SoundEarth Strategies, Inc.
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FEASIBILITY STUDY

EAST WATERFRONT PROPERTY

Property:

East Waterfront Property
2750 West Commodore Way
Seattle, Washington

Prepared for:

TOC Holdings Co.
2737 West Commodore Way
Seattle, Washington

Report Date:

June 12, 2014

Feasibility Study

Prepared for:

TOC Holdings Co.
2737 West Commodore Way
Seattle, Washington

East Waterfront Property
2750 West Commodore Way
Seattle, Washington

Project No.: 0440-004

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SoundEarth Strategies

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
2003 BINMIC Report	the *BINMIC Hydrogeologic and Environmental Settings Report* prepared by Floyd Snider and McCarthy in 2003
ARAR	applicable or relevant and appropriate requirement
AS	air sparge
bcy	bank cubic yards
bgs	below ground surface
BINMIC	Ballard Interbay North Manufacturing Industrial Center
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CFR	Code of Federal Regulations
COPC	chemical of potential concern
CSM	conceptual site model
DCA	disproportionate cost analysis
DNR	Department of Natural Resources
DPD	Department of Planning and Development
DPE	Dual-phase extraction
DRPH	diesel-range petroleum hydrocarbons
East Waterfront Property	located at 2750 West Commodore Way, and is part of King County Tax Parcel No. 112503-9120
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
FS Report	Feasibility Study report prepared by SoundEarth Strategies, Inc.
GRPH	gasoline-range petroleum hydrocarbons
Hdf	Holocene Depression Fillings geologic unit

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Hf	Holocene Fill geologic unit
mg/L	milligrams per liter
MNA	monitored natural attenuation
msl	mean sea level
MTCA	Washington State Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NAPL	nonaqueous-phase liquid
NFA	No Further Action
O&M	operation and maintenance
OMB	U.S. Office of Management and Budget
ORPH	oil-range petroleum hydrocarbons
PCS	petroleum-contaminated soil
Qpf	pre-Fraser-age glacial deposits
Qpff	fine-grained pre-Fraser-age glacial deposits
Qpfc	coarse-grained pre-Fraser-age glacial deposits
RAO	remedial action objective
RCW	Revised Code of Washington
RI	remedial investigation
RI Report	Remedial Investigation Report prepared by SoundEarth Strategies, Inc., dated June 10, 2014
ROW	right-of-way
Site	encompasses the eastern, upland portion of the East Waterfront Property, with the western edge at the approximate location of monitoring well 02MW13
SoundEarth	SoundEarth Strategies, Inc.
SVE	soil vapor extraction

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TOC	TOC Holdings Co.
TPH	Total petroleum hydrocarbons
USC	United States Code
USGS	U.S. Geological Survey
UST	underground storage tank
VCP	Voluntary Cleanup Program
WAC	Washington Administrative Code

1.0 INTRODUCTION

SoundEarth Strategies, Inc. (SoundEarth; formerly Sound Environmental Strategies Corporation) has prepared this Feasibility Study Report (FS Report) on behalf of TOC Holdings Co. (TOC; formerly named Time Oil Co.) for the East Waterfront Property. The East Waterfront Property is located at 2750 West Commodore Way in Seattle, Washington (Figure 1). The East Waterfront Property is part of the Seattle Terminal Properties. The Seattle Terminal Properties include four real properties (King County Tax Parcel Numbers 112503-9050, 112503-9120 [East Waterfront Property], 423790-0405, and 112503-9081) and one parcel leased from the Washington State Department of Natural Resources (DNR; King County Tax Parcel Number 112503-9113). The Seattle Terminal Properties are identified as the Bulk Terminal Property, East Waterfront Property, ASKO Hydraulic Property, West Waterfront Property, and the Washington State DNR Aquatic Lease Land Property. The Seattle Terminal Properties and West Commodore Way are located in Section 11, Township 25 North, Range 3 East. The latitude and longitude of the Seattle Terminal Properties is approximately 47°39’41−51”North and 122°23’28−41”West. The layout of the Seattle Terminal Properties is shown on Figure 2. The City of Seattle West Commodore Way right-of-way (ROW) runs from east to west and separates the Bulk Terminal Property and ASKO Hydraulic Property from the East Waterfront Property and West Waterfront Property. The Seattle Terminal Properties and West Commodore Way are located within the Ballard Interbay North Manufacturing Industrial Center (BINMIC) designated by the City of Seattle in 1994.

SoundEarth conducted a remedial investigation (RI) to address data gaps identified from the data presented in previous subsurface investigations and interim actions conducted by SoundEarth and others that had confirmed releases of chemicals of potential concern (COPC) to the environment at the East Waterfront Property. The releases of COPCs resulted in the migration of contamination in soil and groundwater. The confirmed and suspected sources of COPCs are associated with historical facility operations; however, the release mechanisms are unknown. The previous investigations and interim actions conducted at the East Waterfront Property are summarized in the Remedial Investigation Report (RI Report) prepared by SoundEarth in 2014.

The feasibility study (FS) was performed as part of an ongoing cleanup action in accordance with Washington State Model Toxics Control Act (MTCA) Cleanup Regulation as established in Chapter 173-340 of the Washington Administrative Code (WAC 173-340). In accordance with WAC 173-340-360(2), the final cleanup action will meet the cleanup standards at the defined points of compliance, protect human health and the environment, comply with applicable state and federal laws, provide for compliance monitoring, and provide a permanent solution to the maximum extent practicable.

1.1 PURPOSE

The objective of this FS is to develop and evaluate cleanup action alternatives to facilitate selection of a final cleanup action for the site in accordance with WAC 173-340-350(8). A FS includes the development, screening, and evaluation process for numerous remedial alternatives.

The FS Report has been prepared to develop and evaluate cleanup action alternatives for the site and to select the most appropriate alternative based on the evaluation criteria as defined by MTCA WAC 173-340-350 through 173-340-390. According to MTCA, a cleanup action alternative must satisfy all of the following threshold criteria, as specified in WAC 173-340-360(2):

- Protect human health and the environment.
- Comply with cleanup standards.
- Comply with applicable state and federal laws.
- Provide for compliance monitoring.

While these criteria represent the minimum standards for an acceptable cleanup action, WAC 173-340-360(2)(b) also recommends that the cleanup action alternative satisfy the following criteria:

- Use permanent solutions to the maximum extent practicable.
- Provide for a reasonable restoration time frame.
- Consider public concerns.

1.2 PRELIMINARY SITE DEFINITION

According to Washington State Department of Ecology (Ecology) *Guidelines for Property Cleanups under the Voluntary Cleanup Program* dated July 2008, a site is defined by the nature and extent of contamination associated with one or more releases of hazardous substances (such as the release of gasoline from a leaking underground storage tank [UST]) prior to any cleanup of that contamination (Ecology 2008). Based on the information gathered to date, the Site encompasses the eastern upland portion of the East Waterfront Property with the western edge at the approximate location of monitoring well 02MW13. The general boundary for the Site is shown on Figure 3.

1.3 PRELIMINARY CLEANUP LEVELS

Preliminary cleanup levels were established for individual hazardous substances in each medium during the scoping of the RI based on various phases of investigation performed by others. The preliminary cleanup levels were refined during the RI. The final cleanup levels will be defined in the subsequent Cleanup Action Plan as additional information becomes available on the potential future land use.

The East Waterfront Property is zoned industrial. However, the City of Seattle will permit commercial uses in industrial areas to the extent that they reinforce the industrial character of the region and new residential uses will not be permitted except for special types of dwellings that are related to the industrial area or that would not restrict or disrupt industrial activity.

Total petroleum hydrocarbons (TPH) are the primary suspected source(s) of potential releases of hazardous substances at the East Waterfront Property, based on the historical land use as a petroleum bulk storage facility. Based on the results of the RI, the primary COPC at the Site is TPH and associated volatile petroleum compounds (benzene, toluene, ethylbenzene, and total xylenes [BTEX]). The preliminary cleanup levels for individual hazardous substances including TPH are based on established MTCA Method A cleanup levels in accordance with WAC 173-340-720 through WAC 173-340-760. The preliminary cleanup levels for COPCs confirmed or suspected in environmental media of potential concern are provided in Table 1.

The final cleanup standards will be determined based on the selected cleanup action(s) and the current and potential future land and resource uses. The final cleanup standards for the Site including cleanup levels, points of compliance, and remediation levels, if applicable, will be defined in the Cleanup Action Plan presented under separate cover, in accordance with WAC 173-340-700.

