-28	CS-28	4/26/2011	10	12	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	Yes
CS-29	CS-29	7/13/2011	10	12	TPH-HCID	TPH-G, TPH-Dx, VOCs, total Lead	Yes
CS-30	CS-30	7/20/2011	10	12	TPH-HCID	--	No

Notes:

1	Groundwater (GW) tests included TPH-G, TPH-DX, VOCs, and total and dissolved lead
2	Air tests included VOCs and VPH/APH
3	Soil in this sample location was excavated after sample collection and no longer represents current site conditions
bgs	below ground surface
TPH-HCID	Total Petroleum Hydrocarbon Identification for Gasoline, Diesel, and Oil
TPH-G	Total Petroleum Hydrocarbons- Gasoline Range
TPH-Dx	Total Petroleum Hydrocarbons- Diesel and Oil Range
VOCs	Volatile Organic Compounds
PAHs	Polycyclic Aromatic Hydrocarbons
Total Metals	Arsenic, Barium, Cadmium Chromium, Lead, Mercury, Selenium, and Silver
VPH	Volatile Petroleum Hydrocarbons
APH	Aliphatic/Aromatic Petroleum Hydrocarbons
EPH	Extractable Petroleum Hydrocarbons
--	Not available or applicable

Table 2a
RI Soil Sampling Results - Petroleum Hydrocarbons

Station ID	Sample ID	Sample Date	Sample Depth	HCID GRO mg/kg	HCID DRO mg/kg	HCID ORO mg/kg	NW-TPH GRO mg/kg	NW-TPH DRO mg/kg	NW-TPH ORO mg/kg	Sum of DRO/ORO mg/kg
			Cleanup Level[1]	100[a]	2,000	2,000	100[a]	2,000	2,000	2000[b]
BH-11	BH-11-0-5	9/27/2010	0 - 5 ft	13.8 U	34.4 U	68.9 U	--	--	--	68.9 U
	BH-11-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	6.51 U	**5,320**	**543 J**	**5,863 J**
	BH-11-10-15		10 - 15 ft	17.8 U	44.5 U	89 U	--	--	--	89 U
	BH-11-15-20		15 - 20 ft	18 U	44.9 U	89.8 U	--	--	--	89.8 U
BH-12	BH-12-0-5	9/28/2010	0 - 5 ft	14.2 U	35.5 U	71.1 U	--	--	--	71.1 U
	BH-12-5-10		5 - 10 ft	17.9 U	44.7 U	89.5 U	--	--	--	89.5 U
	BH-12-10-15		10 - 15 ft	18.4 U	46.1 U	92.2 U	--	--	--	92.2 U
	BH-12-15-20		15 - 20 ft	15 U	37.5 U	75 U	--	--	--	75 U
BH-13	BH-13-0-5	9/28/2010	0 - 5 ft	14.1 U	35.3 U	**DETECT**	5.27 U	**38.4**	**230**	**268 J**
	BH-13-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**9.21**	**1,130**	**134 J**	**1,264 J**
	BH-13-10-15		10 - 15 ft	17.3 U	43.2 U	86.5 U	--	--	--	86.5 U
	BH-13-15-20		15 - 20 ft	14.7 U	36.8 U	73.7 U	--	--	--	73.7 U
BH-14	BH-14-0-5	9/28/2010	0 - 5 ft	14.6 U	36.5 U	72.9 U	--	--	--	72.9 U
	BH-14-5-10		5 - 10 ft	14.1 U	35.4 U	70.7 U	--	--	--	70.7 U
	BH-14-10-15		10 - 15 ft	18.1 U	45.3 U	90.6 U	--	--	--	90.6 U
	BH-14-15-20		15 - 20 ft	22 U	55 U	110 U	--	--	--	110 U
BH-15	BH-15-0-5	9/28/2010	0 - 5 ft	14.1 U	35.3 U	70.7 U	--	--	--	70.7 U
	BH-15-5-10		5 - 10 ft	19.2 U	47.9 U	95.9 U	--	--	--	95.9 U
	BH-15-10-15		10 - 15 ft	23.3 U	58.3 U	117 U	--	--	--	117 U
	BH-15-15-20		15 - 20 ft	20.3 U	50.7 U	101 U	--	--	--	101 U
BH-22	BH-22-0-5	11/8/2010	0 - 5 ft	19.3 U	48.2 U	**DETECT**	--	**5.23 J**	**72.5**	**77.7 J**
	BH-22-5-10		5 - 10 ft	20.5 U	51.3 U	**DETECT**	--	**15.7 J**	**96.4**	**112 J**
	BH-22-10-15		10 - 15 ft	23.7 U	59.3 U	119 U	--	--	--	119 U
	BH-22-15-20		15 - 20 ft	23.4 U	58.6 U	117 U	--	--	--	117 U
BH-23	BH-23-0-5	11/8/2010	0 - 5 ft	19.4 U	48.5 U	97 U	--	--	--	97 U
	BH-23-5-10		5 - 10 ft	21.4 U	53.6 U	107 U	--	--	--	107 U
	BH-23-10-15		10 - 15 ft	22 U	54.9 U	110 U	--	--	--	110 U
	BH-23-15-20		15 - 20 ft	25.7 U	64.2 U	128 U	--	--	--	128 U
BH-24	BH-24-0-5	11/9/2010	0 - 5 ft	17.9 U	44.8 U	89.7 U	--	--	--	89.7 U
	BH-24-5-10		5 - 10 ft	15 U	37.4 U	74.8 U	--	--	--	74.8 U
	BH-24-10-15		10 - 15 ft	**DETECT**	**DETECT**	**DETECT**	7.42 U	**1,950**	**209 J**	**2,159 J**
	BH-24-15-20		15 - 20 ft	18.4 U	46 U	92 U	--	--	--	92 U
BH-25	BH-25-0-5	11/9/2010	0 - 5 ft	16.1 U	40.2 U	80.4 U	--	--	--	80.4 U
	BH-25-5-10		5 - 10 ft	17.7 U	44.4 U	88.7 U	--	--	--	88.7 U
	BH-25-10-15		10 - 15 ft	20.2 U	50.5 U	101 U	--	--	--	101 U
	BH-25-15-20		15 - 20 ft	25.9 U	64.7 U	129 U	--	--	--	129 U
BH-26	BH-26-0-5	11/9/2010	0 - 5 ft	16.8 U	42 U	84 U	--	--	--	84 U
	BH-26-5-10		5 - 10 ft	15 U	37.6 U	75.2 U	--	--	--	75.2 U
	BH-26-10-15		10 - 15 ft	22.3 U	55.8 U	112 U	--	--	--	112 U
	BH-26-15-20		15 - 20 ft	18.4 U	46 U	92 U	--	--	--	92 U
BH-27	BH-27-0-5	11/9/2010	0 - 5 ft	15.1 U	37.7 U	75.3 U	--	--	--	75.3 U
	BH-27-5-10		5 - 10 ft	16.8 U	42 U	84 U	--	--	--	84 U
	BH-27-10-15		10 - 15 ft	20.3 U	50.9 U	102 U	--	--	--	102 U
	BH-27-15-20		15 - 20 ft	24.8 U	61.9 U	124 U	--	--	--	124 U
BH-28	BH-28-0-5	11/9/2010	0 - 5 ft	14.5 U	36.3 U	72.6 U	--	--	--	72.6 U
	BH-28-5-10		5 - 10 ft	**DETECT**	**DETECT**	77.1 U	**1,230**	**615**	**32.9 J**	**648 J**
	BH-28-10-15		10 - 15 ft	18.5 U	46.3 U	92.7 U	--	--	--	92.7 U
	BH-28-15-20		15 - 20 ft	26.5 U	66.3 U	133 U	--	--	--	133 U
BH-33	BH-33-SO-0-5	6/16/2011	0 - 5 ft	20.1 U	50.2 U	100 U	--	--	--	100 U
	BH-33-SO-5-10		5 - 10 ft	22.8 U	57 U	114 U	--	--	--	114 U
	BH-33-SO-10-15		10 - 15 ft	24 U	59.9 U	120 U	--	--	--	120 U
	BH-33-SO-15-20		15 - 20 ft	23.8 U	59.4 U	119 U	--	--	--	119 U
BH-34	BH-34-SO-0-5	6/17/2011	0 - 5 ft	20 U	50.1 U	100 U	--	--	--	100 U
	BH-34-SO-5-10		5 - 10 ft	21.8 U	54.4 U	109 U	--	--	--	109 U
	BH-34-SO-10-15		10 - 15 ft	24.6 U	61.5 U	123 U	--	--	--	123 U
	BH-34-SO-15-20		15 - 20 ft	29 U	72.5 U	145 U	--	--	--	145 U

Table 2a
RI Soil Sampling Results - Petroleum Hydrocarbons

Station ID	Sample ID	Sample Date	Sample Depth	HCID GRO mg/kg	HCID DRO mg/kg	HCID ORO mg/kg	NW-TPH GRO mg/kg	NW-TPH DRO mg/kg	NW-TPH ORO mg/kg	Sum of DRO/ORO mg/kg
Cleanup Level[1]				100[a]	2,000	2,000	100[a]	2,000	2,000	2000[b]
BH-35	BH-35-SO-0-5	6/16/2011	0 - 5 ft	20.3 U	50.8 U	102 U	--	--	--	102 U
	BH-35-SO-5-10		5 - 10 ft	**DETECT**	**DETECT**	**DETECT**	**80.8**	**121**	**137**	**258**
	BH-35-SO-10-15		10 - 15 ft	25.4 U	63.6 U	127 U	--	--	--	127 U
	BH-35-SO-15-20		15 - 20 ft	24.1 U	60.3 U	121 U	--	--	--	121 U
BH-36	BH-36-SO-0-5	6/16/2011	0 - 5 ft	21.2 U	52.9 U	106 U	--	--	--	106 U
	BH-36-SO-5-10		5 - 10 ft	**DETECT**	**DETECT**	106 U	**120**	**837**	**92.1**	**929**
	BH-36-SO-10-15		10 - 15 ft	25 U	62.4 U	125 U	--	--	--	125 U
	BH-36-SO-15-20		15 - 20 ft	25.5 U	63.7 U	127 U	--	--	--	127 U
BH-37	BH-37-SO-0-5	6/16/2011	0 - 5 ft	19.2 U	48.1 U	96.1 U	--	--	--	96.1 U
	BH-37-SO-5-10		5 - 10 ft	20.5 U	51.1 U	102 U	--	--	--	102 U
	BH-37-SO-10-15		10 - 15 ft	25.4 U	63.5 U	127 U	--	--	--	127 U
	BH-37-SO-15-20		15 - 20 ft	24 U	60 U	120 U	--	--	--	120 U
BH-38	BH-38-SO-0-5	6/16/2011	0 - 5 ft	19.7 U	49.2 U	98.5 U	--	--	--	98.5 U
	BH-38-SO-5-10		5 - 10 ft	22 U	54.9 U	110 U	--	25 U	50 U	110 U
	BH-38-SO-10-15		10 - 15 ft	23.9 U	59.7 U	119 U	--	--	--	119 U
	BH-38-SO-15-20		15 - 20 ft	22.8 U	56.9 U	114 U	--	--	--	114 U
BH-39	BH-39-SO-0-5	6/16/2011	0 - 5 ft	21.1 U	52.7 U	105 U	--	--	--	105 U
	BH-39-SO-5-10		5 - 10 ft	21.8 U	54.5 U	109 U	--	--	--	109 U
	BH-39-SO-10-15		10 - 15 ft	24.6 U	61.4 U	123 U	--	--	--	123 U
	BH-39-SO-15-20		15 - 20 ft	25.6 U	64 U	128 U	--	--	--	128 U
TP-2	TP-2-4-6E	9/28/2010	4 - 6 ft	14.8 U	37.1 U	74.1 U	--	--	--	74.1 U
	TP-2-4-6W		4 - 6 ft	16.4 U	40.9 U	81.9 U	--	--	--	81.9 U
	TP-2-6-8W		6 - 8 ft	**DETECT**	**DETECT**	**DETECT**	**783**	**2,840**	**312 J**	**3,152 J**
	TP-2-8-9E		8 - 9 ft	15.3 U	38.3 U	76.7 U	--	--	--	76.7 U
TP-5	TP-5-4-5	2/16/2011	4 - 5 ft	--	--	--	**116**	**898**	**57.4 J**	**955.4 J**
TP-6	TP-6-1-4	10/29/2010	1 - 4 ft	17.8 U	44.5 U	88.9 U	--	--	--	88.9 U
	TP-6-4-10		4 - 10 ft	26 U	64.9 U	130 U	--	--	--	130 U
TP-7	TP-7-1-5	10/28/2010	1 - 5 ft	22.9 U	57.4 U	115 U	--	--	--	115 U
	TP-7-6-10		6 - 10 ft	25 U	62.6 U	125 U	--	--	--	125 U
TP-8	TP-8-1-6	10/29/2010	1 - 6 ft	16.8 U	42.1 U	84.2 U	--	--	--	84.2 U
	TP-8-6-9		6 - 9 ft	21.5 U	53.6 U	107 U	--	--	--	107 U
TP-9	TP-9-1-5	10/28/2010	1 - 5 ft	22.7 U	56.7 U	113 U	--	--	--	113 U
	TP-9-8-10		8 - 10 ft	23.5 U	58.7 U	117 U	--	--	--	117 U
TP-10	TP-10	6/15/2011	4.5 - 5 ft	20.5 U	51.3 U	103 U	--	--	--	103 U
TP-11	TP-11	6/15/2011	6 - 6.5 ft	20.8 U	**DETECT**	104 U	--	**90.8**	**59**	**59**
CS-11	CS-11	11/5/2010	0 - 10 cm	19.4 U	48.4 U	**DETECT**	--	**23.4 J**	**232**	**255 J**
CS-12	CS-12	11/4/2010	0 - 10 cm	20.8 U	51.9 U	104 U	--	--	--	104 U
CS-13	CS-13	11/4/2010	0 - 10 cm	20.6 U	51.6 U	103 U	--	--	--	103 U
CS-14	CS-14	11/2/2010	0 - 10 cm	**DETECT**	**DETECT**	105 U	**10.3**	**159**	**38.1 J**	**197 J**
CS-15	CS-15	11/2/2010	0 - 10 cm	22 U	54.9 U	**DETECT**	--	**11.2 J**	**59.9 J**	**71.1 J**
CS-20	CS-20	1/26/2011	0 - 10 cm	--	--	--	11.6 U	**8.24 J**	**26.3 J**	**34.54 J**
CS-21	CS-21	1/28/2011	0 - 10 cm	--	--	--	10.7 U	**7.22 J**	**18.3 J**	**25.52 J**
CS-22	CS-22	4/18/2011	10 - 12 ft	27.1 U	67.8 U	136 U	--	--	--	136 U
CS-23	CS-23	4/19/2011	10 - 12 ft	26.3 U	65.7 U	131 U	--	--	--	131 U
CS-24	CS-24	4/19/2011	10 - 12 ft	26.7 U	66.7 U	133 U	--	--	--	133 U
CS-25	CS-25	4/19/2011	10 - 12 ft	26.1 U	65.1 U	130 U	--	--	--	130 U
CS-26	CS-26	4/19/2011	10 - 12 ft	23.8 U	59.5 U	119 U	--	--	--	119 U
CS-27	CS-27	4/26/2011	10 - 12 ft	23.3 U	58.2 U	116 U	7.36 U	**23.9**	23.5 U	**23.9**
CS-28	CS-28	4/26/2011	10 - 12 ft	**DETECT**	**DETECT**	**DETECT**	**1,480 J**	**8,260**	430 U	**8,260**
CS-29	CS-29	7/13/2011	10 - 12 ft	**DETECT**	**DETECT**	95.4 U	**1,980**	**525**	**114**	**639**
CS-30	CS-30	7/20/2011	10 - 12 ft	23.4 U	58.5 U	117 U	--	--	--	117 U

Table 2a
RI Soil Sampling Results - Petroleum Hydrocarbons

Notes:

MTCA	Model Toxics Control Act	--	Not analyzed
ft	feet	**Bold**	Detected
cm	centimeters	J	Estimated
mg	milligram	U	Compound analyzed, but not detected above detection limit
kg	kilogram	UJ	Compound analyzed, but not detected above estimated detection limit

1. Cleanup levels presented for petroleum based on MTCA Method A cleanup levels for screening purposes. Petroleum factionation testing was used along with Ecology's TPH Workbook to develop a site-specific cleanup level (Appendix B). A site-specific TPH soil cleanup level of 2,724 mg/kg was developed based on protection of direct contact for unrestricted land use, and for protection of groundwater quality.

a Gasoline mixtures without benzene and total of ethylbenzene, toluene, and xylenes less than 1% of the gasoline mixture have a screening level of 100 mg/kg. Mixtures with benzene, etc. have a screening level of 30 mg/kg.

b If the sum of TPH-diesel and oil exceed the MTCA cleanup criteria, the result is considered an exceedance.