1.4 REPORT ORGANIZATION

This FS Report is organized into the following sections:

- **Section 2.0, Background.** This section provides a description of general facility information and Site conditions for the East Waterfront Property, a description of current and historical land uses for the East Waterfront Property, and a summary of the environmental setting for the East Waterfront Property.
- **Section 3.0, Summary of the Conceptual Site Model.** This section provides a summary of the conceptual site model (CSM) developed for the Site based on the completion of the RI conducted by SoundEarth, and previous investigations performed by others.
- **Section 4.0, Remedial Alternatives Assessment.** This section lists the remedial action objectives (RAO) developed for the Site which were used to define the technical elements for the screening evaluation and to select a cleanup action alternative. The technical elements include applicable or relevant and appropriate requirements (ARAR), COPCs, media of concern, and preliminary cleanup standards. This section provides the comparative evaluation of cleanup action alternatives and disproportionate cost analysis, and presents the recommended cleanup action alternative.
- **Section 5.0, Bibliography.** This section lists references used to develop this document.
- **Section 6.0, Limitations.** This section presents SoundEarth's standard limitations associated with conducting the work reported herein and preparing this FS Report.

2.0 BACKGROUND

This section provides a description of general facility information and Site conditions for the East Waterfront Property, a description of current and historical land uses for the East Waterfront Property, and a summary of the environmental setting, including topography, surface water and sediments, soil and geology, hydrogeology, and air.

2.1 PROPERTY DESCRIPTION

The East Waterfront Property is located at 2750 West Commodore Way, Seattle, Washington. The East Waterfront Property is comprised of a single tax parcel (King County Tax Parcel Number 112503-9120) with a total area of 3.05 acres (133,007 square feet; King County Assessor 2013). The East Waterfront Property is currently vacant with the exception of the former storage warehouse on the west-central portion of the East Waterfront Property. The tenant of this building is currently ASKO Selective Plating, an electroplating company.

The Washington State DNR Aquatic Lease Land Property and Salmon Bay are located to the north of the East Waterfront Property; the eastern portion is bounded by Port of Seattle land; the southern portion is bounded by the West Commodore Way ROW and beyond the ASKO Hydraulic Property to the southwest and the Bulk Terminal Property to the southeast; the western portion is bounded by the West Waterfront Property (Figure 2).

The northern portion of the East Waterfront Property extends into Salmon Bay. The east-central portion of the East Waterfront Property was developed in 1930 with a 6,400-square-foot Warehouse Building which was constructed on pilings that partially extended into Salmon Bay (U.S. Appraisal Co. 1957) (Figure 3). The Warehouse Building was demolished between January and February 2012. Adjacent to the south of the Warehouse Building is a 1950-vintage, 2,250-square-foot, one-walled shed/canopy, with an eastern addition in 1956. Adjacent to the south of the shed/canopy is a 1944-vintage, 1,518-square-foot garage. A 1950-vintage, 226-square-foot Laboratory Building is located near the southeast corner of the East Waterfront Property, adjacent to the north of West Commodore Way (Figure 3). The Laboratory Building was formerly used for quality testing of oil (King County Assessor 2009) and is currently used as a shed. A 1970-vintage, 1,920-square-foot storage warehouse (current ASKO Industrial Repair) is located on the west-central portion of the East Waterfront Property (King County Assessor 2013; Figure 3). The remainder of the East Waterfront Property contains the entrance to the Shipping Terminal Dock, a gravel driveway, a parking lot, and low-growing vegetation.

Additional historical features on the East Waterfront Property included the northern end of the East Barrel Incline, which extended to one of two former barreling sheds (Barreling Shed #2) located on the Bulk Terminal Property and operated from approximately 1941 to 1952; the northern end of the West Barrel Incline, which extended to a former barreling shed (Barreling Shed #3) located on the ASKO Hydraulic Property; and the northern end of the Pipeline Utilidor connecting the Shipping Terminal Dock to the Lower Tank Yard on the Bulk Terminal Property (Foster Wheeler 2000b). The East and West Barrel Inclines merged in a tunnel underneath the West Commodore Way ROW and entered the East Waterfront Property as a single conveyance line. The East and West Barrel Inclines were removed by 1960 (Foster Wheeler 2000b). The Pipeline Utilidor was removed from the East Waterfront Property in 2005.

The East Waterfront Property is serviced by overhead electrical, cable, and telephone utilities. A water main located beneath the north shoulder of the West Commodore Way ROW supplies water to the East Waterfront Property (former Warehouse Building and ASKO Industrial Repair building). Electricity is provided to the Warehouse Building, the ASKO Industrial Repair building, and garage on the East Waterfront Property. According to the City of Seattle Department of Planning and Development (DPD) Side Sewer Cards, a side sewer connection equipped with a pump serves the ASKO Selective Plating building on the East Waterfront Property. A side sewer connection is not shown on the available Side Sewer Cards for the Warehouse Building. The Warehouse Building had a restroom and the drains were connected to side sewer line that flowed to the south towards the North Trunk Sewer. The North Trunk Sewer was constructed beneath the West Commodore Way ROW by the City of Seattle between 1909 and 1913 (Converse Davis Dixon Associates, Inc. 1976). The tunneled portions of the North Trunk Sewer located within the West Commodore Way ROW were reportedly constructed as brick crown within a timber set and lagging tunnel. The top of the tunnel is approximately 25 feet below ground surface (bgs). The diameter of the section of the North Trunk Sewer running through the West Commodore Way ROW is 144 inches.

2.2 PROPERTY LAND USE AND HISTORY

The current and historical use information presented in this FS Report for the East Waterfront Property is compiled from reviewed sources, including City of Seattle DPD, King County Assessor's website, historical assessor records obtained from Puget Sound Regional Archives, Sanborn Fire Insurance Maps;

Kroll and Baist Atlases; Polk and Cole City Directories; aerial photographs, historical records provided by Ecology and TOC, and previous reports prepared by others. Historical documentation referenced in this section is provided in the RI Report.

According to the *Ballard Interbay North Manufacturing Industrial Center (BINMIC) Hydrogeologic and Environmental Settings Report* (the 2003 BINMIC Report) prepared by The Floyd Snider McCarthy Team, the East Waterfront Property within the BINMIC (Figure 2 of the 2003 BINMIC Report). The current land use of the East Waterfront Property is industrial.

The East Waterfront Property is zoned as Industrial General 1 Unlimited/45. The Industrial General 1 Unlimited/45 zoning classification allows for a broad range of industrial and commercial uses. Typical land use includes general and heavy manufacturing, commercial, entertainment, transportation and utility services, and salvage and recycling. In addition, the City of Seattle has designated portions of the East Waterfront Property as environmentally critical areas listed for 40 percent Steep Slope, Archaeological Buffer, Heron Habitat, Shoreline Habitat Buffer, and Wildlife Preservation Area.

The East Waterfront Property was used in conjunction with the Bulk Terminal Property and the ASKO Hydraulic Property for fueling transport ships using the Pipeline Utilidor. Drums were filled with petroleum products in three former barreling sheds (Former Barreling Sheds #1 through #3), located on the ASKO Hydraulic Property and Bulk Terminal Property, and conveyed along the East and West Barrel Inclines through the East Waterfront Property to the Shipping Terminal Dock. The Warehouse Building was leased by George Broom's Sons Inc., a sail and rigging warehouse, from approximately 1972 to 2010. In addition, Scow Haven, a fishing boat dock access lot, leased space in the Warehouse Building for an unknown time period. Historically, TOC used the garage south of the shed for vehicle repair and equipment lubrication activities.

A summary table, including dates and names of the owners/operators in chronological order, facility addresses (if known), reference sources, and development description based on available current and historical information for the East Waterfront Property, is provided in the RI Report. Historical property features are also presented on Figure 4.

2.3 ENVIRONMENTAL SETTING AND REGULATORY CLASSIFICATIONS

A summary of the environmental setting, including topography, surface water and sediments, soils and geology, hydrogeology, and air, for the East Waterfront Property and vicinity is provided below. Further background and references of the environmental setting and regulatory classifications for the East Waterfront Property are provided in the RI Report.

2.3.1 Regional Topography

The East Waterfront Property is located within the Puget Trough or Lowland portion of the Pacific Border Physiographic Province. The Puget Lowland is a broad, low-lying region situated between the Cascade Range to the east and the Olympic Mountains and Willapa Hills to the west. In the north, the San Juan Islands form the division between the Puget Lowland and the Strait of Georgia in British Columbia. The province is characterized by roughly north–south-oriented valleys and ridges, with the ridges that locally form an upland plain at elevations of up to about 500 feet above sea level. The moderately to steeply sloped ridges are separated by swales, which are often occupied by wetlands, streams, and lakes. The physiographic nature of the Puget Lowland was prominently formed by the last retreat of the Vashon Stade of the Fraser Glaciation, which is estimated to have occurred between 14,000 and 18,000 years before present. The elevation of the East Waterfront Property ranges from approximately 18 feet above mean sea level next to the shoreline to 44 feet above mean sea level at the West Commodore Way ROW.