Detected concentration is greater than MTCA Method A screening level.

Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated.

QA1 validation applied.

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

Table 2b
RI Soil Sampling Results - VOCs and Lead

Analyte	Station ID	BH-11	BH-13	BH-24	BH-28	BH-35	BH-36	TP-2	TP-5	CS-14	CS-20	CS-21	CS-27	CS-28	CS-29
	Sample Name	BH-11-5-10	BH-13-5-10	BH-24-10-15	BH-28-5-10	BH-35-SO-5-10	BH-36-SO-5-10	TP-2-6-8W	TP-5-4-5	CS-14	CS-20	CS-21	CS-27	CS-28	CS-29
	Sample Date	9/27/2010	9/28/2010	11/9/2010	11/9/2010	6/16/2011	6/16/2011	9/28/2010	2/16/2011	11/2/2010	1/26/2011	1/28/2011	4/26/2011	4/26/2011	7/13/2011
	Depth	5 - 10 ft	5 - 10 ft	10 - 15 ft	5 - 10 ft	5 - 10 ft	5 - 10 ft	6 - 8 ft	4 - 5 ft	0 - 10 cm	0 - 10 cm	0 - 10 cm	10 - 12 ft	10 - 12 ft	10 - 12 ft
Conventional Parameters (percent)	**Cleanup Level**														
Total solids	--	**80.1**	**83**	**76.8**	**89.4**	**88.1**	**87.9**	**81.1**	**77.2**	**81.6**	**59.9**	**60.1**	**79.6**	**85.7**	**85.7**
Volatile Organics (mg/kg)															
Benzene	0.03	0.0163 U	0.0153 U	0.0185 U	0.0257 U	0.0153 U	**0.0097 J**	0.0653 U	0.0164 U	0.00871 U	0.0289 U	0.0268 U	0.0184 U	**0.0647**	0.0172 U
Ethylbenzene	6.0	0.0325 U	**0.0183 J**	0.0371 U	0.0515 U	0.0305 U	0.0267 U	**0.0783 J**	**0.0347**	0.0174 U	0.0578 U	0.0537 U	0.0368 U	0.154 U	0.0686 U
Toluene	7.0	0.0651 U	0.0611 U	0.0742 U	0.103 U	0.0611 U	0.0533 U	0.261 U	0.0654 U	0.0348 U	0.116 U	0.107 U	0.0736 U	0.308 U	0.0343 U
m,p-Xylene	--	0.0651 U	0.0611 U	0.0742 U	0.103 U	0.0611 U	0.0533 U	**0.159 J**	0.0654 U	0.0522 U	0.116 U	0.107 U	0.0736 U	**0.157**	**0.174**
o-Xylene	--	0.0325 U	0.0306 U	0.0371 U	0.0669 U	0.0305 U	**0.0192 J**	**0.123 J**	0.0327 U	0.0209 U	0.0578 U	0.107 U	0.0368 U	**0.123**	0.0686 U
Total Xylene (U = 1/2)	9.0	0.0651 U	0.0611 U	0.0742 U	0.103 U	0.0611 U	**0.04585**	**0.282 J**	0.0654 U	0.0522 U	0.116 U	0.107 U	0.0736 U	**0.28**	**0.208**
1,2-Dibromoethane (EDB)	0.005	0.0325 U	0.0306 U	0.0371 U	0.0515 U	0.00277 U	0.0267 U	0.131 U	0.0327 U	0.0174 U	0.0578 U	0.0537 U	0.0368 U	0.154 U	0.0343 U
1,2-Dichloroethane	--	**0.0202 J**	**0.022 J**	0.0371 U	0.0515 U	0.0305 U	0.0267 U	0.131 U	0.0327 U	0.0174 U	0.0578 U	0.0537 U	0.0368 U	0.154 U	0.0343 UJ
Methyl tert-butyl ether (MTBE)	0.1	0.0651 U	0.0611 U	0.0742 U	0.103 U	0.0611 U	0.0533 U	0.261 U	0.0327 U	0.0348 U	0.116 U	0.107 U	0.0736 U	0.308 U	0.0686 U
Metals (mg/kg)															
Lead	250	**6.41**	**1.16 J**	**5.36**	**4.46**	**5.29**	**5.66**	**13.2**	**12.6**	**--**	**9.45**	**11.9**	**--**	**8.42**	**4.92**

Notes:
MTCA - Model Toxics Control Act
ft - feet
cm - centimeters
mg - milligram
kg - kilogram

-- - Not analyzed
Bold - Detected result
J - Estimated value
U - Compound analyzed, but not detected above detection limit
UJ - Compound analyzed, but not detected above estimated detection limit

Detected concentration is greater than MTCA Method A screening level
Non-detected concentration is above one or more identified screening levels
Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated

QA1 validation applied.
Total 17 LPAH (Low PAH) are the total of 2-Methylnapthalene, Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene and Anthracene.
Total 17 HPAH (High PAH) are the total of Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(x)fluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c,d)pyrene, Dibenzo(a,h)anthracene and Benzo(g,h,i)perylene.
Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

Table 2c
RI Soil Sampling Results - PAHs, Metals, and Petroleum Fractionation

Analyte	Station ID	BH-11	BH-35	BH-36	TP-11
	Sample Name	BH-11-5-10	BH-35-SO-5-10	BH-36-SO-5-10	TP-11
	Sample Date	9/27/2010	6/16/2011	6/16/2011	6/15/2011
	Depth	5 - 10 ft	5 - 10 ft	5 - 10 ft	6 - 6.5 ft
Conventional Parameters (percent)	**Cleanup Level**				
Total solids	--	**80.1**	**88.1**	**87.9**	**93.1**
Polycyclic Aromatic Hydrocarbons (mg/kg)					
1-Methylnaphthalene	--	0.118 U	--	--	--
2-Methylnaphthalene	--	0.119 U	--	--	--
Benzo(a)anthracene	--	0.0592 U	--	--	--
Benzo(a)pyrene	0.1	0.0592 U	--	--	--
Benzo(b)fluoranthene	--	0.0592 U	--	--	--
Benzo(k)fluoranthene	--	0.0592 U	--	--	--
Benzo(b+k)fluoranthene	--	0.0592 U	--	--	--
Chrysene	--	0.0592 U	--	--	--
Dibenzo(a,h)anthracene	--	0.0592 U	--	--	--
Indeno(1,2,3-c,d)pyrene	--	0.0592 U	--	--	--
Naphthalene	--	0.118 U	--	--	--
Total cPAH TEQ (U = 1/2)	0.1	0.0592 U	--	--	--
Total Naphthalenes (U = 1/2)	5.0	0.119 U	--	--	--
Metals (mg/kg)					
Arsenic	20	**6.54**	--	--	--
Barium	--	**16.3**	--	--	--
Cadmium	2.0	**0.432 J**	--	--	--
Chromium	2,000	**22.6**	--	--	--
Lead	250	**6.41**	--	--	--
Mercury	2.0	**0.0381 J**	--	--	--
Selenium	--	2.4 U	--	--	--
Silver	--	1.2 U	--	--	--
Extractable Petroleum Hydrocarbons (mg/kg)					
C8-C10 Aliphatic	--	--	2.3 U	**4.8**	2 U
C10-C12 Aliphatic	--	--	**3.4**	**31**	2 U
C12-C16 Aliphatic	--	--	**20**	**180**	**5.4**
C16-C21 Aliphatic	--	--	**33**	**140**	**36**
C21-C34 Aliphatic	--	--	**56**	**39**	**21**
C8-C10 Aromatic	--	--	2.3 U	2.3 U	2 U
C10-C12 Aromatic	--	--	2.3 U	**2.5**	2 U
C12-C16 Aromatic	--	--	**3.6**	**28**	2 U
C16-C21 Aromatic	--	--	**15**	**87**	**2.7**
C21-C34 Aromatic	--	--	**16**	**26**	**4.9**
Volatile Petroleum Hydrocarbons (mg/kg)					
C5-C6 Aliphatic	--	--	12 U	9.7 U	--
C6-C8 Aliphatic	--	--	12 U	9.7 U	--
C12-C13 Aromatic	--	--	**40**	9.7 U	--
Benzene	--	--	1.2 U	0.970 U	--
Ethylbenzene	--	--	1.2 U	0.970 U	--
Toluene	--	--	1.2 U	0.970 U	--
m,p-Xylene	--	--	2.4 U	1.9 U	--
o-Xylene	--	--	1.2 U	0.970 U	--
n-Pentane (C5)	--	--	1.2 U	0.970 U	--
n-Hexane	--	--	1.2 U	0.970 U	--
n-Octane (C8)	--	--	1.2 U	0.970 U	--
n-Decane (C10)	--	--	**2.2**	0.970 U	--
n-Dodecane (C12)	--	--	**3.7**	0.970 U	--
Methyl tert-butyl ether (MTBE)	--	--	1.2 U	0.970 U	--

Notes:

MTCA - Model Toxics Control Act

ft - feet

mg - milligram

kg - kilogram

PAH - Polycyclic Aromatic Hydrocarbon

-- - Not analyzed

Bold - Detected result

J - Estimated value

U - Compound analyzed, but not detected above detection limit

UJ - Compound analyzed, but not detected above estimated detection limit

Detected concentration is greater than MTCA Method A screening level

Non-detected concentration is above one or more identified screening levels

Soil at this sample location was excavated after sample collection and no longer represents current site conditions unless otherwise stated

QA1 validation applied.

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

Total Naphthalenes includes Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene.

cPAH minimum 7 analytes calculation includes Benzo(a)pyrene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene and Indeno(1,2,3-c,d)pyrene. Per MTCA cleanup Regulation, Table 708-2 "Toxicity Equivalency Factors for Minimum Required Carcinogenic Polyaromatic Hydrocarbons (cPAHs) under WAC 173-340-708(e).

Table 3a
Historical Compliance Groundwater Sampling Results

Analyte	Sample Number	MW-13A				MW-15	
	Sample Date	2/18/2002	5/23/2002	8/7/2002	11/1/2002	8/7/2002	11/1/2002
Total Petroleum Hydrocarbons (µg/l)	**Cleanup Level**						
Gasoline Range Hydrocarbons	800	50 U	50 U	50 U	50 U	**163**	**149**
Diesel Range Hydrocarbons	500	250 U	250 U	250 U	250 U	250 U	250 U
Residual Range Hydrocarbons	500	750 U	750 U	750 U	750 U	750 U	700 U
Volatile Organics (µg/l)							
Benzene	23	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Ethylbenzene	2,100	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
Toluene	15,000	0.20 U	0.20 U	0.20 U	0.20 U	**0.871**	0.20 U
Total Xylene (U = 1/2)	1,000	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U

Notes:

A summary of the development of groundwater cleanup levels is presented in Table 6 and are based on the protection of marine surface water.

Bold Detected result

J Estimated value

U Compound analyzed, but not detected above detection limit

Data is from the GeoEngineers November 2002 Quarterly Groundwater Monitoring Reports (December 5, 2002)

Table 3b
RI Groundwater Sampling Results

Analyte	Station ID	BH-33	BH-34	BH-37	BH-38	Field QC	Field QC
	Sample Name	BH-33-GW	BH-34-GW	BH-37-GW	BH-38-GW	EB-06172011	TRIP BLANK
	Sample Date	6/16/2011	6/17/2011	6/16/2011	6/16/2011	6/17/2011	6/17/2011
	Screen Depth	6 - 11 ft	5 - 10 ft	6 - 11 ft	6 - 11 ft	--	--
Total Petroleum Hydrocarbons (µg/l)	**MTCA A Cleanup Level**						
Gasoline Range Hydrocarbons	800	100 U	100 U	100 U	**392**	100 U	100 U
Diesel Range Hydrocarbons	500	189 U	189 U	**110 J**	**471**	198 U	--
Residual Range Hydrocarbons	500	377 U	377 U	377 U	**340 J**	396 U	--
Volatile Organics (µg/l)							
Benzene	23	**0.15 J**	0.25 U	0.25 U	**0.15 J**	0.25 U	0.25 U
Ethylbenzene	2,100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	15,000	**0.63 J**	**0.51 J**	1 U	**3.89**	1 U	1 U
m,p-Xylene	--	1 U	1 U	1 U	**1.68**	1 U	1 U
o-Xylene	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Total Xylene (U = 1/2)	1,000	1 U	1 U	1 U	**1.93**	1 U	1 U
1,2-Dibromoethane (EDB)	0.01	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	37	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-butyl ether (MTBE)	20	1 U	1 U	1 U	1 U	1 U	1 U
Dissolved Metals (µg/l)							
Lead	8.1	1 U	1 U	1 U	1 U	--	--
Total Metals (µg/l)							
Lead	--	**1.18**	**1.14**	**1.59**	1 U	1 U	--

Notes:

A summary of the development of groundwater cleanup levels is presented in Table 6 and are based on the protection of marine surface water.

Bold Detected result

J Estimated value

U Compound analyzed, but not detected above detection limit

Table 4
RI Soil Vapor Sampling Results

Analyte	Location ID	BH-36	BH-39
	Sample Name	BH-36-SV	BH-39-SV
	Sample Date	6/17/2011	6/16/2011
	Sample Depth	4.5 - 4.5 ft	5 - 5 ft
Total Petroleum Hydrocarbons (µg/m3)	**Screening Level[1]**		
APH (C5-C8 Aliphatic)	270,000	**8,000**	**184**
APH (C8-C12 Aliphatic)	14,000[2]	**6,480**	135 U
APH (C8-C10 Aromatic)	18,000[3]	**2,800**	**160**
APH (C10-C12 Aromatic)	--	130 U	120 U
Volatile Organics (µg/m3)			
1,2-Dibromoethane (Ethylene dibromide)	1.1	8.9 U	8.3 U
1,2-Dichloroethane	9.6	4.7 U	4.4 U
Benzene	32	**93**	**11**
Ethylbenzene	46,000	**300**	**25**
m,p-Xylene	4,600	**1,300**	**110**
Methyl tert-butyl ether (MTBE)	960	4.2 U	3.9 U
o-Xylene	4,600	**410**	**30**
Toluene	220,000	**1,400**	**150**
Total Xylene (U = 1/2)	--	**1,710**	**140**

Notes:

Totals are calculated as the sum of all detected results and 1/2 the undetected reporting limit. If all are undetected results, the highest reporting limit value is reported as the sum.

1 Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State, Table B-1

2 Criteria is for C9-C12 fraction but analytical data included C8 range therefore the concentration is a conservative value

3 Criteria is for C9-C10 fraction but analytical data included C8 range therefore the concentration is a conservative value

Bold Detected result

N Normal Field Sample

U Compound analyzed, but not detected above detection limit

Detected concentration is greater than screening level

Non-detected concentration is above screening level

Table 5
Soil Cleanup Levels

Analyte	Soil Cleanup Level[1]	Protection of Surface Water[2] Soil-Unsaturated[3]	Site-Specific TPH Cleanup Level[4]
Total Petroleum Hydrocarbons (mg/kg)			
Gasoline Range Hydrocarbons	NA	--	--
Diesel Range Hydrocarbons	NA	--	--
Residual Range Hydrocarbons	NA	--	--
TPH (site-specific)	2,724	--	2,724
Volatile Organics (mg/kg)			
Benzene	0.13	0.13	--
Ethylbenzene	18.1	18.1	--
Toluene	109	109	--
Xylenes, total	NA	--	--
Metals (mg/kg)			
Lead	1,620	1,620	--

Notes:

1 Proposed cleanup levels are based on the most stringent applicable criteria

2 All Cleanup Level criteria were researched from Ecology 's CLARC Database on 2/9/2012

3 Soil cleanup levels protective of surface water calculated using MTCA equation 747-1 for unsaturated (vadose zone) soils.

4 A site-specific TPH celanup level was calculated using the CLARC TPH Workbook (MTCATPH11.1.xls)

MTCA= Model Toxics Control Act

mg/kg= milligram per kilogram

"--" means research has not been conducted and no value exists in the database for this parameter.

NA means no criteria is applicable for this parameter

Table 6
Groundwater Cleanup Levels

Analyte	Groundwater Cleanup Level[1] (µg/L)	Surface Water Criteria (Aquatic)[2]			Surface Water Criteria (Human Health)[2]		
		WAC 173-201A (µg/L)	Clean Water Act Section 304 (µg/L)	National Toxics Rule, 40 CFR 131 (µg/L)	MTCA Method B Surface Water Criteria (µg/L)	Clean Water Act Section 304 (µg/L)	National Toxics Rule, 40 CFR 131 (µg/L)
Total Petroleum Hydrocarbons (µg/l)							
Gasoline Range Hydrocarbons	NA	--	--	--	--	--	--
Diesel Range Hydrocarbons	NA	--	--	--	--	--	--
Residual Range Hydrocarbons	NA	--	--	--	--	--	--
Volatile Organics (µg/l)							
Benzene	23	--	--	--	23	51	71
Ethylbenzene	2,100	--	--	--	6,900	2,100	29,000
Toluene	15,000	--	--	--	19,000	15,000	200,000
Xylenes, total	NA	--	--	--	--	--	--
Dissolved Metals (µg/l)							
Lead	8.1	8.1	8.1	8.1	--	--	--

Notes:

1 Groundwater cleanup level based on protection of marine surface water and selected value is most stringent of applicable marine surface water criteria.

2 All values were researched from Ecology 's CLARC Database on 2/9/2012

MTCA= Model Toxics Control Act

WAC= Washington Administrative Code

CFR = Code of Federal Regulations

"--" Indicates surface water criteria is not available.

µg/L = micrograms per Liter

NA means no criteria is applicable for this parameter

Table 7
Remediation Alternatives Estimated Costs

Alternative 1 - Soil Removal and Off-site Disposal						
Items		**Unit Description and Quantity**			**Cost per Unit**	**Cost per Item**
1	Removal of existing concrete sidewalk	Existing Concrete (cy)	40	**1**	$10.0	$400
2	Hauling and disposal of removed concrete	Haul and dispose concrete (tons)	81	**2**	$40.0	$3,240
3	Excavation of soil	Soil w/ side slopes (tons)	1020.938	**3**	$15.0	$15,314
4	Hauling and disposal of dry contaminated soil	dry contaminated soil (tons)	255.2344	**4**	$60.0	$15,314
5	Hauling and disposal of wet contaminated soil	wet contaminated soil (tons)	765.7031	**5**	$70.0	$53,599
6	Confirmation Sample Collection and testing	Bulk Samples (each)	10	**6**	$400.0	$4,000
7	Compacted backfill	Soil Volume w/ side slopes (tons)	1225.125	**7**	$25.0	$30,628
8	Replacement of concrete sidewalk	Replacement of Concrete (sf)	2110	**8**	$7.2	$15,192
9	Replacement of lawn	Replacement of lawn (sf)	1500	**9**	$2.0	$3,000
10	Mobilization/Demobilization	2 excavators and compt. Equip (total)	1	**10**	$5,000.0	$5,000
11	Site Preparation, Staging/Stockpile Area Mangement, TESC	Site dimensions (sy)	3333.333	**11**	$1.5	$5,000
12	Construction Oversight	One week of oversight (hrs)	50	**12**	$140.0	$7,000
13	**Subtotal**			**13**		**$157,687**
14	Contingency	percent	30%	**14**		$47,306
15	**Total Cost**			**15**		**$204,994**

Notes:

cy-= cubic yard

sf= square feet

sy= square yard

hrs= hours

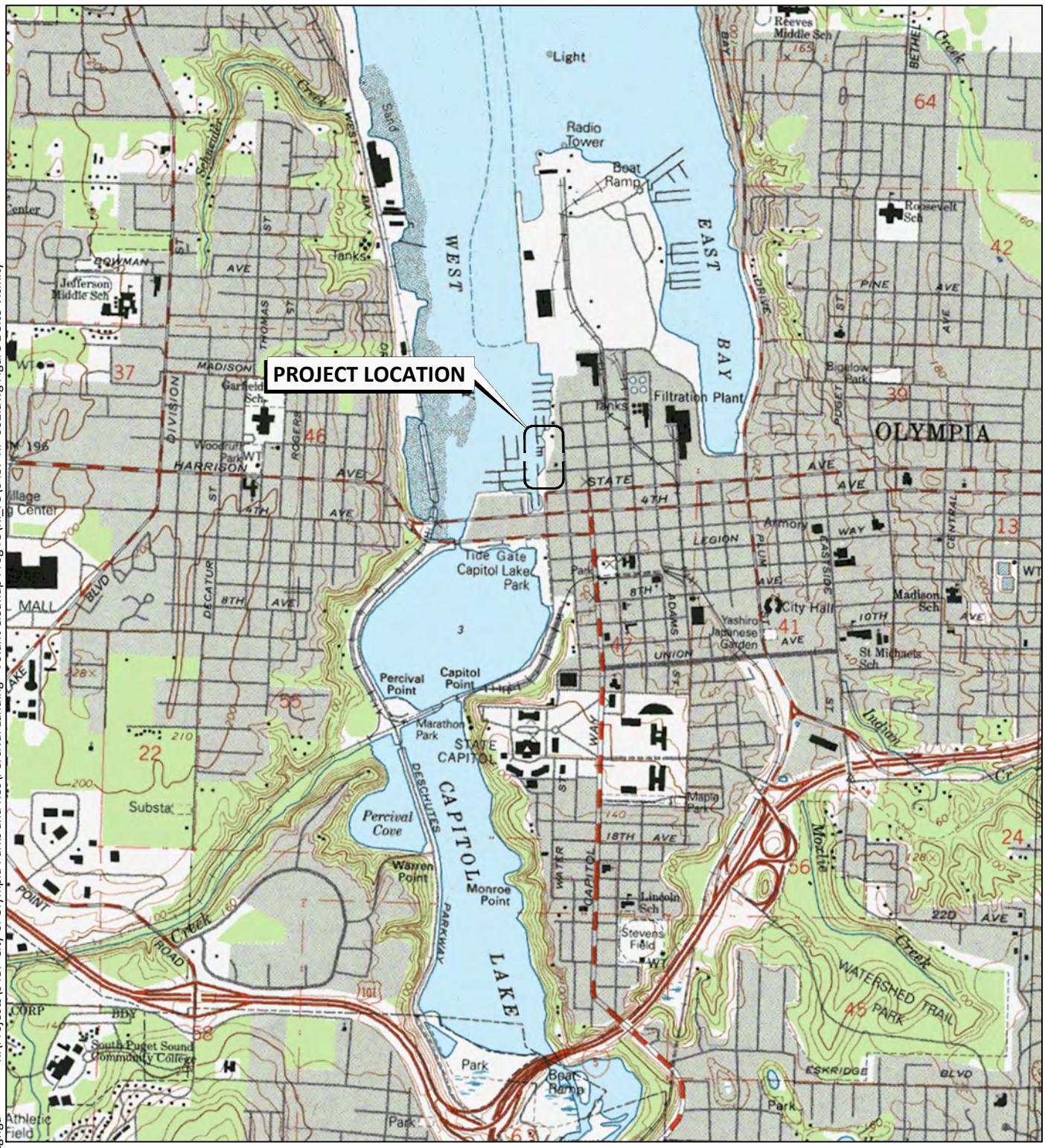
Design and cleanup reporting costs are not included

Alternative 2 - Institutional Control Costs			
Items	**Cost per hour**	**Number of Hours**	
Legal Fees	$ 300.00	8	$2,400.00
Consultant Fees	$ 155.00	10	$1,550.00
Miscellaneous Fees	--	--	$1,000.00
Total Cost			**$4,950.00**

Notes:

Reporting costs are not included

FIGURES



K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-002.dwg Figure 1 Site Vicinity

Apr 09, 2012 3:07pm tgriga

SOURCE: Base map prepared from Terrain Navigator Pro
USGS 7.5 minute quadrangle map(s) of Tumwater, WA.

Figure 1
Site Vicinity
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

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Harbor House Building
Unocal Keylocks for Pumps and Regular and Diesel
Unocal 3,800 gal Gasoline and Diesel USTs
Unocal 430 gal Waste Oil UST
ASTs
Unocal USTs
Unocal 6,300 gal Heavy Oil UST
Unocal Underground Product Lines
UST
Existing 30" Sewer Main
Excavated Unocal Pipelines
DNR Lease Boundary
Unocal Underground Product Lines
Union Oil Dock
Unocal USTs
Unocal ASTs
Unocal 2,000 gal UST
Pipeline Portion Not Removed
COLUMBIA STREET
OLYMPIA AVENUE
PUBLIC PLACE
CAPITOL WATERWAY LINE
INNER HARBOR LINE
MEANDER LINE
BOARDWALK
TOP OF SLOPE
TOE OF SLOPE
MARINA DOCK
FLOAT
ROW
VACATED ORDINANCE #1764
VACATED ORDINANCE #1639
THE WINE LOFT M.G. BURGHER & ASSOCIATES TP#78509800000

NOTE: UNOCAL location data from 1995 Geo Engineers figure.
SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.
HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.
VERTICAL DATUM: National Ocean Service Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

- Former Unocal and Hulco Property RI-FS Study Area
- Approximate Location of Historical Features
- Historic Hulco Property Boundary
- Historic Unocal Property Boundary
- DNC Lease Boundary

0 40
Scale in Feet

Aug 29, 2012 3:40pm tgriga K:\Projects\0487-City Of Olympia Parks And Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-003.dwg Figure 2 Current and Historical Property Boundaries and Features

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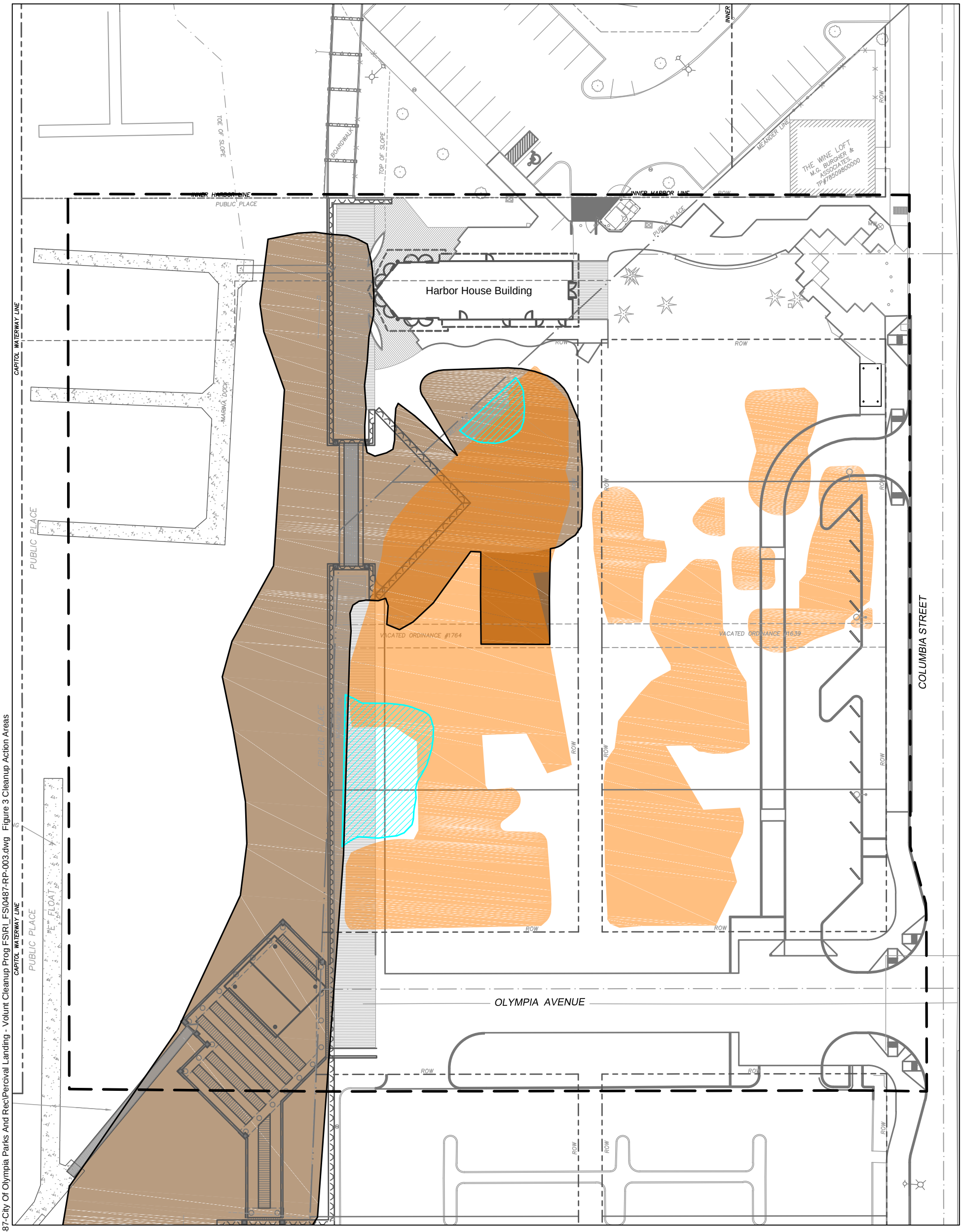
Figure 2
Current and Historical Property Boundaries and Features
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property



NOTE: UNOCAL location data from 1995 Geo Engineers figure.
SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.
HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.
VERTICAL DATUM: National Ocean Service Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

- Former Unocal and Hulco Property RI-FS Study Area
- Approximate Location of 1995 Excavation Areas
- Approximate Location of 2001 Excavation Areas
- 2011 Excavation Area

0 40
Scale in Feet

Aug 29, 2012 3:40pm tgriga K:\Projects\0487-City Of Olympia Parks And Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-003.dwg Figure 3 Cleanup Action Areas