2.3.2 Surface Water and Sediments

The East Waterfront Property is located on the south shore of Salmon Bay. Salmon Bay and the Lake Washington Ship Canal comprise a narrow body of water in Seattle, connecting Lake Union to the east with Puget Sound to the west through the Hiram M. Chittenden Locks. Salmon Bay was originally a saltwater bay, but was inundated with freshwater in 1914 when the locks were constructed to the west of Salmon Bay and connected the bay to Lake Union through the Lake Union Ship Canal. The Lake Washington Ship Canal is a narrow channel with some shallow embayments on the southern shoreline near the west end of the canal (Ecology 2000a).

2.3.2.1 Surface Water

Saltwater intrudes into Salmon Bay as a result of the operation of the Hiram M. Chittenden Locks, which connect the Lake Washington Ship Canal with Puget Sound. Depending on the levels of salinity present, sediments in certain areas may be classified as marine, low-salinity, or freshwater (Ecology 2000a). It is unlikely that Salmon Bay could be used as a drinking water source as it is known to be mildly saline as a result of mixing with seawater at the Hiram M. Chittenden Locks.

Groundwater from Salmon Bay and the Lake Washington Ship Canal upland areas moves primarily laterally from topographically higher elevations towards the lower elevations adjacent where it discharges to these surface water bodies. Locally, variations in soil conditions and engineering of shallow soils may cause groundwater to flow for short distances in other directions; however, eventually the groundwater discharges to the main surface water bodies.

The surface of the undeveloped portions of the East Waterfront Property is primarily unpaved with the exception of the driveway entrance to the Shipping Terminal Dock. During major storm events, surface water at the East Waterfront Property travels as sheet flow from the upland portions of the East Waterfront Property to Salmon Bay, infiltrates the upland soils, and/or evaporates to the ambient air. Outfalls linked to catch basins have not been observed on the East Waterfront Property. Runoff from the roofs tops is captured in gutters which flow to downspouts that discharge to the surface.

2.3.2.2 Sediments

General deposition processes for Salmon Bay include eroded soils and discharged outfall sediments from Salmon Bay and the Lake Washington Ship Canal upland areas and associated sediment transport from the Lake Washington Ship Canal. Erosion control measures at the East Waterfront Property consist of a barrier of cobbles and boulders placed along the shoreline with vegetation and/or concrete surface upgradient of the barrier. These control measures are in place to minimize the erosion of soils from the upland portion of the East Waterfront Property. The rate of sediment deposition for Salmon Bay is unknown.

2.3.3 Soils and Geology

According to the Geologic Map of Northwestern Seattle, the surficial geology in the vicinity of the East Waterfront Property consists of deposits corresponding to the Vashon Stade of the Fraser Glaciation and pre-Fraser glacial and interglacial periods. In the immediate vicinity of the East Waterfront Property, surficial deposits consist of pre-Fraser Olympia beds, and modified land, which is characterized fill and/or graded natural deposits that obscure or alter the original deposit.

The youngest pre-Fraser deposits in the Seattle area, known as the Olympia beds, were deposited during the last interglacial period, approximately 18,000 to 70,000 years ago. The Olympia beds consist of very dense, fine to medium, clean to silty sands and intermittent gravel channel deposits, interbedded with hard silts and peats (Booth et al. 2005; Galster and Laprade 1991). Organic matter and localized iron-oxide horizons are common. The Olympia beds have known thicknesses of up to 80 feet. Beneath the Olympia beds are various older deposits of glacial and nonglacial origin. In general, deposits from older interglacial and glacial periods are similar to deposits from the most recent glacial cycle, due to similar topographic and climactic conditions (Booth et al. 2005).

The Vashon ice-contact deposits are located on the hillside above the south adjacent ASKO Hydraulic Property and are generally discontinuous, highly variable in thickness and lateral extent, and consist of loose to very dense, intermixed glacial till and glacial outwash deposits. The till typically consists of sandy silts with gravel. The outwash consists of sands and gravels, with variable amounts of silt (Booth et al. 2005).

The Vashon advance outwash deposits are located on the hillside above the south adjacent ASKO Hydraulic Property, and are generally discontinuous and consist of loose to very dense, layered sands and gravels, which are generally well-sorted (poorly graded). Layers of silty sands and silts are less common. The Vashon recessional lacustrine deposits consist of layered silts and clays, which range in plasticity from low to high, and may contain localized intervals of sand or peat. The recessional lacustrine deposits may grade into recessional outwash deposits (Booth et al. 2005).

The undeveloped portions of the East Waterfront Property are either covered with grasses, small shrubs, or gravel. The location of the former Warehouse Building is covered with quarry spalls, gravel, and sand. According to geologic cross sections in the 2003 BINMIC Report; Galster and Laprade (1991); Booth et al. (2005); boring logs and cross sections in the Fort Lawton Parallel Tunnel Project, Geotechnical Report (Municipality of Metropolitan Seattle 1989)*;* and subsurface investigations conducted at the Seattle Terminal Properties, the uppermost soil layer in the vicinity of the Seattle Terminal Properties and the West Commodore Way ROW typically consists of fine- to coarse-grained soils classified as the Holocene Fill (Hf) geologic unit. The Hf geologic unit ranges from approximately 5 to greater than 20 feet thick, and consists of very loose to very dense, highly variable engineered and non-engineered fill material. Underlying the Hf geologic unit is the Holocene Depression Fillings (Hdf) geologic unit that consists of very soft to medium stiff fine-grained sand, silt, and clay, with scattered organic particles and very soft peat deposits. The Hf and Hdf geologic units are not depicted on the BINMIC geologic cross section B-B', which shows the Seattle Terminal Properties and the West Commodore Way ROW underlain by an approximate 35-foot thickness of "Unknown Outwash" that overlies clay or glaciolacustrine deposits; however, based on boring logs from the vicinity of the Seattle Terminal Properties, the "unknown Outwash" could be interpreted as the Hf and Hdf geologic units. Underlying the Hf and Hdf geologic units are the pre-Fraser-age glacial deposits (Qpf). The Qpf geologic unit consists of dense to hard, interbedded sand, gravel, and silt. These deposits can be further subdivided into fine- (Qpff) and coarse-grained (Qpfc) deposits.

2.3.4 Hydrogeology

Regional groundwater flow typically discharges to the closest major surface water body. Salmon Bay is located directly offshore of the East Waterfront Property and within the entire Washington State DNR Aquatic Lease Land Property. The general direction of groundwater flow has been toward the north/northwest.

A shallow water-bearing zone was observed beneath the Seattle Terminal Properties from approximately 15 to 40 feet above mean sea level in soils that consist of poorly graded sand and silty sand. Generally, the shallow water-bearing zone is encountered beneath the East Waterfront Property at approximately 1 to 25 feet bgs. The large change in water level is attributed to the topography of the East Waterfront Property and the proximity to Salmon Bay. The shallow water-bearing zone is underlain by two semiconfined to confined water-bearing zones with characteristics similar to soils within the shallow water-bearing zone. The intermediate water-bearing zone was observed beneath the East Waterfront Property at approximately 20 to 25 feet bgs. The two water-bearing zones are separated by silt and clay with silty sand layers that act as regional confining units that partially confine or confine the groundwater stored within the shallow and intermediate water-bearing zones. A third water-bearing zone identified as the deep water-bearing zone was observed at the ASKO Hydraulic Property located hydraulically upgradient of the East Waterfront Property. The deep water-bearing zone is located from approximately 52 to 62 feet bgs at the ASKO Hydraulic Property, which topographically is approximately 2 feet above the southern property line of the East Waterfront Property. The general groundwater flow direction for the shallow water-bearing zone is to the northwest-north (Figure 5).

According to the BINMIC Hydrogeologic and Environmental Settings Report, three water supply wells were located in the BINMIC area. Two of the wells are located north of Salmon Bay and the East Waterfront Property, and the third was reportedly located 0.85 miles southeast of the East Waterfront Property. The wells were reportedly all used for industrial or commercial purposes and are thought to be abandoned.

Seattle Public Utilities provides the potable water supply to Seattle. Seattle Public Utilities' main source of water is derived from surface water reservoirs located within the Cedar and South Fork Tolt River watersheds. According to King County's Interactive Map for the County's Groundwater Program, there are no designated aquifer recharge or wellhead protection areas within several miles of the East Waterfront Property.

2.3.5 Air

Climate in the Seattle area is generally mild and experiences moderate seasonal fluctuations in temperature. Average temperatures range from the 60s in the summer to the 40s in the winter. The warmest month of the year is August, which has an average maximum temperature of 74.9 degrees Fahrenheit (°F), while the coldest month of the year is January, which has an average minimum temperature of 36.0 °F. The annual average rainfall in the Seattle area is 38.25 inches, with December as the wettest month of the year, when the area receives an average rainfall total of 6.06 inches. The prevailing wind direction in the Seattle area is from the south in winter and spring, northwest in the summer and early fall and south-southeast in the fall and early winter (Western Regional Climate Center 2013).

The main underlying sources for ambient air pollutants in Seattle are motor vehicle traffic and residential wood burning (PSCAA 2010). Airborne pollutants can reach the terrestrial surfaces and sediment directly, through the deposition of airborne chemicals, primarily in the form of particulate matter onto the water surface, and indirectly, through the deposition of particulate matter on terrestrial surfaces from which they are conveyed via surface water runoff and stormwater to water bodies (Anchor QEA 2012).

3.0 SUMMARY OF THE CONCEPTUAL SITE MODEL

A CSM identifies confirmed and suspected source areas of hazardous substances, primary release mechanisms for COPCs, affected media, transport mechanisms, fate of hazardous substances in the environment, environmental media of potential concern, and exposure pathways for potential receptors. The CSM is the basis for developing technically feasible cleanup action alternatives from which a final cleanup action approach is selected. The CSM may be refined when additional information becomes available during the implementation of the FS and the cleanup action. Preliminary exposure assessment for the Site is presented on Figure 6. A schematic drawing showing the CSM based on the preliminary exposure assessment for the Site is presented in Figure 7. This section summarizes the CSM developed for the Site based on completion of the RI conducted by SoundEarth and others. A summary of the confirmed and suspected source areas, affected media, contaminant fate and transport and the preliminary exposure assessment is presented below. A detailed summary of these technical components of the CSM is provided in the RI report.

3.1 CONFIRMED AND SUSPECTED SOURCE AREAS

A source area is the location of a release of a hazardous substance (i.e., TPH) that has affected soil, surface water, groundwater, and/or air quality at the Site. The historical distribution infrastructure and mechanical systems used for facility operations and processes, and unknown releases, including spills and leaks, are identified as confirmed and suspected sources of releases of hazardous substances. The confirmed and suspected areas are listed below:

- Former East and West Barrel Inclines
- Former Pipeline Utilidor
- Former USTs (i.e., Waste Oil UST)

Confirmed and suspected source areas for the Site are located in the vicinity of the historical distribution infrastructure and mechanical systems, and where the highest concentrations of COPCs are present at the Site (Figure 4). Based on the results of the RI, the primary COPC at the Site is TPH and associated volatile petroleum compounds (BTEX).

3.2 AFFECTED ENVIRONMENTAL MEDIA

The affected environmental media consists of soil and groundwater with COPCs that were detected at concentrations exceeding their respective preliminary cleanup levels. Soil vapor and outdoor air has been retained as a medium of potential concern based on the concentrations of TPH in soil and groundwater. The cleanup of the affected soil and groundwater is expected to result in the elimination of soil vapor and outdoor air as a future medium of concern for the Site.

3.3 CONTAMINANT FATE AND TRANSPORT

Fate and transport of COPCs in affected environmental media are dependent on the physical and chemical properties of the COPC and the geochemical and hydraulic properties of the subsurface environment. Contaminants may exist in four phases in a subsurface environment from a release of a hazardous substance. The four phases include: free-phase (nonaqueous-phase liquid [NAPL]), sorbed-phase (adsorbed to organics or clay soil particles), aqueous-phase (dissolved in water) and gaseous-phase (volatilization from soil or water to air). Commonly, contaminants exist in multiple phases with some degree of partitioning between phases. The contaminant phase depends not only on the properties of the COPC and the site-specific geological properties, but also on the magnitude and extent of release. The physical and chemical properties that control the fate and transport of COPCs include specific gravity, solubility, vapor pressure, Henry's Law constant, and the octanol-water partition coefficient.

The primary indicator hazardous substances for the affected environmental media at the Site include TPH. TPH is a primary indicator hazardous substance based on historical facility operations and processes to distribute TPH and because it is pervasive throughout the affected environmental media (soil and groundwater) at the Site. Therefore, TPH will be the focus of the discussion of contaminant fate and transport for the Site. The chemical-specific fate and transport of the primary COPCs at the East Waterfront Property are discussed below.

3.3.1 Petroleum Hydrocarbons

Petroleum hydrocarbons with lower carbon numbers (e.g., gasoline-range petroleum hydrocarbons [GRPH] and BTEX) are more soluble, and have lower log K_{ow} values and higher vapor pressures than petroleum hydrocarbons with higher carbon numbers (e.g., diesel-range petroleum hydrocarbons [DRPH] and oil-range petroleum hydrocarbons [ORPH]). Therefore, GRPH and BTEX are more mobile, have less affinity to sorb to soil organic matter, are more likely to exist in vapor form, and are more easily biodegraded than heavy fuel fraction. For example, benzene is moderately water soluble (1,770 milligrams per liter [mg/L]), tends to rapidly volatilize from water ($H = 5.48 \times 10^{-3}$), is quite hydrophobic and will sorb to soil (log K_{ow} = 2.05). Dodecane (a 12 carbon compound in DRPH) is nearly insoluble in water (S= 0.008 mg/L), may volatilize from water (H=24.2), but not as free-phase (P_v=0.3 mm Hg), and will strongly sorb to soil (log K_{ow}=6.44).

Biodegradation of TPH in groundwater is dependent on the oxidation-reduction conditions of the groundwater, which is a function of the presence or absence of electron acceptors that support biologically mediated degradation. Biologically mediated oxidation of TPH occurs most effectively under aerobic conditions. Aerobic metabolism occurs when microorganisms transfer electrons from the electron donor (TPH) to an electron acceptor (O_2) in order to gain energy. O_2

is the most energetically favored electron acceptor followed by nitrate (NO_3^-), manganese or ferric oxides (MnO_2), sulfate (SO_4^{2-}) and carbon dioxide (CO_2, methanogenesis). Aerobic metabolism tends to be the quickest form of biodegradation of TPH. Biodegradation occurs when the contaminants are in the dissolved-phase in groundwater or in the capillary fringe. TPH biodegrades at faster rates under aerobic conditions, which are typically found at dissolved-phase plume boundaries. Aerobic biodegradation occurs first in the source area, depleting oxygen levels and creating a predominantly anaerobic environment.

The principal fate and transport mechanisms for TPH and BTEX in affected environmental media are summarized below:

- The lateral distribution of concentrations of TPH and BTEX in soil is a result of transport via adsorption of the soil matrix and direct contact of LNAPL.
- Surface erosion may transport contaminated soil to surface water. The direct contact of contaminated soil with surface water and groundwater may result in soil to water partitioning via leaching.
- The lateral distribution of concentrations of TPH and BTEX in groundwater is a result of direct contact with historical releases of LNAPL and associated LNAPL to water partitioning, and leaching of adsorbed-phase petroleum-contaminated soil via soil-to-water partitioning, and the natural attenuation processes, such as advection/dispersion, diffusion, sorption, and biodegradation.
- Natural mechanisms, including temperature, groundwater, and barometric pressure fluctuations, may result in the volatilization of TPH and BTEX in soil and groundwater to soil vapor via soil and/or groundwater to air partitioning. Soil vapor with concentrations of TPH and BTEX may transport to the surface with barometric pressure fluctuations.
- Release(s) of TPH from historical facility operations and processes to the subsurface environment may result in an accumulation of LNAPL and/or the contamination of the environmental media of potential concern via phase partitioning. No LNAPL has been observed at the Site in the monitoring well network.

The results from this RI indicate the presence of DRPH, ORPH, GRPH, and BTEX at concentrations that exceed the preliminary cleanup levels in soil and groundwater beneath the Site (Figures 8 through 11). The RI conducted by SoundEarth and historical investigations conducted by others at the Site have demonstrated the following:

- The highest concentrations of TPH were in soil samples collected adjacent to the former Pipeline Utilidor and East and West Barrel Inclines and from the north, south, and east ends of the 1991 waste oil UST excavation. These confirmed and suspected source areas are located in the eastern central portion of the East Waterfront Property (Figures 8 and 9). Concentrations of COPCs in soil exceeding the preliminary cleanup levels were present approximately 2 to 13 feet bgs at the Site.
- The highest concentrations of TPH and/or BTEX in groundwater are present in the shallow water-bearing zone near the Pipeline Utilidor and the East and West Barrel

Inclines. Additional concentrations of TPH and/or BTEX exceeding the preliminary cleanup levels in groundwater have been observed near the 1991 waste oil UST excavation. The lateral extent of DRPH and GRPH in groundwater above the preliminary cleanup levels is shown on Figures 10 and 11.

3.4 PRELIMINARY EXPOSURE ASSESSMENT

The preliminary exposure assessment identifies potential receptors for exposure pathways for environmental media of potential concern from contaminant fate and transport mechanisms. Potential receptors at risk from exposure associated with the presence of COPCs at the Site are human and ecological receptors. The two potential receptors were segregated into subcategories to better identify the potential receptors at risk of exposure from the presence of COPCs in environmental media of potential concern. The subcategories for human health include workers, recreational use, drinking water consumption, and fish and shellfish consumption; the subcategories for ecological include terrestrial and aquatic biota.