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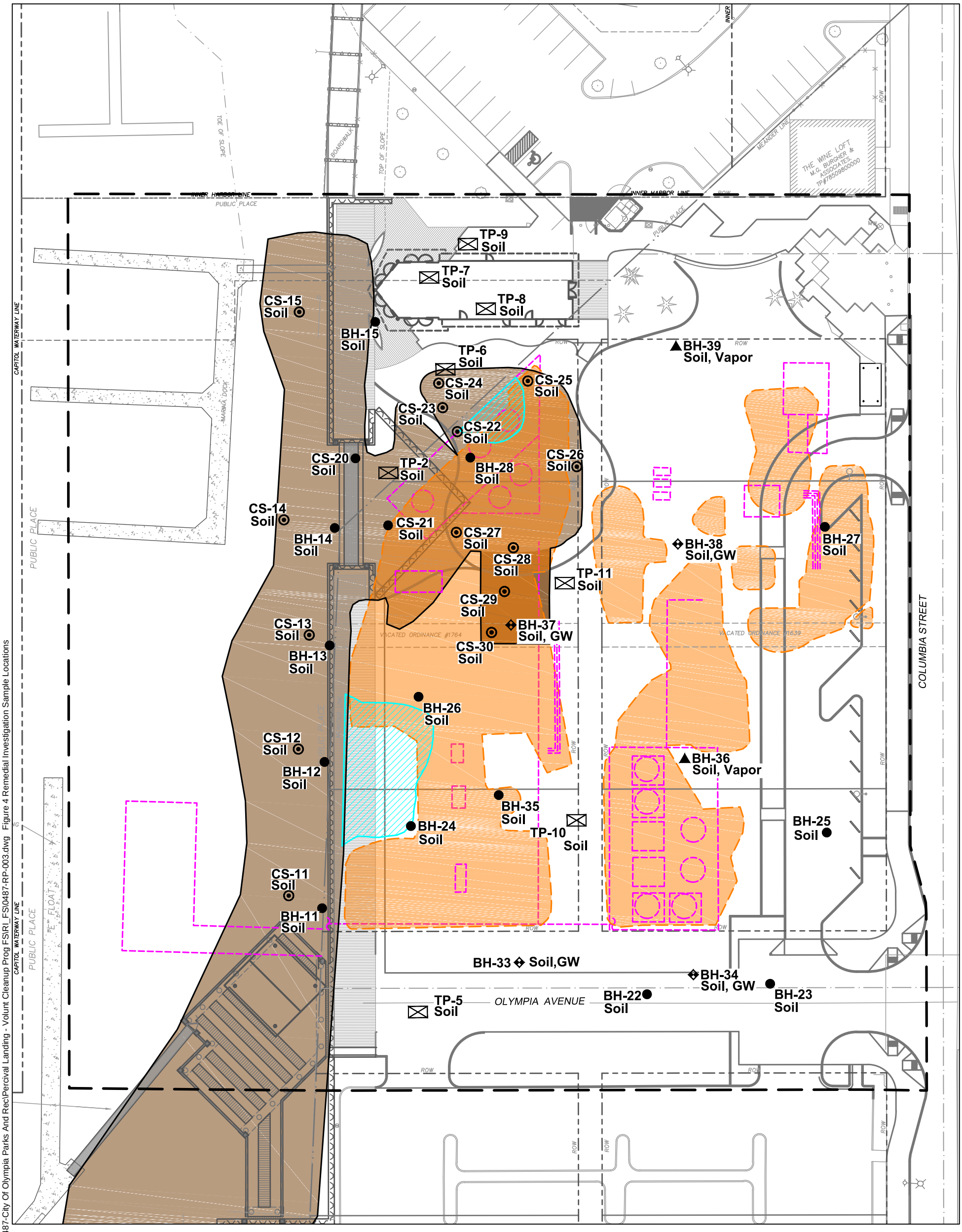
Figure 3
Cleanup Action Areas
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property



SOURCE: Percival Landing Major Rehabilitation QA25, Section A, Phase 1, Construction Drawings, dated 8/02/10.
HORIZONTAL DATUM: Washington State Plane, South, NAD 83/96 CORS.
VERTICAL DATUM: National Ocean Service Mean Lower Low Water (MLLW), 1983-2001 Epoch.

LEGEND:

- BH-11 ● Geoprobe (Soil)
- BH-34 ❖ Geoprobe (Soil and Groundwater)
- BH-36 ▲ Geoprobe (Soil and Soil Vapor)
- TP-2 ⊠ Test Pit
- CS-11 ⊙ Confirmation Sample Location
- Former Unocal and Hulco Property RI-FS Study Area
- Approximate Location of Historical Features
- Approximate Location of 1995 Excavation Areas
- Approximate Location of 2001 Excavation Areas
- 2011 Excavation Area

0 40
Scale in Feet

Aug 29, 2012 3:41pm tgriga K:\Projects\0487-City Of Olympia Parks And Rec\Percival Landing - Volunt Cleanup Prog FS\RI_FS\0487-RP-003.dwg Figure 4 Remedial Investigation Sample Locations

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Figure 4
Remedial Investigation Sample Locations
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

Locations Above MTCA Method A*

Exceeds GRO
Exceeds DRO/ORO
Non-detect
Location excavated after sampling
Historical Features
1995 Excavation Areas
2001 Excavation Areas
2011 Excavation Area
New Paved Areas
Approximate Site Boundary

TP-9
TP-7
TP-8
BH-15
CS-15
BH-39
TP-6
CS-25
CS-24
CS-23
CS-22
CS-20
BH-28
CS-26
TP-2
BH-27
BH-14
CS-14
CS-21
CS-27
BH-38
CS-28
TP-11
CS-29
BH-37
CS-30
CS-13
BH-13
BH-26
BH-36
120 mg/kg GRO
5-10 feet
BH-24
2,159 mg/kg DRO
10-15 feet
CS-12
BH-12
BH-35
TP-10
BH-25
CS-11
BH-11
BH-33
BH-34
BH-23
BH-22
TP-5
116 mg/kg GRO

NOTES
Locations shown were sampled between 9/27/10 and 7/20/11.
Only results that exceed MTCA cleaup levels are presented.

***MTCA Method A Cleanup Levels**

TPH Gasoline:
100 mg/kg.

TPH Diesel and Oil:
2,000 mg/kg.

Q:\Jobs\100487-01_Percival_Landing_CM_Support\Maps\2012_04\Sample Locations with MTCA Exceedance 11X17.mxd tgriga 8/29/2012 3:47:56 PM

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Feet
0 40 80

Figure 5
Soil Sample Locations with MTCA Method A Cleanup Level Exceedances
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

Groundwater Samples
New Paved Areas
Historical Features
1995 Excavation Areas
2001 Excavation Areas
2011 Excavation Area
Approximate Site Boundary
Historical Compliance Monitoring Well (GeoEng 2002, approx.)

MW-15

MW-13a

BH-37

BH-38
Benzene: 0.15 µg/l
Toluene: 3.89 µg/l
Total Xylenes: 1.93 µg/l

BH-33
Benzene: 0.15 µg/l
Toluene: 0.63 µg/l

BH-34
Toluene: 0.51 µg/l

NOTES
Locations shown were sampled in June 2011.
Groundwater concentrations were compared to marine surface water criteria.

Q:\Jobs\100487-01_Percival_Landing_CM_SupportMaps\2012_04\Groundwater Samples.mxd tgriga 8/29/2012 3:53:31 PM

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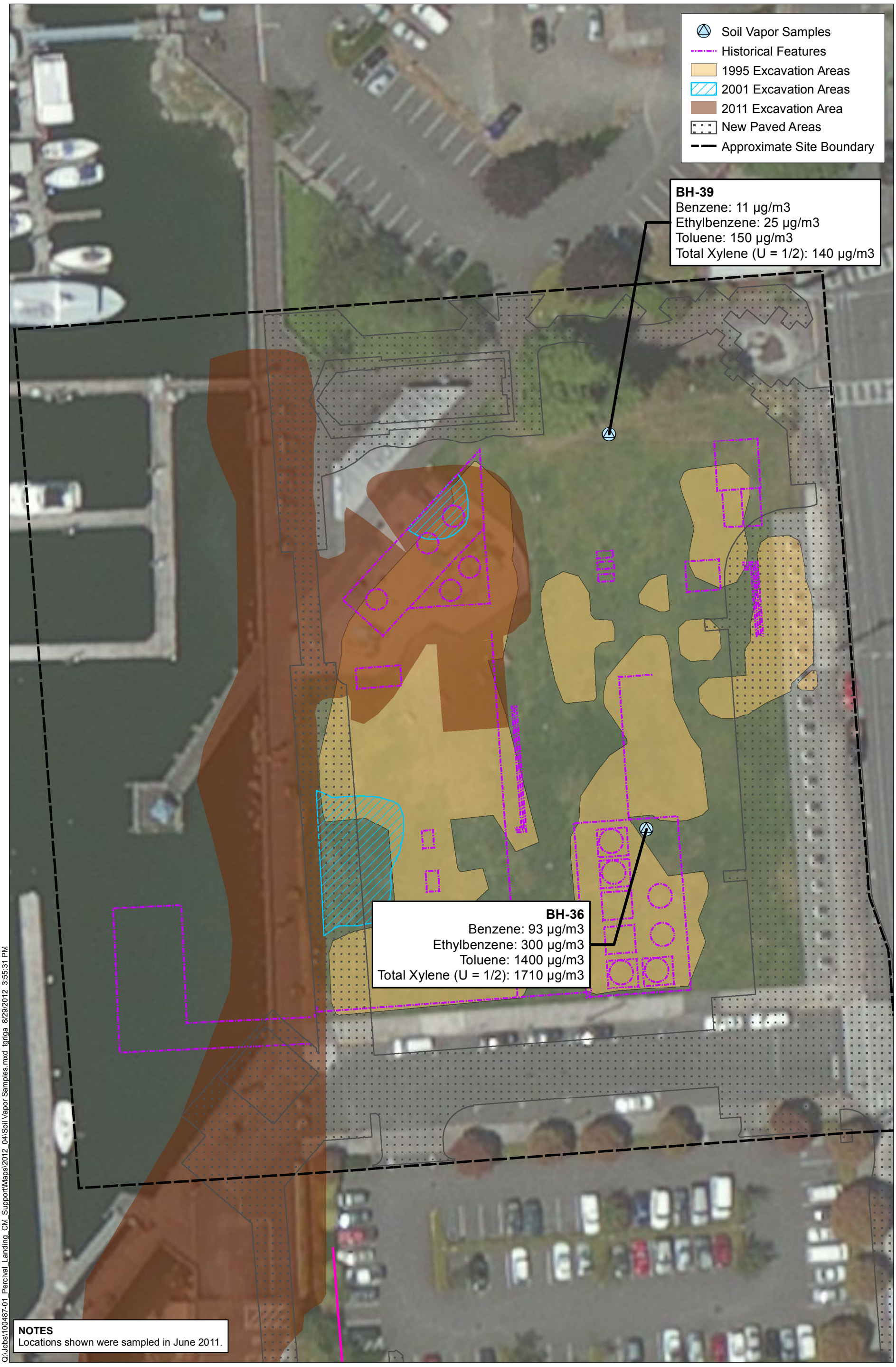
Feet
0 40 80

Figure 6
Groundwater VOC Concentrations
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property



ANCHOR QEA

Feet
0 40 80

Figure 7
Soil Vapor VOC Concentrations
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

K:\Projects\0487-City of Olympia Parks and Rec\Percival Landing - Volunt Cleanup Prog FSIRI_FSI0487-RP-003.dwg Figure 8 Conceptual Site Model

Aug 29, 2012 3:41pm tgriga

AERIAL: Aerial Images NW, March 2012
NOT TO SCALE

LEGEND:

Approximate Sheet Pile Wall Location

ANCHOR QEA

Figure 8
Conceptual Site Model
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

Washington State Department of Ecology
Toxics Cleanup Program

Terrestrial Ecological Evaluation Process - Primary Exclusions

Documentation Form

Exclusion #	Exclusion Detail	Yes or No?	Are Institutional Controls Required If The Exclusion Applies?
1	Will soil contamination be located at least 6 feet beneath the ground surface and less than 15 feet?	(Yes) / No	Yes
	Will soil contamination located at least 15 feet beneath the ground surface?	Yes / (No)	No
	Will soil contamination located below the conditional point of compliance?	(Yes) / No	Yes
2	Will soil contamination be covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed?	(Yes) / No	Yes
3	Is there less than 1.5 acres of contiguous undeveloped land on the site, or within 500 feet of any area of the site affected by hazardous substances **other than** those listed in the table of Hazardous Substances of Concern? And Is there less than 0.25 acres of contiguous undeveloped land on or within 500 feet of any area of the site affected by hazardous substances **listed in** the table of Hazardous Substances of Concern?	(Yes) / No (Yes) / No	Other factors determine
4	Are concentrations of hazardous substances in the soil less than or equal to natural background concentrations of those substances at the point of compliance	Yes / (No)	No

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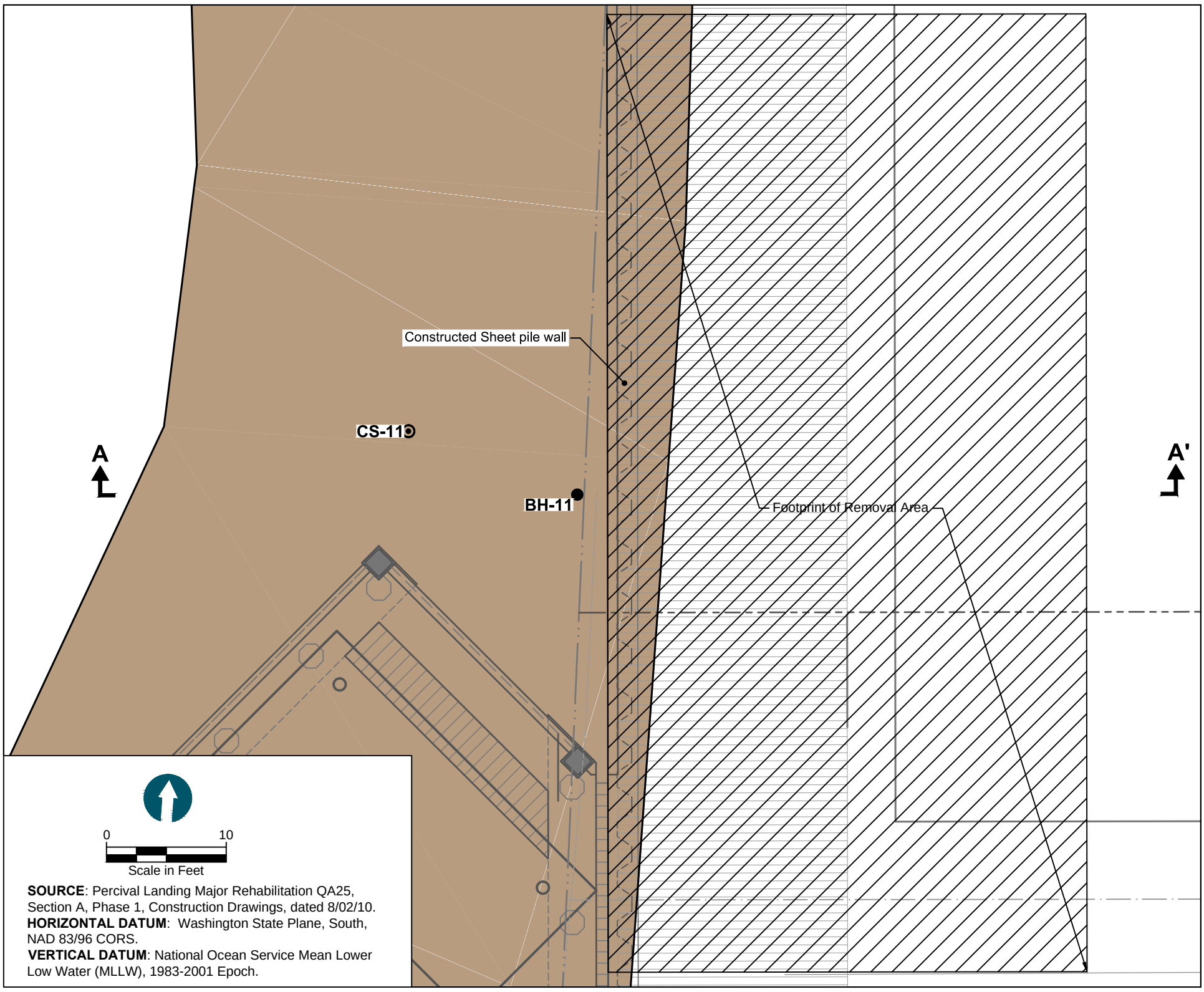
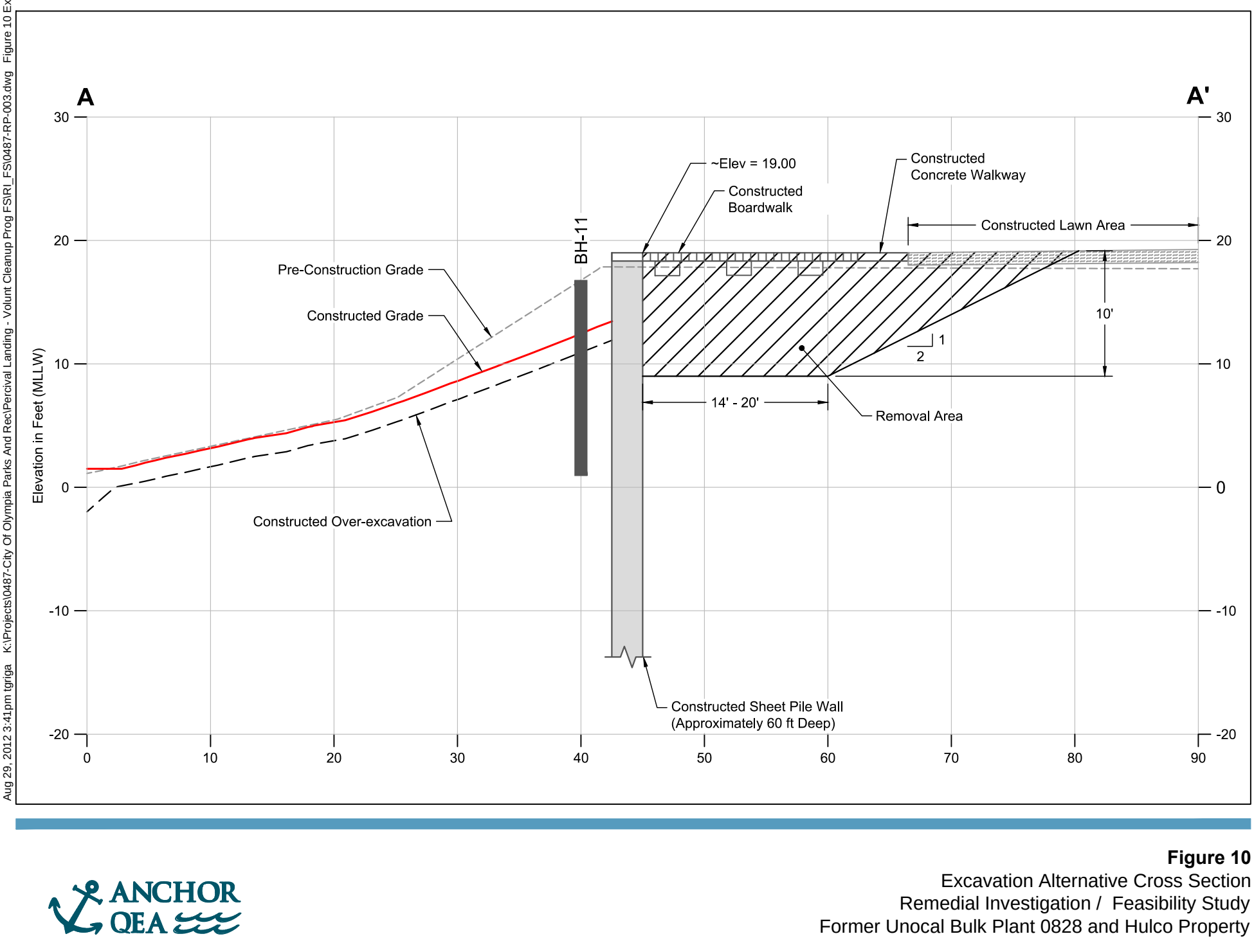
Figure 9
Terrestrial Ecological Evaluation
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property