The objective of the preliminary exposure assessment is to assess the completeness of exposure pathways from environmental media of potential concern and associated contaminant fate and transport mechanisms for the potential receptors for the Site. The results from the preliminary exposure assessment will assist with the evaluation of potential feasible cleanup alternatives that are protective of the potential receptors identified as complete. The preliminary exposure assessment for the Site is illustrated in a flow diagram (Figure 6). The preliminary exposure assessment for each exposure pathway and associated environmental media of potential concern is summarized below by affected environmental media.

3.4.1 Soil

Soil with concentrations of COPCs above the preliminary cleanup levels may present a potential exposure pathway to human and/or ecological receptors. The principal contaminant fate and transport mechanisms for soil at the Site include sorption, erosion, leaching, and volatilization (Figure 7). Leaching of TPH and BTEX from soil by dissolution and desorption to groundwater is discussed in the following subsection below.

- **Direct Contact (Dermal Contact and Ingestion) with Subsurface Adsorbed-Phase Contaminated Soil**. This exposure pathway is complete for subsurface soil via dermal contact or ingestion. The standard point of compliance for the direct contact exposure pathway for soil is 15 feet bgs for human health and 6 feet bgs for terrestrial receptors, which represents a reasonable depth that could be excavated during normal redevelopment activities and distributed at the ground surface (WAC 173-340-[6][d] and WAC 173-340-7490[4][b]). COPCs above the preliminary cleanup levels are present in shallow subsurface soil within 6 feet bgs at the Site. Areas where subsurface petroleum contaminated soil is present are covered by paved surfaces or with crushed rock or low growing vegetation to prevent the migration of material by erosion transport mechanisms.
- **Direct Contact of Sediments (Salmon Bay) with Erodible Adsorbed-Phase Contaminated Soil.** This exposure pathway is considered incomplete for potential receptors because residual adsorbed-phase contaminated soil is located 2 feet bgs

or greater based the distribution of COPCs present in soil at the Site. In addition, areas where subsurface petroleum contaminated soil is present are capped by paved surfaces or with crushed rock or low growing vegetation to prevent and/or inhibit contact with erodible absorbed-phase contaminated soil; making the migration pathway for erosion of contaminated soil incomplete.

- **Direct Contact of Surface Water Runoff.** This exposure pathway is considered incomplete for potential receptors. Surface water runoff does not come in contact with residual petroleum contaminated soil, which prevents leaching of COPCs by dissolution or desorption.
- **Inhalation of Soil Vapor/Outdoor Air.** This exposure pathway is considered complete for worker and terrestrial receptors by potential inhalation of volatile COPCs originating in the vadose zone and ambient air. The air-filled pore space between soil grains in the unsaturated zone or partially saturated zone is referred to as soil gas or soil vapor. Low molecular weight aromatic and aliphatic TPH fractions are highly volatile due to their relative low vapor pressures. The volatilization of TPH fractions from LNAPL, and adsorbed-phase contaminated soil can accumulate the concentrations of TPH in soil vapor and migrate to the surface to locally impact outdoor air quality near the unpaved surfaces. Once in the atmosphere, the vapors are unlikely to result in an exposure pathway to the general public due to the vapors being dispersed and/or degraded.

3.4.2 Groundwater

Groundwater is affected by surface and subsurface releases of COPCs and the leaching of LNAPL directly into a groundwater-bearing zone and the leaching of TPH and BTEX into infiltrating surface water that passes through unsaturated adsorbed-phase soil and migrates to groundwater. Groundwater with concentrations of COPCs above the preliminary cleanup levels may present a potential risk to human and/or ecological receptors. The primary contaminant fate and transport mechanism for groundwater at the Site include sorption, advection/dispersion, diffusion, and volatilization (Figure 7). Other contaminant fate and transport processes, such as biodegradation and oxidation, are expected to have minor to no influences in reducing potential exposures of COPCs to receptors. The biodegradation and oxidation processes appear to be occurring at a naturally slow rate to significantly contribute to the fate and transport processes of COPCs for the Site.

- **Direct Contact of Sediments (Salmon Bay).** This exposure pathway is considered incomplete for potential receptors. The discharge of dissolved-phase TPH and BTEX from groundwater hydraulically connected to Salmon Bay sediments is unlikely based on empirical evidence showing that concentrations of TPH and BTEX at monitoring wells located proximate to the shoreline do not contain concentrations of TPH and BTEX above laboratory reporting limits and/or the preliminary cleanup levels.
- **Direct Contact of Surface Water.** This exposure pathway could be complete, but the exposure pathway for potential human and ecological receptors is unlikely.

Potential groundwater with concentrations of TPH and BTEX entering the Salmon Bay would rapidly disperse and volatize more readily.

- **Direct Contact and Inhalation of Groundwater.** The shallow water-bearing zone at the Site has detectable concentrations of COPCs above the preliminary cleanup levels. Current access to the shallow water-bearing zone at the Site is limited to workers via environmental sampling. There are no drinking water supply wells located in the vicinity of the Site. Potential receptors are at risk from this exposure pathway if groundwater beneath the Site is developed for use as drinking water. It is unlikely that water beneath the Site would be used for drinking water because of the availability of municipal water supplies and land use of the Site; however, there is potential that future land use could allow for use of groundwater beneath the Site for drinking water. Therefore, the exposure pathways for groundwater are complete for workers and could be drinking water receptors for the shallow water-bearing zone.

  The exposure pathway for the intermediate water-bearing zone at the Site for potential worker and drinking water receptors could be complete, but the exposure pathway for potential workers and drinking water is unlikely due to the concentrations of TPH and BTEX rapidly attenuating in the shallow water-bearing zone away from the confirmed and suspected source areas. In addition, concentrations of TPH and BTEX in groundwater samples collected from 02MW05 are below the preliminary cleanup levels indicating that the semi-confining unit is acting as an attenuation barrier.

- **Inhalation of Soil Vapor/Outdoor Air.** This exposure pathway is considered complete for worker and terrestrial receptors via volatilization of the COPCs in groundwater to the vadose zone and outdoor air with subsequent inhalation by potential receptors. Low-range fuel fraction TPH and BTEX tend to be highly volatile due to their relative low vapor pressures. The volatilization of TPH from LNAPL, sorbed-phase soil, and dissolved-phase groundwater can accumulate the concentrations of TPH in soil vapor and migrate to the surface to locally impact outdoor air quality near the unpaved surfaces. Once in the atmosphere, the vapors are unlikely to result in an exposure pathway to the general public due to the vapors being dispersed, diluted, and/or degraded by photolysis.

4.0 REMEDIAL ALTERNATIVES ASSESSMENT

The purpose of this FS is to develop and evaluate cleanup action alternatives to facilitate selection of a final cleanup action at the Site in accordance with WAC 173-340-350(8). An FS includes the development, screening, and evaluation process for numerous remedial alternatives.

The FS is used to screen cleanup action alternatives to eliminate alternatives that are not technically possible or the costs are disproportionate under WAC 173-340-360(3)(e), or alternatives that will substantially affect the future planned business operations at the Site. Based on the screening, the FS presented below evaluates the most advantageous remedial components to recommend a final cleanup action for the Site in conformance with WAC 173-340-360 through WAC 173-340-390.

4.1 CLEANUP STANDARDS

The selected cleanup action alternative must comply with MTCA cleanup regulations specified in WAC 173-340 and with applicable federal and state laws. The preliminary cleanup levels and remedial action objectives for the Site are discussed in this section.

4.1.1 Applicable or Relevant and Appropriate Requirements

Under WAC 173-340-350 and 173-340-710, applicable requirements include regulatory cleanup standards, standards of control, and other environmental requirements, criteria, or limitations established under state or federal law that specifically address a contaminant, remedial action, location, or other circumstances at a site.

MTCA defines relevant and appropriate requirements as follows:

> …those cleanup action standards, standards of control, and other human health and environmental requirements, criteria, or limitations established under state and federal law that, while not legally applicable to the hazardous substance, cleanup action, location, or other circumstances at a site, the department determines address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. The criteria specified in WAC 173-340-710(3) shall be used to determine if a requirement is relevant and appropriate.

The criteria used to make this determination are presented in WAC 173-340-710(4)(a)-(i). Remedial actions conducted under MTCA must comply with the substantive requirements of the ARARs but are exempt from their procedural requirements (WAC 173-340-710[9]). Specifically, this exemption applies to state and local permitting requirements under the Washington State Water Pollution Control Act, Solid Waste Management Act, Hazardous Waste Management Act, Clean Air Act, State Fisheries Code, and Shoreline Management Act.

4.1.1.1 Screening of ARARs

ARARs were screened to assess their applicability to the Site. Only those that were deemed appropriate and applicable were retained as RAOs. The following table identifies the preliminary ARARs that may be applicable to the Site.

Preliminary ARARs for the Site

Preliminary ARAR	Citation or Source
MTCA	Chapter 70.105 of the Revised Code of Washington (RCW)
MTCA Cleanup Regulation	WAC 173-340
Ecology, Toxics Cleanup Program – Guidance To Be Considered	*Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*, Review DRAFT, October 2009, Publication No. 09-09-047
State Environmental Policy Act	RCW 43.21C
Washington State Shoreline Management Act	RCW 90.58; WAC 173-18, 173-22, and 173-27

Preliminary ARAR	Citation or Source
The Clean Water Act	33 United States Code [USC] 1251 et seq.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	42 USC 9601 et seq. and Part 300 of Title 40 of the Code of Federal Regulations [40 CFR 300]
The Fish and Wildlife Coordination Act	16 USC 661-667e; the Act of March 10, 1934; Ch. 55; 48 Stat. 401
Endangered Species Act	16 USC 1531 et seq.; 50 CFR 17, 225, and 402
Native American Graves Protection and Repatriation Act	25 USC 3001 through 3013; 43 CFR 10 and Washington's Indian Graves and Records Law (RCW 27.44)
Archaeological Resources Protection Act	16 USC 470aa et seq.; 43 CFR 7
Washington Dangerous Waste Regulations	WAC 173-303
Solid Waste Management Act	RCW 70.95; WAC 173-304 and 173-351
Occupational Safety and Health Administration Regulations	29 CFR 1910, 1926
Washington Department of Labor and Industries Regulations	WAC 296
Water Quality Standards for Surface Waters of the State of Washington	RCW 90.48 and 90.54; WAC 173-201A
Water Quality Standards for Ground Water	WAC 173-200
Department of Transportation Hazardous Materials Regulations	40 CFR 100 through 185
Washington State Water Well Construction Act	RCW 18.104; WAC 173-160
King County regulations, codes, and standards	All applicable or relevant and appropriate regulations, codes, and standards
City of Seattle regulations, codes, and standards	All applicable or relevant and appropriate regulations, codes, and standards

4.1.2 Development of Cleanup Standards

The selected cleanup alternative must comply with the MTCA cleanup regulations specified in WAC 173-340 and with applicable state and federal laws. The preliminary cleanup levels selected for those portions of the Site located within the East Waterfront Property boundary and for the greater Site are consistent with the RAOs, which state that the RAO is to reduce concentrations of COPCs in soil and/or groundwater beneath the Site to below their preliminary cleanup levels or remediation levels, if applicable, at defined points of compliance. In addition to mitigating risks to human health and the environment, achieving the RAOs will allow Ecology to issue Property- and/or Site-specific determinations of No Further Action (NFA). The preliminary cleanup levels for the media and COPCs are presented in Table 1.

4.1.3 Remedial Action Objectives

RAOs are administrative goals for a cleanup action that address the overall MTCA cleanup process. The purpose of establishing RAOs for a site is to provide remedial alternatives that protect human health and the environment (WAC 173-340-350). In addition, RAOs are designated to:

- Implement administrative principles for cleanup (WAC 173-340-130).
- Meet the requirements, procedures, and expectations for conducting an FS and developing cleanup action alternatives as discussed in WAC 173-340-350 through 173-340-370.
- Develop cleanup levels (WAC 173-340-700 through 173-340-760) and remedial alternatives that are protective of human health and the environment.

In particular, RAOs must address the following threshold requirements from WAC 173-340:

- Protect human health and the environment.
- Comply with cleanup levels.
- Comply with applicable state and federal laws.
- Provide for compliance monitoring.

The RAOs for the Site are to mitigate potential exposure pathways for human and terrestrial receptors and to comply with ARARs and Site-specific cleanup standards to demonstrate compliance and obtain an NFA determination from Ecology. The implementation of the selected cleanup action alternative will address the potential exposure pathways to protect the human health and the environment. Compliance monitoring will demonstrate the cleanup standards have been met at the established points of compliance defined in the cleanup action plan. A request for an NFA determination from Ecology will be made upon completion of the compliance monitoring plan.

4.2 IDENTIFICATION AND EVALUATION OF TECHNOLOGIES

SoundEarth evaluated remedial alternatives for the Site with respect to the cleanup requirements set forth in MTCA. According to MTCA, a cleanup action alternative must satisfy the minimum threshold requirements for RAOs, as outlined in Section 4.1.3 above. WAC 173-340-360 (2)(b) also requires the cleanup action alternative to meet the following requirements:

- Use permanent solutions to the maximum extent practicable.
- Provide for a reasonable restoration time frame.
- Consider public concerns.

A comprehensive list of remedial components and the rationale for inclusion or exclusion of specific components options with respect to the MTCA evaluation criteria are summarized in Table 2. The remedial components are separated into nine distinct component groups, including passive remediation, in situ physical treatment, in situ thermal, source removal, ex situ source treatment, in situ chemical oxidation, containment/immobilization, phytoremediation, and in situ bioremediation. The nine component groups are further subdivided into component options that are possible controls and technologies to achieve the RAOs. One or a combination of these component options may apply to remediate COPCs for the Site.

The remedial components retained after the screening evaluation include the following:

- Monitored Natural Attenuation
- Soil vapor extraction (SVE)
- Air sparging
- Dual-phase extraction (DPE)
- Excavation without shoring
- Landfill Disposal
- Aerobic bioremediation

A comprehensive list of remedial technologies is presented in Table 2. The remedial alternatives were evaluated using the above criteria. The screening matrix of each cleanup action alternatives is discussed in further detail below.

4.2.1 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a passive process that depends on intrinsic environmental factors to reduce contaminant concentrations over time in the absence of human effort through natural processes, such as biodegradation, adsorption, dissolution, diffusion, and advection and dispersion.

MNA includes the active process of monitoring and documenting the effectiveness of an otherwise passive technology. It is often used as a polishing technology after an active technology has reduced contaminant concentrations but is unable to achieve cleanup levels. Monitoring is needed to evaluate the effectiveness of natural attenuation and to document the achievement of cleanup levels.

4.2.2 Soil Vapor Extraction

SVE is proven technology for recovering volatile petroleum hydrocarbons from unsaturated soil. This technology is implemented by installing vertical and/or horizontal wells within the zone of contamination. Vacuum is applied to recover contaminants in the vapor phase for subsequent treatment and disposal, if necessary. This technology is not suitable for the treatment or recovery of contaminated groundwater and is not suitable for the remediation of middle- to heavy-range petroleum hydrocarbons. The initial treatment of recovered soil vapor would likely be required prior to release to the atmosphere.

4.2.3 Air Sparging

Air sparging is a proven technology for the remediation of VOCs, including volatile TPH, in saturated soil and groundwater. This technology is implemented by installing vertical or horizontal wells within the saturated zone and below the treatment zone. Compressed ambient air is injected into the air sparge wells to air strip volatile VOCs located in the saturated zone. Air sparging is combined with SVE to recover contaminants in the vapor phase. Air sparging is also referred to as biosparging when treating source areas with semivolatile TPH compounds, such as diesel and oil. Biosparging is an air or oxygen delivery system that uses lower air flow rates than an air sparging system. The goal of biosparging is to increase dissolved oxygen in the subsurface and stimulate biodegradation. The volatile compounds are degraded as dissolved-phase and vapor-phase contaminants slowly move through the biologically active soil.

4.2.4 Dual-phase Extraction

DPE is proven technology for the remediation of VOCs in soil and groundwater. A DPE remediation system typically consists of a submersible pump to recover groundwater, simultaneous application of vacuum to the exposed soil column to recover VOCs from the soil in the vapor phase. The recovery of groundwater reduces the mobility of the dissolved-phase contaminant plume through hydraulic containment. Groundwater extraction can be effective for low- to high- permeability soils (EPA 1999). The vapor extraction component removes mass from the semi-saturated and unsaturated soil zones by volatilizing the contaminant and capturing the mass in the vapor phase for ex situ treatment or discharge.

4.2.5 Excavation without Shoring and Land Disposal

Excavation without and land disposal are remedial components for the excavation of source material. Excavation of source material is a proven technology for the removal of contaminants from the subsurface. Soil and groundwater excavated from the source area for petroleum-contaminated soil would be directly land disposal at a permitted facility. It is assumed that the generated waste stream will be designated as non-hazardous waste. Contaminated soils might require pretreatment prior to land disposal if concentrations of regulated substances exceed levels permissible for land disposal; otherwise, excavated source material would be land disposed directly without pretreatment in accordance with federal, state, and local regulations.

4.2.6 Aerobic Bioremediation

Bioremediation of COPCs in soil and groundwater is most efficient and sustainable under aerobic conditions (i.e., in the presence of oxygen). Increasing the availability and concentration of oxygen in the subsurface by an engineered method enhances the rate at which the COPCs are degraded aerobically. Proven methods to increase oxygen concentrations in the saturated zone include injecting chemical reactants that produce elemental oxygen (e.g., sodium percarbonate or peroxide salts) and sparging compressed air or oxygen gas directly into the water-bearing zone. The increased oxygen concentration resulting from these enhancements produces an increased and sustained rate of biodegradation of COPCs.