Aug 29, 2012 3:41pm tgriga K:\Projects\0487-City Of Olympia Parks And Rec\Percival Landing - Volunt Cleanup Prog FSRI_FS\0487-RP-003.dwg Figure 10 Excavation Alternative Cross Section

Figure 10
Excavation Alternative Cross Section
Remedial Investigation / Feasibility Study
Former Unocal Bulk Plant 0828 and Hulco Property

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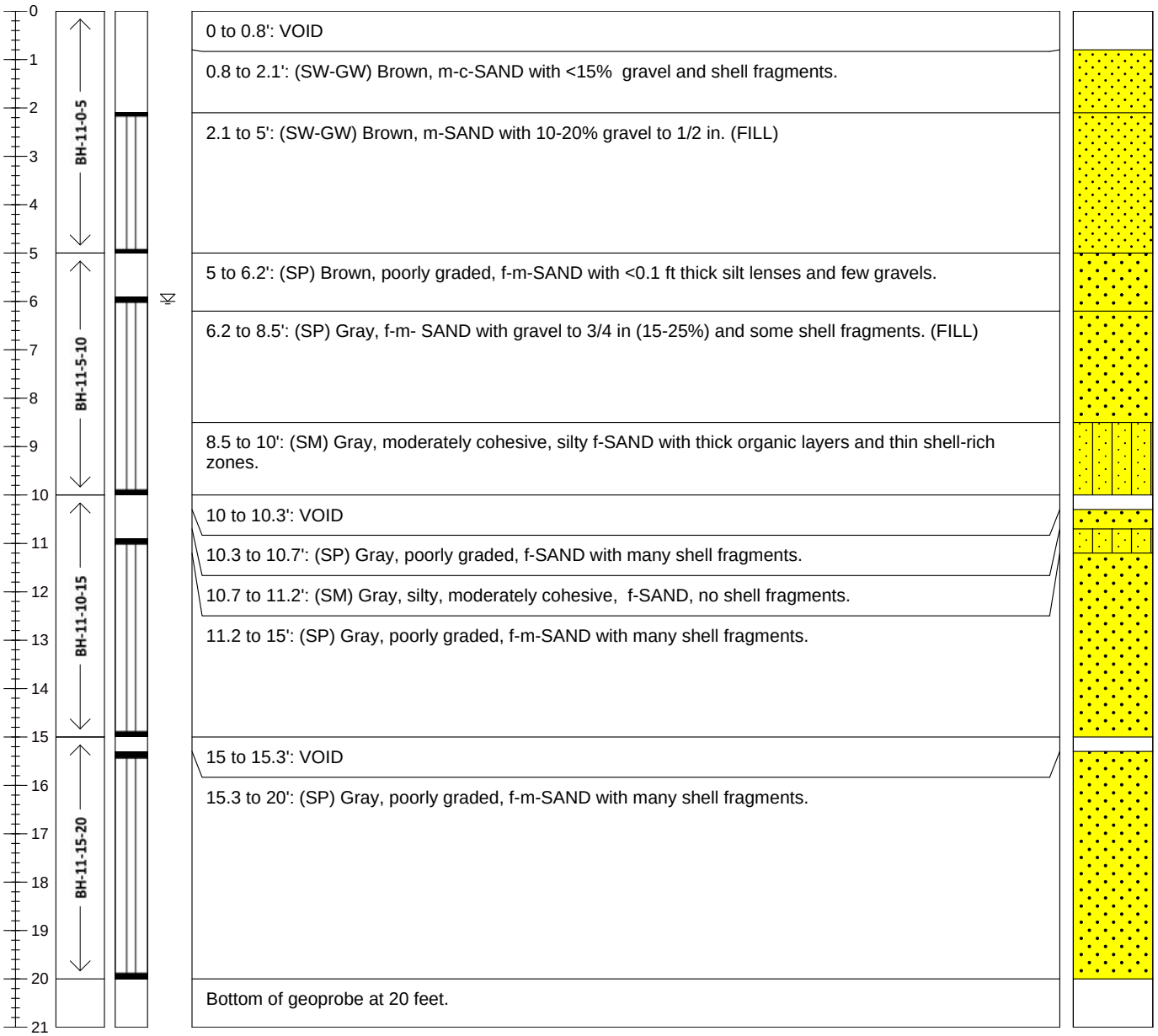
APPENDIX A
SOIL GEOPROBE BORING LOGS

Geoprobe

BH-11

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633891.73** Easting: **1041137.06**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/27/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		



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Geoprobe
BH-12

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633953.42** Easting: **1041133.76**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/28/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-12-0-5			0 to 1.4': VOID 1.4 to 2.2': (SW) Brown, well graded, f-c-SAND. (FILL) 2.2 to 5.9': VOID	
5 to 10	BH-12-5-10			5.9 to 6': (SP-SM) Brown to gray brown, moderately poorly graded, f-SAND with trace to some silt and few shells. 6 to 10': (SP-SM) Gray to dark gray, poorly graded, f-SAND with some silt, occasional thin silt layers, and some shell rich zones.	
10 to 15	BH-12-10-15			10 to 10.4': VOID 10.4 to 15': (SP-SM) Gray to dark gray, poorly graded, f-SAND with some silt, occasional thin silt layers, and some shell rich zones.	
15 to 20	BH-12-15-20			15 to 15.4': VOID 15.4 to 20': (SP-SM) Gray to dark gray, poorly graded, f-SAND with some silt, occasional thin silt layers, and some shell rich zones.	
				Bottom of geoprobe at 20 feet.	

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Geoprobe

BH-13

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **634002.69** Easting: **1041132.50**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/28/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-13-0-5			0 to 0.8': (SM-ML) Sandy SILT and silty sand with organic material. (TOPSOIL) 0.8 to 2': (SW) Brown, well graded, f-c-SAND with few small gravels. (FILL) 2 to 5': (SP) Brown to gray brown, poorly graded, f-SAND with trace silt and few shells.	
5 to 10	BH-13-5-10		▽	5 to 6.3': VOID 6.3 to 6.5': (SP) Brown to gray brown, poorly graded, f-SAND with trace silt and few shells. 6.5 to 10': (SP) Saturated, gray, poorly graded, f-SAND with <5% silt, few f- gravels, and few f- shells.	
10 to 15	BH-13-10-15			10 to 10.3': VOID 10.3 to 12.6': (SP) Saturated, gray, poorly graded, f-SAND with <5% silt, few f- gravels, and few f- shells. 12.6 to 15': (SP) Dark gray, poorly graded SAND with <5% silt, few f- gravels, many shells, and some organic material.	
15 to 20	BH-13-15-20			15 to 15.6': VOID 15.6 to 20': (SP) Dark gray, poorly graded SAND with <5% silt, few f- gravels, many shells, and some organic material.	
				Bottom of geoprobe at 20 feet.	

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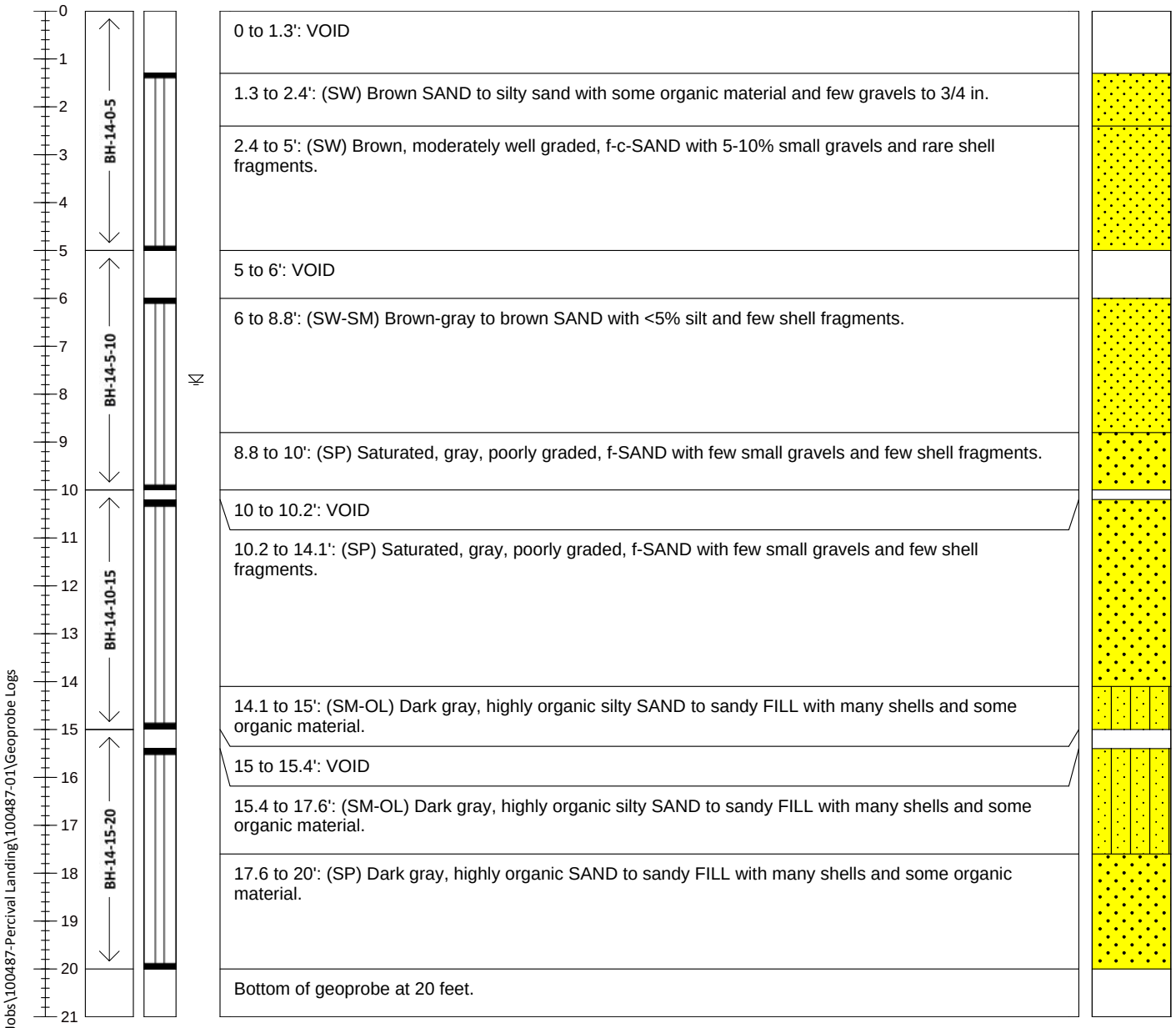
Geoprobe
BH-14

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **634052.31** Easting: **1041131.17**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/28/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		



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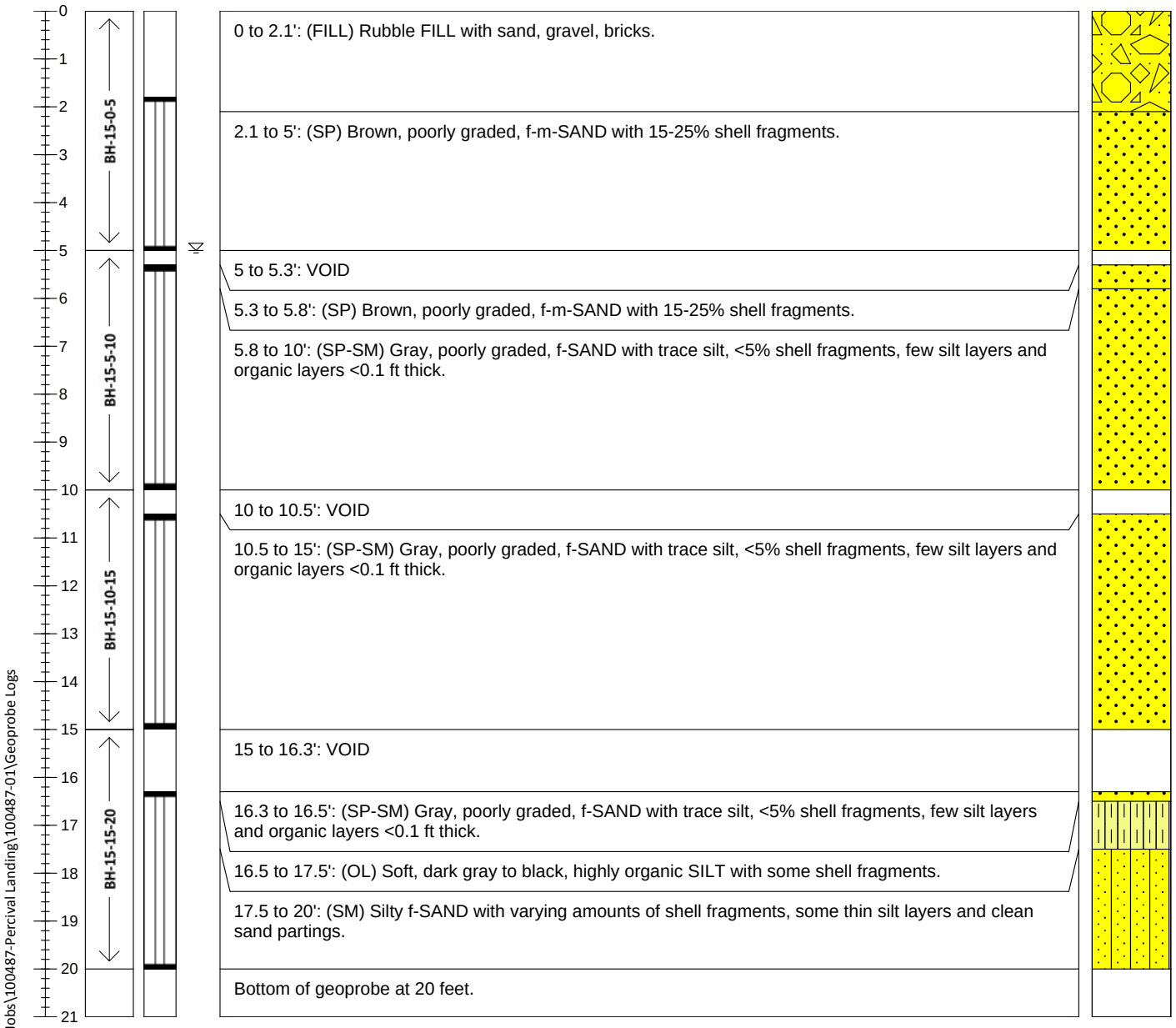
Geoprobe
BH-15