4.3 FOCUSED EVALUATION OF TREATMENT ALTERNATIVES

The focused evaluation of the cleanup action alternatives considers the practicable remedial components confirmed to be effective at treating the COPCs in the affected environmental media. The evaluation also considers whether the Site-specific constraints would preclude the application of a remedial component due to the creation of a greater risk to human health and/or the environment, or that such constraints could result in the remedial technology being technically or administratively infeasible to implement, or if the component was disproportionately costly relative to benefits realized. A detailed description of the three alternatives that were retained for additional consideration is provided below.

4.3.1.1 Cleanup Action Alternative 1, Excavation with Off-Site Disposal

Cleanup Action Alternative 1 involves the excavation of soil with concentrations of COPCs exceeding the preliminary cleanup levels with off-Property transportation and disposal for the petroleum-contaminated soil (PCS). Figure 12 provides a conceptual illustration of how this alternative might be implemented. Clean structural fill would be imported and compacted to restore the excavation area to its original grade. It is assumed that a shoring system would not be required. The excavated material would be transport to a permitted landfill for offsite direct disposal. A large-diameter auger would be used to remove PCS at a depth of approximately 25 feet around the well 02MW05, if necessary to compliance with the final established cleanup standards provided in the future cleanup action plan. The estimated total volume of PCS to be hauled off site is 1,650 bank cubic yards (bcy). Generally, a tonnage conversion rate of 1.5 would be applied to the bank cubic yards; however, a 1.65 tonnage conversion rate was used because of the proximity of the excavation to the shoreline and the anticipated increase in tonnage due to the moisture content of the soil.

Dewatering may also be required during the excavation. Water removed by dewatering would be pretreated on Site and discharged to the King County storm or sanitary sewer system for final disposal. Trucks would transport contaminated soil for off-site disposal, and return with clean fill. Clean fill would be stockpiled temporarily until confirmation soil sampling indicated that the cleanup standards have been met. Clean fill would then be backfilled and compacted in uniform lifts to achieve the specified density.

During excavation activities, compliance soil sampling would be performed to document that the cleanup levels were attained. It is assumed that after petroleum contaminated soil is removed, groundwater would be restored to below cleanup levels. Groundwater would be monitored after completion of excavation activities to confirm that cleanup levels were attained. If cleanup levels are not attained, monitoring of the groundwater would continue until cleanup levels were achieved through natural attenuation. Attainment of all cleanup levels would be confirmed by Ecology through their issuance of an NFA determination for the East Waterfront Property.

Under MTCA, monitored natural attenuation can be considered an active remedial measure if site conditions conform to the expectations listed in WAC 173-340-370(7), as follows:

- Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable.
- Leaving contaminants in place during the restoration time frame does not pose an unacceptable threat to human health or the environment.

- There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the Site.
- Appropriate monitoring requirements are conducted to ensure that the natural attenuation process is taking place and that human health and the environment are protected.

In addition to monitoring changes in concentrations of COPCs in groundwater beneath the East Waterfront Property, critical parameters to be measured would include the following:

- pH
- Dissolved oxygen
- Oxidation-reduction potential
- Metals scan (total iron, ferrous iron, calcium, magnesium, dissolved manganese)
- Anion scan (chloride, sulfate, nitrate included)
- Methane
- Total organic carbon

Key assumptions for this alternative include the following:

- The volume of imported fill would be equivalent to the contaminated and clean overburden soil hauled off the Site (1,650 bcy).
- There are no utilities within the proposed excavation area that require capping, rerouting, or shoring.
- A minimum of 20 compliance soil samples would be required to confirm that PCS had been removed from the Site.
- Whether natural biodegradation of COPCs in groundwater occurs would be evaluated based on monitoring trends over time in COPC concentrations and the critical parameters listed above.
- Compliance groundwater monitoring is assumed to be a total of 3 years for the purposes of the disproportionate cost analysis (DCA). A minimum of 4 consecutive quarters of groundwater monitoring data indicating that concentrations of COPCs are below the cleanup levels for groundwater would be required, and subsequent groundwater monitoring may also be required to assess the progress of natural biodegradation. The subsequent groundwater monitoring is assumed to occur quarterly for an additional 2 years.

The present worth cost to complete Cleanup Action Alternative 1, assuming a discount rate of negative 1.4 percent and a life cycle of 3 years, is approximately $701,000 (Table 3).

4.3.1.2 Cleanup Action Alternative 2, Air Sparging with Soil Vapor Extraction

Cleanup Action Alternative 2 involves the installation and operation of air sparge (AS) wells and shallow horizontal SVE trenches to remediate groundwater and treat the concentrations of

COPCs in soil to below the cleanup standards. Figure 13 provides a conceptual illustration of how this cleanup action alternative might be installed if implemented.

AS wells would be installed in the approximate locations shown on Figure 13. Wells would consist of 1-inch-diameter PVC pipe with the bottommost foot of the pipe slotted to enable compressed air to be bubbled into the saturated zone by way of an air compressor located in the remedial compound. The bottom elevation for each well would be approximately 5 feet above mean sea level (msl) to ensure an air injection depth of at least 10 to 12 feet below the prevailing groundwater surface elevation. Because the East Waterfront Property exhibits an average slope of 11 percent to the north, the southernmost wells would require longer pipe runs than the northernmost wells if the bottom elevation for all wells is set at approximately 5 feet above msl.

Shallow trenches (approximately 3 feet bgs) would be excavated in the approximate locations shown, to be used for SVE. Slotted PVC pipe laterals would be installed in the bottom of each trench and connected to a manifold situated in the remediation compound.

A vacuum would be applied to the trenches to recover vapor-phase COPCs that source from unsaturated zone soils as well as vapor COPCs that are produced by air sparging contaminated groundwater. Recovered vapors from the system would be monitored monthly to assess the effectiveness and progress of the system. Vapors are assumed to require treatment with vapor-phase granular-activated carbon for the initial 6 months of system operation, after which vapors would be at concentrations low enough to discharge directly to the atmosphere. Confirmation soil and groundwater samples would be used to demonstrate that the RAOs were attained at the presumed conclusion of remediation. The compliance monitoring plan would be finalized in a formal cleanup action plan.

Key assumptions for this cleanup action alternative include the following:

- Subsurface geology is favorable for successful implementation of this technology.
- A total of 17 AS wells, placed on 25-foot centers, will be installed.
- Shallow SVE piping will be installed to capture vapors generated from the AS wells.
- The entire treatment area, approximately 16,000 square feet, will be capped before implementation.
- Any water produced due to the operation of the AS/SVE system could be handled minimally using the mechanical equipment and scheduled vacuum truck disposal; therefore, a permitted temporary discharge to the sewer would not be warranted.
- Permit analysis and application will be obtained for the discharge of recovered vapors to ambient air.
- It is assumed that vapors will require treatment with granular-activated carbon for the initial 6 months of system operation.
- The life cycle for this alternative is assumed to be 7 years for the purpose of estimating the present worth cost. This duration should not be construed as a guaranteed remediation time frame.

- Groundwater quality would be monitored quarterly throughout the operational time frame and for at least 4 quarters following the operation of the AS/SVE system to confirm compliance with preliminary cleanup levels.

The present worth cost estimate to implement Cleanup Action Alternative 2, assuming a real discount rate of negative 0.4 percent and a life cycle of 7 years, is approximately $1,181,000 (Table 4).

4.3.1.3 Cleanup Action Alternative 3, Dual-Phase Extraction

Cleanup Action Alternative 3 involves the installation of DPE remediation wells and treatment system. Figure 14 provides a conceptual illustration of how this cleanup action alternative might be installed if implemented.

DPE wells would be installed in the approximate locations shown on Figure 14. Wells would consist of 2-inch-diameter Schedule 40 PVC installed to depths similar to those described for Cleanup Action Alternative 2. The bottom elevation for each well would be approximately 5 feet above msl to ensure the treatment of a saturated thickness of at least 10 to 12 feet below the prevailing groundwater surface elevation. The wells would be constructed with well screens long enough to span the entire saturated zone and at least 5 feet above the historical high water table elevation. Because the East Waterfront Property exhibits an average slope of 11 percent to the north, the southernmost wells would require longer pipe runs than the northernmost wells if the bottom elevation for all wells is set at approximately 5 feet above msl. Air-operated total fluid pumps would be installed in each well to recover contaminated groundwater for treatment. Vacuum would be simultaneously applied to each well to recover soil vapor. The combined effect of groundwater pumping and vapor extraction would remediate the groundwater and soil contamination.

Shallow trenches, approximately 3 feet bgs, would be excavated in the approximate locations shown to be used to run air supply, SVE, and water recovery pipes from the wells to the mechanical equipment located in the remediation compound.