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **634140.34** Easting: **634140.34**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **9/28/10**		Logged By: **CW**
Contractor: **Pacific Soil and Water**		



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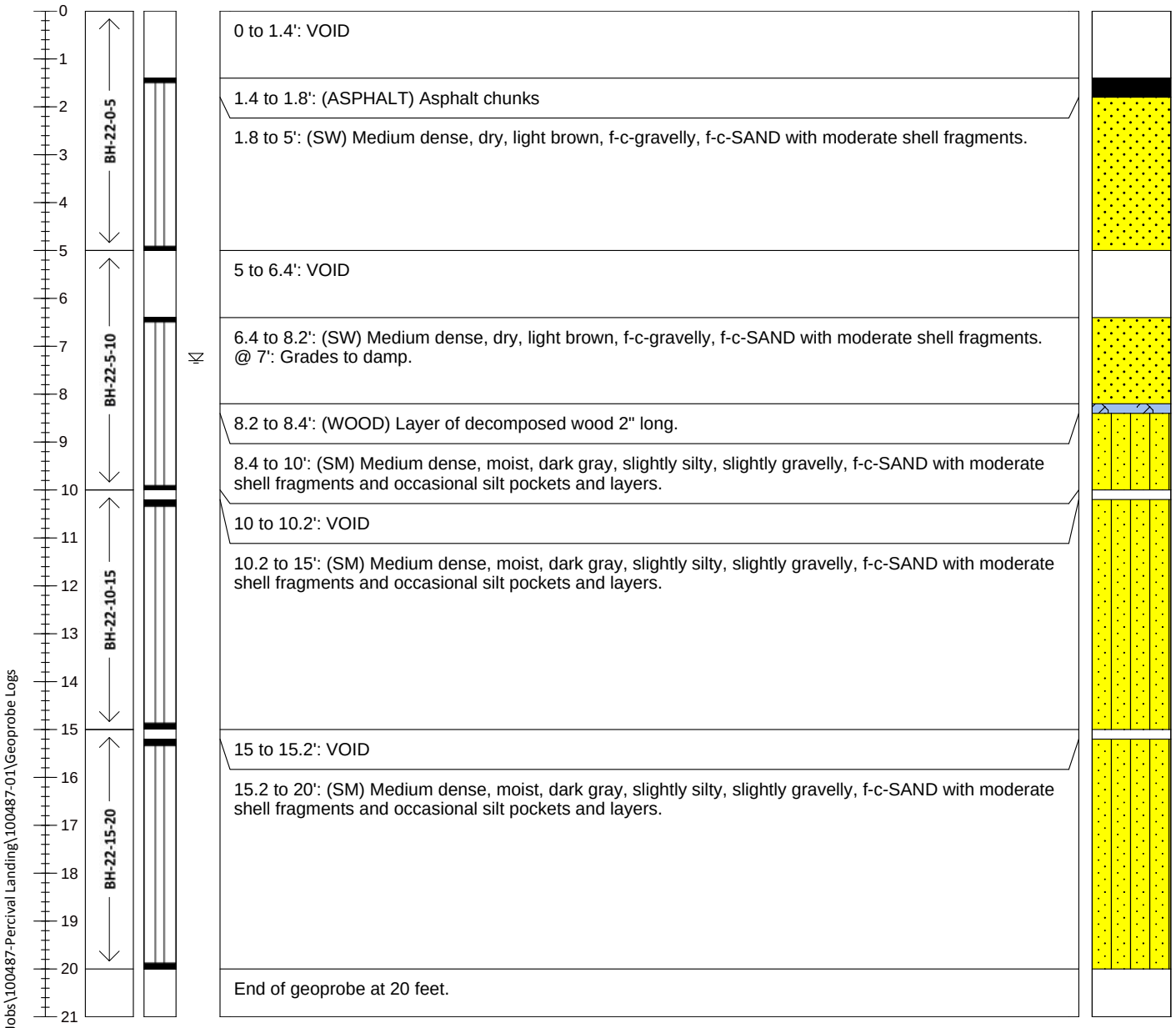
Geoprobe
BH-22

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633865.04** Easting: **1041276.46**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		



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Geoprobe
BH-23

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633873.09** Easting: **1041328.02**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/8/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-23-0-5			0 to 0.3': VOID 0.3 to 1.3': (ASPHALT) Asphalt chunks. 1.3 to 5': (SW) Medium dense, dry, light brown, f-c gravelly, f-c-SAND with occasional shell fragments.	
5 to 10	BH-23-5-10		▽	5 to 5.2': VOID 5.2 to 8': (SW) Medium dense, dry, light brown, f-c gravelly, f-c-SAND with occasional shell fragments. @ 6.4': Grades to damp. 8 to 10': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and wood debris.	
10 to 15	BH-23-10-15			10 to 10.5': VOID 10.5 to 15': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and wood debris.	
15 to 20	BH-23-15-20			15 to 15.3': VOID 15.3 to 20': (SM) Medium dense, moist, dark gray, slightly silty, slightly f-gravelly, f-c-SAND with occasional shell fragments and wood debris. @ 16.6': Grades to medium stiff, moist, olive gray, SILT with occasional decomposed wood debris. @ 18.1': 1/2" layer of f-SAND. End of geoprobe at 20 feet.	

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Geoprobe
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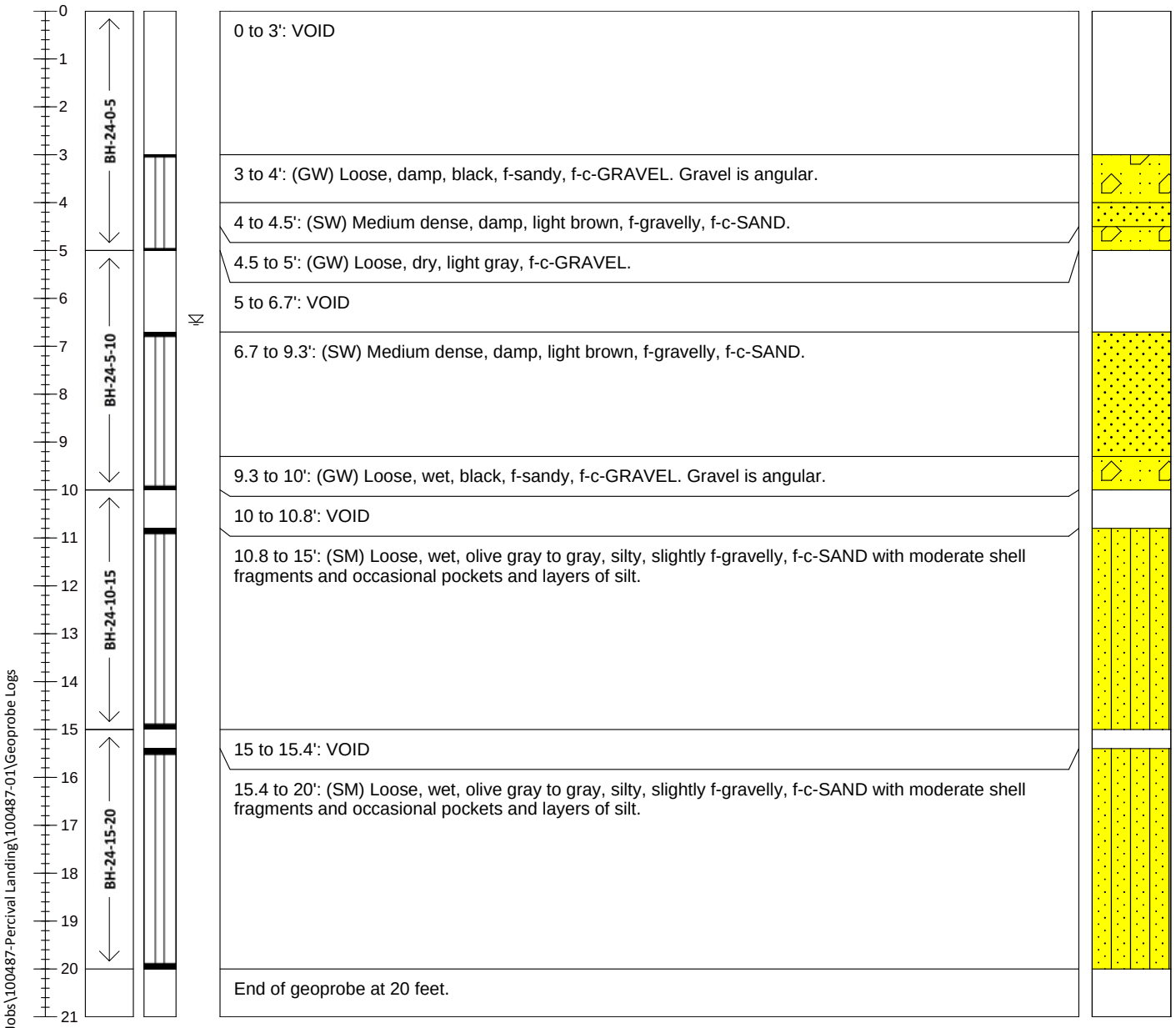
Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633928.97** Easting: **1041172.05**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		



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Geoprobe
BH-25

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633938.49** Easting: **1041347.40**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
	BH-25-0-5			0 to 1.1': VOID	
				1.1 to 1.4': (OL) Loose, damp, brown, SILT with abundant organics (grass).	
				1.4 to 1.8': (GW) Loose, damp, dark brown, f-sandy, f-GRAVEL.	
				1.8 to 2.1': (SW) Medium dense, damp, light brown, gravelly (f), f-c-SAND.	
				2.1 to 2.7': (ML) Medium stiff, damp, dark brown, slightly f-sandy SILT.	
				2.7 to 5': (SW) Medium dense, damp, light brown, f-gravelly, f-c-SAND.	
	BH-25-5-10			5 to 5.2': VOID	
				5.2 to 8.2': (SW) Medium dense, damp, light brown, f-gravelly, f-c-SAND with moderate shell fragments. @ 6.2': Grades to moist.	
			▽	8.2 to 10': (SM) Medium dense, moist to wet, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional pockets and layers of silt.	
	BH-25-10-15			10 to 10.5': VOID	
				10.5 to 16': (SM) Medium dense, moist to wet, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional pockets and layers of silt.	
				16 to 16.5': (ML) Layer of medium stiff, moist, olive gray SILT.	
	BH-25-15-20			16.5 to 20': (SM) Medium dense, moist to wet, dark gray, slightly silty, f-c-SAND with moderate shell fragments and occasional pockets and layers of silt.	
				End of geoprobe at 20 feet.	

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

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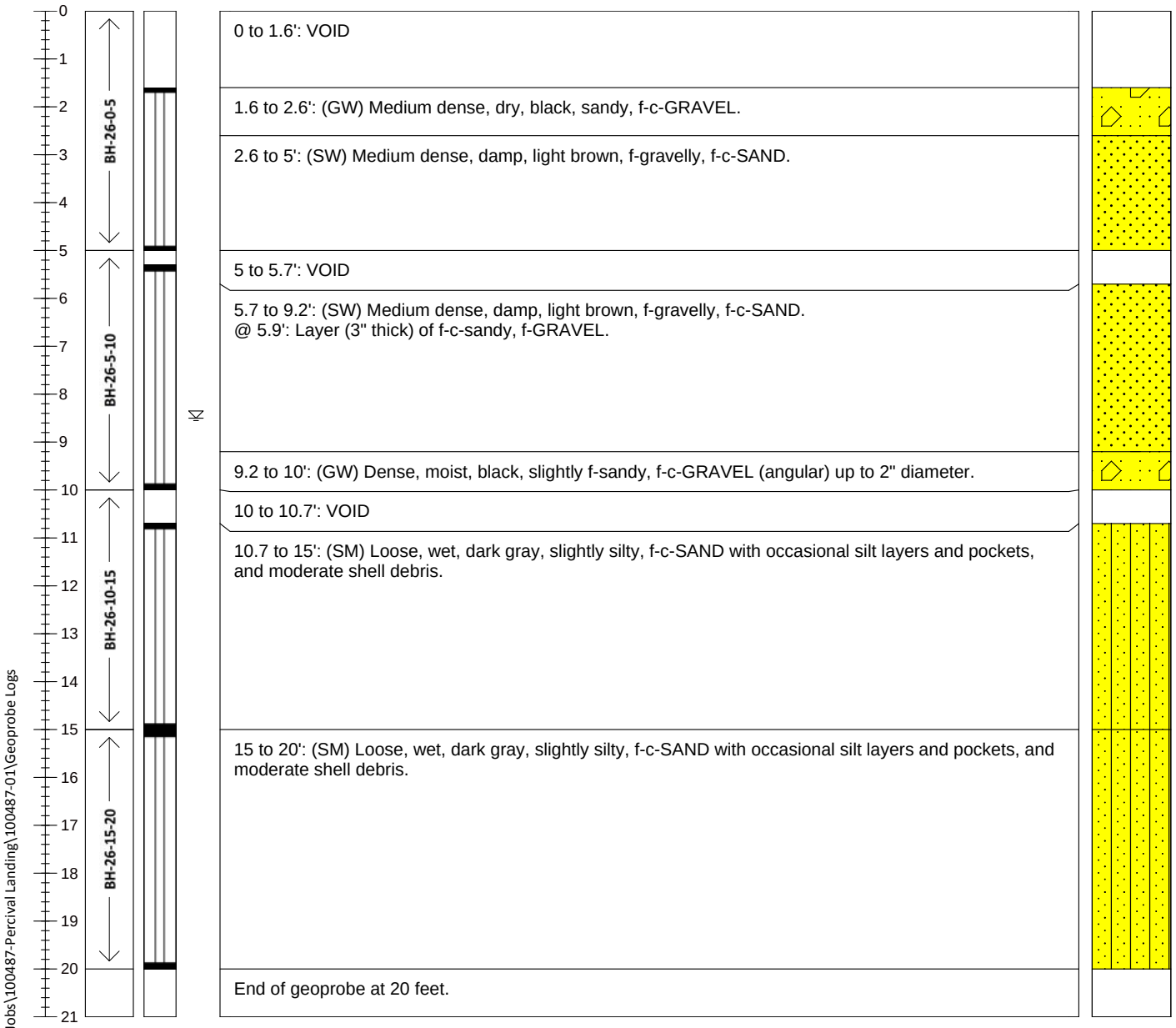
Geoprobe
BH-26

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **633983.66** Easting: **1041171.46**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		



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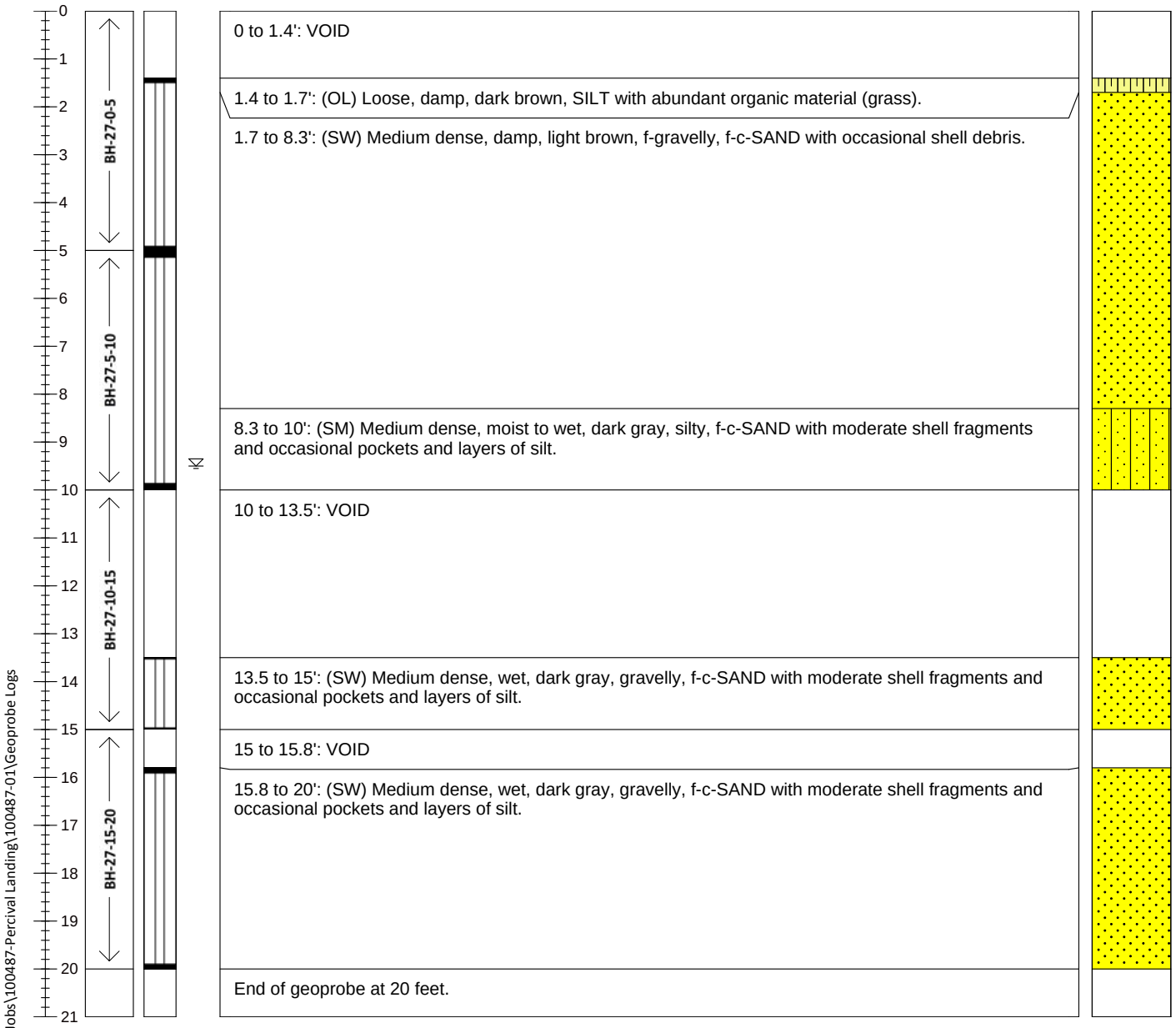
Geoprobe
BH-27

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **634067.22** Easting: **1041337.59**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		



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Geoprobe
BH-28

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Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID: **Geoprobe**
Project #: **100487-01**	Northing: **634085.96** Easting: **1041186.21**	Tube Length (ft): **20.0**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20.0**
Collection Date: **11/9/10**		Logged By: **AC/JD**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-28-0-5			0 to 1.4': VOID 1.4 to 2.2': (WOOD) Wood chips/bark. 2.2 to 5': (SW) Medium dense, damp, light brown, f-gravelly, f-c-SAND.	
5 to 10	BH-28-5-10		▽	5 to 6.1': VOID 6.1 to 7.6': (SW) Medium dense, damp, light brown, f-gravelly, f-c-SAND. 7.6 to 8.5': (GW) Medium dense, moist, black, sandy, f-c-GRAVEL (angular). 8.5 to 10': (SM) Medium dense, moist, dark gray, slightly f-gravelly, slightly silty f-c-SAND with occasional shell fragments and moderate HC-like odor.	
10 to 15	BH-28-10-15			10 to 10.2': VOID 10.2 to 15': (SM) Medium dense, moist, dark gray, slightly f-gravelly, slightly silty, f-c-SAND with occasional shell fragments and moderate HC-like odor. @ 14': 2" rainbow sheen floret. @ 14.1 to 14.3': Layer of medium stiff, moist, olive gray, f-sandy SILT.	
15 to 20	BH-28-15-20			15 to 17.7': VOID 17.7 to 20': (SM) Medium dense, moist, dark gray, slightly f-gravelly, slightly silty f-c-SAND with occasional shell fragments and moderate HC-like odor.	
20 to 21				End of geoprobe at 20 feet.	

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Geoprobe
BH-33

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Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633874.70** Easting: **1041221.72**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-33-SO-0-5			0 to 1.5': VOID 1.5 to 1.9': (GP) Gravel (FILL) 1.9 to 5.0': (SW) Medium dense, dry, light brown, slightly f-gravelly, f-c SAND. Occasional shell fragments.	
5 to 10	BH-33-SO-5-10		▽	5 to 6.7': VOID 6.7 to 20': (SW) Medium dense, moist, light brown, slightly f-gravelly, f-c SAND. Occasional shell fragments. @ 7.7': (SW) Grades to dark gray, trace layers of medium stiff, moist, dark gray, SILT (ML).	
10 to 15	BH-33-SO-10-15				
15 to 20	BH-33-SO-15-20			Bottom of geoprobe at 20 feet.	

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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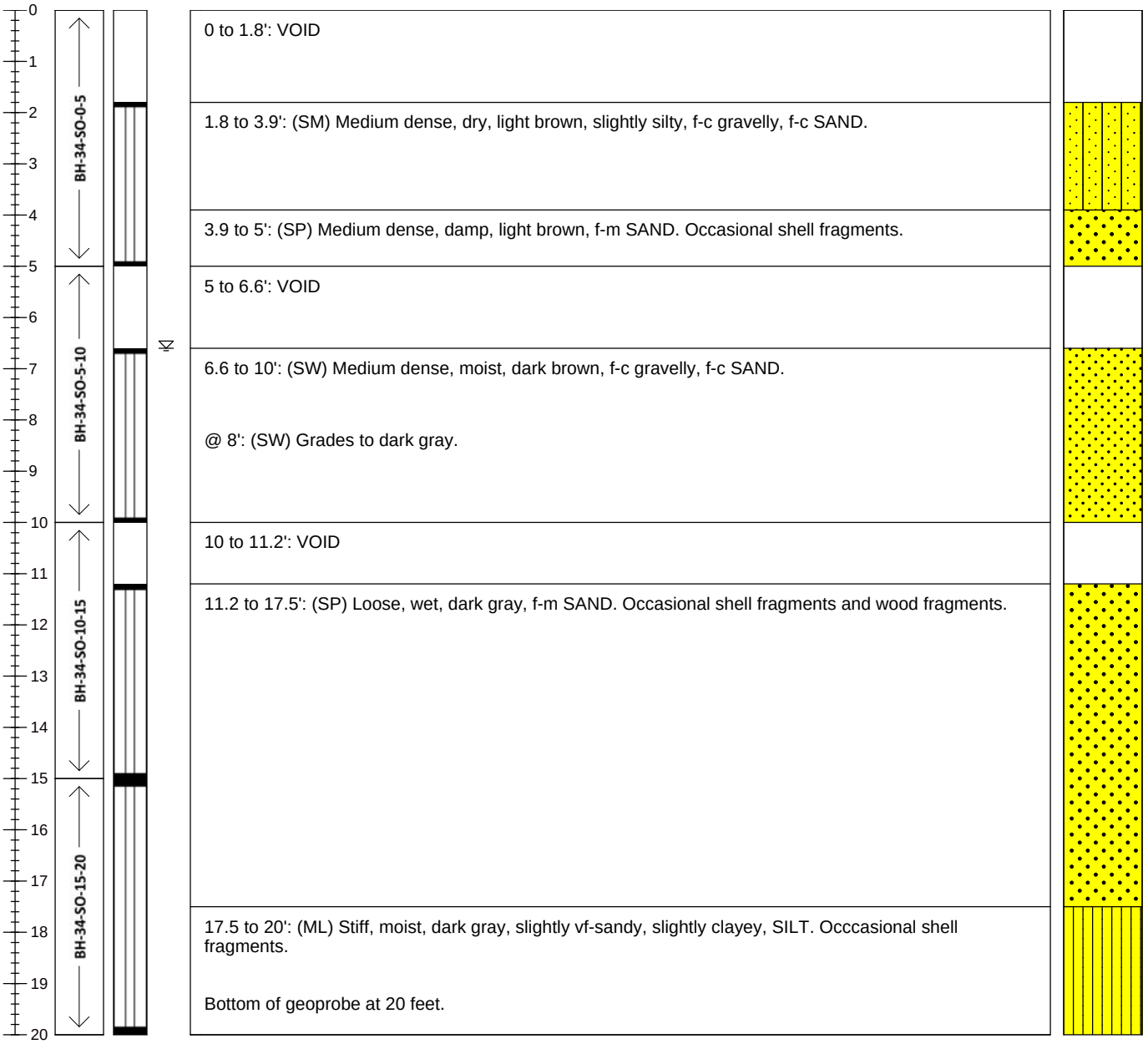
Note: Groundwater sample collected. Screen set 6-11 feet below ground surface.

Geoprobe
BH-34

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633874.65** Easting: **1041295.40**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-17-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		



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Note: Groundwater sample collected. Screen set 5-10 feet below ground surface.

Geoprobe
BH-35

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633944.61** Easting: **1041208.13**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0 to 5	BH-35-SO-0-5			0 to 0.4': VOID 0.4 to 1': (GP) Gravel (FILL) 1 to 5': (SM) Medium dense, dry, light brown, slightly silty, f-gravelly, f-c SAND.	
5 to 10	BH-35-SO-5-10		▽	5 to 6.8': VOID 6.8 to 7.4': (SM) Medium dense, dry, light brown, slightly silty, f-gravelly, f-c SAND. 7.4 to 10': (SP) Medium dense, damp, light brown, f-m SAND. Moderate shell fragments. @ 8.5': (SP) Grades to dark gray, occasional layers and beds of medium stiff, moist, dark gray, SILT (ML).	
10 to 15	BH-35-SO-10-15			10 to 10.4': VOID 10.4 to 15': Medium dense, damp, dark gray, f-m SAND. Occasional layers and beds of medium stiff, moist, dark gray, SILT (ML).	
15 to 20	BH-35-SO-15-20			15 to 15.5': VOID 15.5 to 20': Medium dense, damp, dark gray, f-m SAND. Occasional layers and beds of medium stiff, moist, dark gray, SILT (ML). Bottom of geoprobe at 20 feet.	

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Note:

Geoprobe
BH-36

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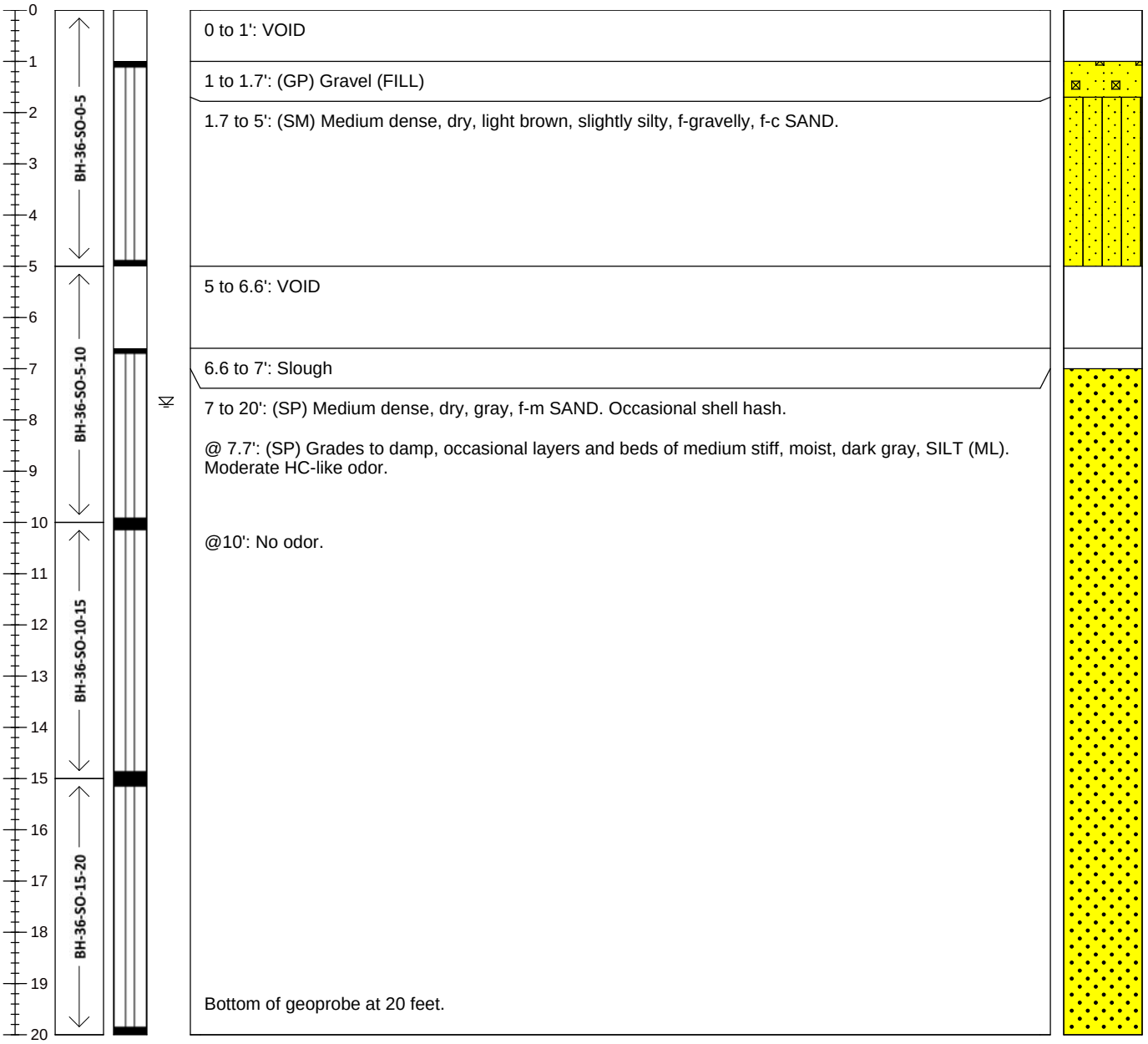
Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **633964.91** Easting: **1041285.46**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		



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Note: Groundwater sample collected. Screen set 6-11 feet below ground surface (bgs). Soil vapor sample collected at 0-4' bgs.

Geoprobe
BH-37

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **634016.64** Easting: **1041208.28**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		

Recoverd Depth (ft)	Sample Name	Sample Recovery	Groundwater	Sediment Description	Graphic Log
0–5	BH-37-SO-0-5			0 to 1': VOID 1 to 3.1': (GP) Gravel (FILL) 3.1 to 5': (SM) Medium dense, dry, light brown, slightly silty, slightly f-gravelly, f-c SAND.	
5–10	BH-37-SO-5-10			5 to 7.2': VOID 7.2 to 7.4': (GP) Gravelly slough (FILL) 7.4 to 9.5': (SM) Medium dense, dry, light brown, slightly silty, slightly f-gravelly, f-c SAND. @ 8.5': Grades to damp. @ 9.2 to 9.4': Layer of dense, moist, black, f-c GRAVEL (GW). Gravel is subangular.	
10–15	BH-37-SO-10-15		▽	9.5 to 20': (SP) Medium dense, moist, dark gray, f-m SAND. Trace layers of medium stiff, moist, dark gray, SILT (ML). Moderate shell fragments.	
15–20	BH-37-SO-15-20			Bottom of geoprobe at 20 feet.	

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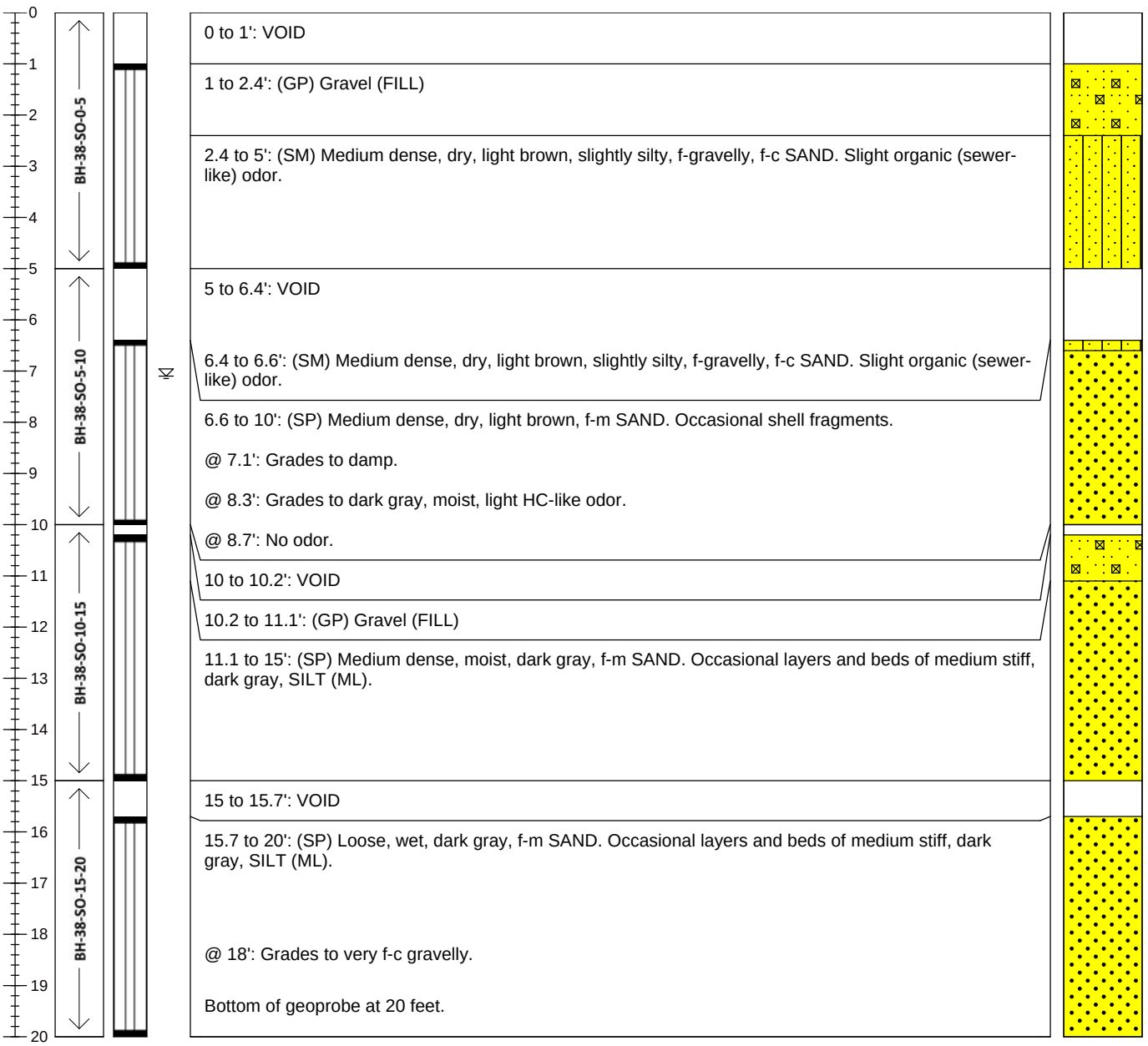
ANCHOR QEA
720 Olive Way, Suite 1900
Seattle, WA 98101
206-287-9130

Note: Groundwater sample collected. Screen set 6-11 feet below ground surface.

Geoprobe
BH-38

Sheet 1 of 1

Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **634055.68** Easting: **1041276.19**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		



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ANCHOR QEA
720 Olive Way, Suite 1900
Seattle, WA 98101
206-287-9130

Note: Groundwater sample collected. Screen set 6-11 feet below ground surface.

Geoprobe
BH-39

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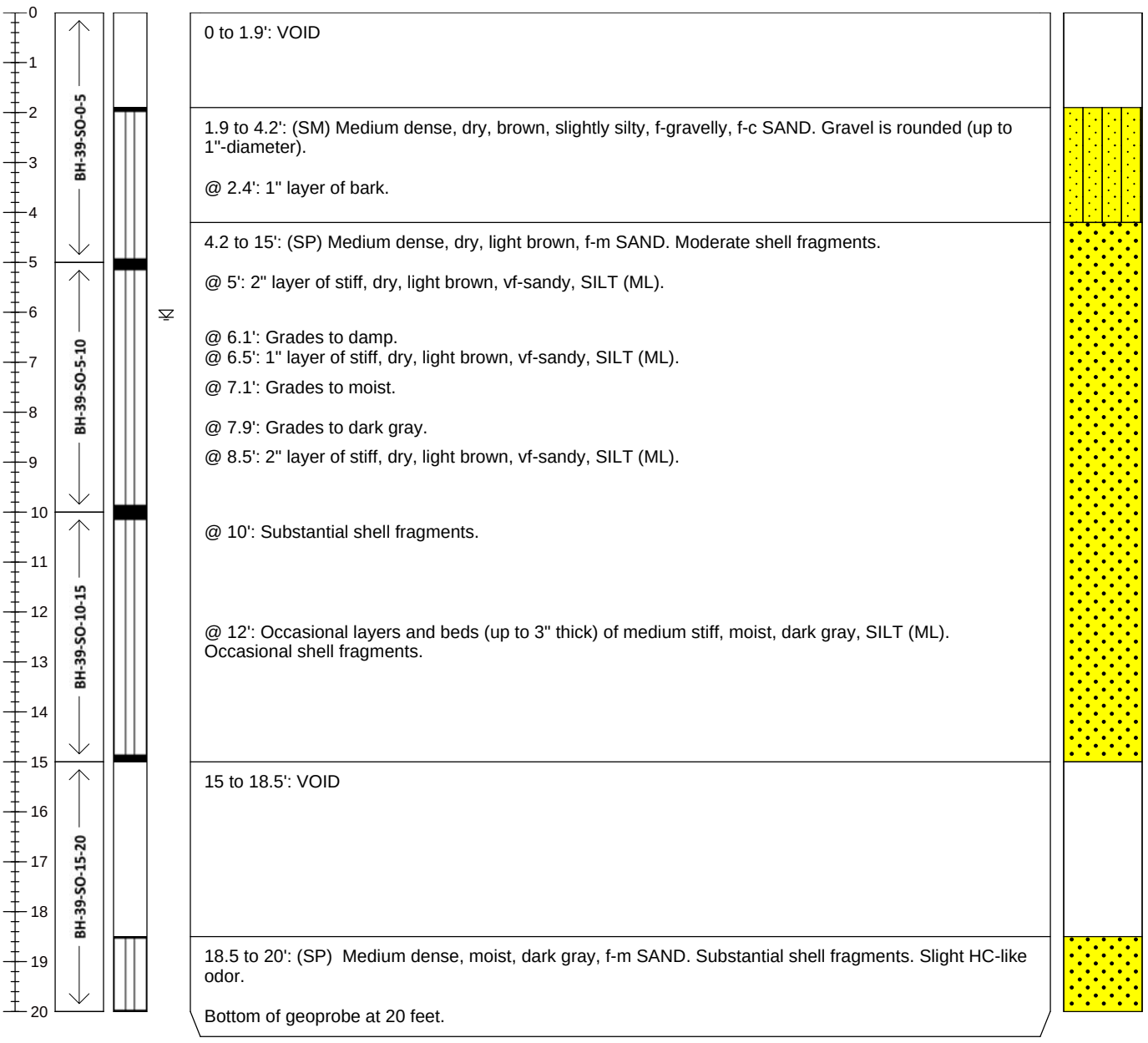
Project: **Percival Landing**	Location: **Budd Inlet West Bay**	Method/Tube ID:**Geoprobe**
Project #: **100487-01**	Northing: **634138.47** Easting: **1041269.61**	Tube Length (ft): **20**
Client: **Port of Olympia**	Horiz. Datum: **NAD83 WA SP S Feet**	Penetration Depth (ft): **20**
Collection Date: **6-16-2011**		Logged By: **AC**
Contractor: **Pacific Soil and Water**		



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ANCHOR QEA
720 Olive Way, Suite 1900
Seattle, WA 98101
206-287-9130

Note: Soil vapor sample collected at 0-5 feet below ground surface.

APPENDIX B
LABORATORY DATA REPORTS

(See attached DVD)

APPENDIX C
DATA QUALITY CONTROL AND VALIDATION

(See attached DVD)

APPENDIX D
TPH CLEANUP LEVEL DEVELOPMENT

A1 Soil Cleanup Levels: Worksheet for Soil Data Entry: Refer to WAC 173-340-720, 740,745, 747, 750

1. Enter Site Information

Date: 02/13/12
Site Name: Former Unocal and Hulco Property
Sample Name: BH-36

2. Enter Soil Concentration Measured

Chemical of Concern or Equivalent Carbon Group	Measured Soil Conc dry basis mg/kg	Composition Ratio %
Petroleum EC Fraction		
AL_EC >5-6	4.9	0.89%
AL_EC >6-8	4.9	0.89%
AL_EC >8-10	4.8	0.87%
AL_EC >10-12	31	5.64%
AL_EC >12-16	180	32.76%
AL_EC >16-21	140	25.48%
AL_EC >21-34	39	7.10%
AR_EC >8-10	1.2	0.22%
AR_EC >10-12	2.5	0.46%
AR_EC >12-16	28	5.10%
AR_EC >16-21	87	15.84%
AR_EC >21-34	26	4.73%
Benzene	0.0097	0.00%
Toluene	0.0266	0.00%
Ethylbenzene	0.0133	0.00%
Total Xylenes	0.04585	0.01%
Naphthalene	0	0.00%
1-Methyl Naphthalene	0	0.00%
2-Methyl Naphthalene	0	0.00%
n-Hexane	0	0.00%
MTBE	0	0.00%
Ethylene Dibromide (EDB)	0	0.00%
1,2 Dichloroethane (EDC)	0	0.00%
Benzo(a)anthracene	0	0.00%
Benzo(b)fluoranthene	0	0.00%
Benzo(k)fluoranthene	0	0.00%
Benzo(a)pyrene	0	0.00%
Chrysene	0	0.00%
Dibenz(a,h)anthracene	0	0.00%
Indeno(1,2,3-cd)pyrene	0	0.00%
Sum	549.39545	100.00%

Notes for Data Entry | Set Default Hydrogeology

Clear All Soil Concentration Data Entry Cells

Restore All Soil Concentration Data cleared previously

REMARK:
Enter site-specific information here……..

3. Enter Site-Specific Hydrogeological Data

Total soil porosity:	0.43	Unitless
Volumetric water content:	0.3	Unitless
Volumetric air content:	0.13	Unitless
Soil bulk density measured:	1.5	kg/L
Fraction Organic Carbon:	0.001	Unitless
Dilution Factor:	20	Unitless

4. Target TPH Ground Water Concentration (if adjusted)

If you adjusted the target TPH ground water concentration, enter adjusted value here: 500 ug/L

A2 Soil Cleanup Levels: Calculation and Summary of Results. Refer to WAC 173-340-720, 740, 745, 747, 750

Site Information

Date: 2/13/2012
Site Name: Former Unocal and Hulco Property
Sample Name: BH-36
Measured Soil TPH Concentration, mg/kg: **549.395**

1. Summary of Calculation Results

Exposure Pathway	Method/Goal	Protective Soil TPH Conc, mg/kg	With Measured Soil Conc		Does Measured Soil Conc Pass or Fail?
			RISK @	HI @	
Protection of Soil Direct Contact: Human Health	Method B	2,724	5.34E-10	2.02E-01	Pass
	Method C	33,873	7.15E-11	1.62E-02	Pass
Protection of Method B Ground Water Quality (Leaching)	Potable GW: Human Health Protection	100% NAPL	1.54E-06	1.40E-01	Pass
	Target TPH GW Conc. @ 500 ug/L	100% NAPL	NA	NA	Pass

Warning! Check to determine if a simplified or site-specific Terrestrial Ecological Evaluation may be required (Refer to WAC 173-340-7490 through ~7494).

2. Results for Protection of Soil Direct Contact Pathway: Human Health

	Method B: Unrestricted Land Use	Method C: Industrial Land Use
Protective Soil Concentration, TPH mg/kg	**2,723.69**	**33,872.54**
Most Stringent Criterion	**HI =1**	**HI =1**

Soil Criteria	Protective Soil Concentration @Method B				Protective Soil Concentration @Method C			
	Most Stringent?	TPH Conc, mg/kg	RISK @	HI @	Most Stringent?	TPH Conc, mg/kg	RISK @	HI @
HI =1	YES	2.72E+03	2.65E-09	1.00E+00	YES	3.39E+04	4.41E-09	1.00E+00
Total Risk=1E-5	*NO*	1.03E+07	1.00E-05	3.78E+03	*NO*	7.68E+07	1.00E-05	2.27E+03
Risk of Benzene= 1E-6	*NO*	1.03E+06	1.00E-06	3.78E+02	NA			
Risk of cPAHs mixture= 1E-6	NA	NA	NA	NA				
EDB	NA	NA	NA	NA				
EDC	NA	NA	NA	NA				

3. Results for Protection of Ground Water Quality (Leaching Pathway)

3.1. Protection of Potable Ground Water Quality (Method B): Human Health Protection

Most Stringent Criterion	**NA**
Protective Ground Water Concentration, ug/L	**NA**
Protective Soil Concentration, mg/kg	**Soil-to-Ground Water is not a critical pathway!**

Ground Water Criteria	Protective Potable Ground Water Concentration @Method B				Protective Soil Conc, mg/kg
	Most Stringent?	TPH Conc, ug/L	RISK @	HI @	
HI=1	YES	1.02E+02	5.09E-06	2.45E-01	100% NAPL
Total Risk = 1E-5	YES	1.02E+02	5.09E-06	2.45E-01	100% NAPL
Total Risk = 1E-6	YES	6.55E+01	1.00E-06	1.18E-01	3.11E+02
Risk of cPAHs mixture= 1E-5	NA	NA	NA	NA	NA
Benzene MCL = 5 ug/L	YES	1.02E+02	5.09E-06	2.45E-01	100% NAPL
MTBE = 20 ug/L	NA	NA	NA	NA	NA

Note: 100% NAPL is 73000 mg/kg TPH.

3.2 Protection of Ground Water Quality for TPH Ground Water Concentration previously adjusted and entered

Ground Water Criteria	Protective Ground Water Concentration			Protective Soil Conc, mg/kg
	TPH Conc, ug/L	Risk @	HI @	
Target TPH GW Conc = 500 ug/L	1.02E+02	5.09E-06	2.45E-01	**100% NAPL**