Water recovered by the system would be pretreated on site using air stripping or granular-activated carbon. Treated water would be discharged to the King County storm or sanitary sewer system for final disposition. Recovered vapors from the system would be monitored monthly to assess the effectiveness and progress of the system. Vapors are assumed to require treatment with vapor-phase granular-activated carbon for the initial 6 months of system operation, after which vapors would be at concentrations low enough to discharge directly to the atmosphere. Confirmation soil and groundwater samples would be used to demonstrate that the RAOs were attained at the presumed conclusion of remediation. The compliance monitoring plan would be finalized in a formal cleanup action plan.

Key assumptions for this cleanup action alternative include the following:

- Subsurface geology is favorable for successful implementation of this technology.
- A total of 20 DPE wells placed on 25-foot centers will be installed.
- The entire treatment area, approximately 16,000 square feet, will be capped before implementation.

- Permit analysis and application will be obtained for the discharge of groundwater to the sanitary sewer or stormwater mains located in the ROW and recovered vapors to ambient air.
- Vapors will require treatment with granular-activated carbon for the initial 6 months of DPE system operation.
- The life cycle for this alternative is assumed to be 10 years for the purpose of estimating the present worth cost. This duration should not be construed as a guaranteed remediation time frame.
- Groundwater quality would be monitored quarterly throughout the operational time frame and for at least 4 quarters following the operation of the system to confirm compliance with cleanup levels.

The present worth cost estimate to implement Cleanup Action Alternative 3, assuming a real discount rate of 0.1 percent and a life cycle of 10 years, is approximately $1,719,000 (Table 5).

4.4 ALTERNATIVE EVALUATION PROCESS

This section presents the criteria used to evaluate the potentially feasible cleanup action alternatives with respect to the RAOs established for the Site. Remedial components were identified in accordance with the requirements set forth in MTCA under WAC 173-340-350(8)(b) and the focused screening of potential remedial components using the requirements and procedures for selecting cleanup actions as set forth in MTCA under WAC 173-340-360(2)(a)(b). The criteria used to evaluate and compare applicable cleanup action alternatives were derived from WAC 173-340-360(3)(f) and include the following:

- **Protectiveness.** The overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, the time required to reduce risk at the facility and attain cleanup standards, the risks resulting from implementing the alternative, and improvement of overall environmental quality of the Site.
- **Permanence.** 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 the sources of releases, the degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated during the treatment process.
- **Effectiveness over the long term.** The degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time over which hazardous substances are expected to remain on the Site, and the magnitude of residual risk associated with the contaminated soil and/or groundwater components. The following types of cleanup action components, presented in descending order, may be used as a guide when assessing the relative degree of long-term effectiveness of the chosen alternative: reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined, and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.

- **Management of short-term risks.** The risk to human health and the environment associated with the alternative during its construction and implementation, and the effectiveness of measures that will be taken to manage such risks.
- **Technical and administrative implementability.** The ability to implement the alternative; includes consideration of the technical feasibility of the alternative, administrative and regulatory requirements, permitting, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with the future development plans for the East Waterfront Property.
- **Consideration of public concerns.** Consideration of public concerns is mandated under the MTCA cleanup regulation for an Ecology-led or potentially liable person-led cleanup action under an Agreed Order or Consent Decree. This is typically implemented by Ecology through a mandatory public review and comment period on a proposed cleanup action plan. Because this public review and comment process is not implemented by the private party responsible for the cleanup under the Voluntary Cleanup Program (VCP) and because this FS Report was prepared within the purview of the VCP, public concerns regarding cleanup actions for this Site were not evaluated in this document.
- **Cost.** The cost to implement the alternative, including the cost of construction, the net present value of long-term costs, and Ecology oversight costs. Long-term costs that were considered include those associated with operation and maintenance (O&M), monitoring, equipment replacement, reporting, and maintaining institutional controls. Many of these costs are evaluated as part of the disproportionate cost analysis section presented below.

4.5 COMPARISON OF ALTERNATIVES

A summary of the evaluation of the cleanup action alternatives using the MTCA evaluation criteria (WAC 173-340-360[3][f]) is presented in Table 6 and summarized below:

- **Protectiveness.** The cleanup action alternatives are protective of human health and the environment, but Cleanup Action Alternative 1 provides more protectiveness than the competing alternatives because it involves the permanent removal and off-site disposal of PCS.
- **Permanence.** The three cleanup action alternatives provide a degree of permanence. Although Cleanup Action Alternative 1 would provide an extra measure of permanence than the other two alternatives, there is a potential that groundwater restoration would not result as quickly as predicted with the removal of PCS, which could prolong the restoration time frame for this alternative to a point equal to or longer than that predicted for the competing alternatives.
- **Effectiveness over the Long Term.** The three cleanup action alternatives employ proven technologies for the remediation of the identified COPCs. The long-term effectiveness for Cleanup Action Alternative 1 is slightly higher than other alternatives because of the permanent removal of PCS.
- **Management of Short-Term Risks.** The short-term risks are significantly higher for Cleanup Action Alternative 1 than for Cleanup Action Alternatives 2 and 3 because the former involves excavation, transportation, and material handling hazards. Cleanup Action Alternatives 2 and 3 are considered to present fewer short-term risks compared to Cleanup Action Alternative 1 since there is limited contact and/or exposure to COPCs for shallow system trenching.

- **Technical and Administrative Implementability.** The technical and administrative obstacles to implement Cleanup Action Alternative 1 are greater than the other alternatives due to the extensive permitting requirements potentially imposed by the City of Seattle related to excavating in proximity to buildings and utilities located on the East Waterfront Property. Cleanup Action Alternative 1 would also result in significant disruption to the East Waterfront Property and its users. Cleanup Action Alternatives 2 and 3 present fewer obstacles in comparison to Cleanup Action Alternative 1.

As indicated in Table 6, when equal weighing factors are used for each of the evaluation criteria, Cleanup Action Alternative 1 achieved the highest ranking score (37). Cleanup Action Alternatives 2 and 3 achieved lower ranking scores, 35 and 33, respectively.

4.6 DISPROPORTIONATE COST ANALYSIS

The purpose of a DCA is to facilitate selection of the cleanup action alternative providing the highest degree of permanence to the maximum extent practicable. The DCA considers Cleanup Action Alternatives 1 through 3. Costs are considered disproportionate if the incremental costs of one alternative versus a less expensive alternative exceed the incremental benefit achieved by the more expensive alternative. The following is a description of the factors that were used to estimate the cost of the three cleanup action alternatives discussed above.

- **Capital Costs.** These costs include expenditures for equipment, labor, and material necessary to install a remedial action. Indirect costs may be incurred for engineering, financial, or other services not directly involved with installation of remedial alternatives but necessary for completion of this activity.

- **Operation and Maintenance Costs.** These are post-construction costs necessary to provide effective implementation of the alternative. Such costs may include, but are not limited to, operating labor; maintenance materials and labor; disposal of residues; and administrative, insurance, and licensing costs.

- **Monitoring Costs.** These costs are incurred from monitoring activities associated with remedial activities. Cost items may include sampling labor, laboratory, analyses, and report preparation.

- **Present Worth Analysis.** Present worth analysis provides a method of evaluating and comparing costs that occur over different time periods by discounting all future expenditures to the present year. The present worth cost or value represents the amount of money which, if invested in year 0 and disbursed as needed, would be sufficient to cover all costs associated with a remedial alternative. The assumptions necessary to derive a present worth cost are inflation rate, discount rate, and period of performance. A discount rate, which is similar to an interest rate, is used to account for the time value of money. The U.S. Environmental Protection Agency (EPA) policy on the use of discount rates for DCA cost analyses are stated in the preamble to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) published at the Federal Register (55 FR 8722) and in Office of Solid Waste and Emergency Response Directive 9355.3-20 titled *Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis* (EPA 1993). Based on the NCP and this directive, a discount rate of 7 percent is recommended in developing present value cost estimates for remedial action alternatives during the DCA. This recommended rate is intended to represent a "real" discount rate in that it approximates the marginal pretax rate of return on an average historical investment in the private sector and has been adjusted to eliminate the effect of expected inflation. For this DCA, a more conservative real discount rate was selected based on the December 2013 revisions to Appendix C of the U.S. Office of Management and Budget (OMB) Circular A-94. The real discount rates used to estimate the present worth of annual operating costs are based on the estimated restoration time frame (life cycle) for each alternative and the associated real discount rates from the referenced OMB Circular, which is published annually in December.

It is assumed that all capital costs are incurred in year 0, the present worth analysis is performed only on annual O&M and groundwater monitoring costs. The total present worth for a given alternative is equal to the sum of the capital costs and the present worth of annual O&M and monitoring costs over the anticipated life cycle of the alternative.

Using these criteria, the present worth costs of Cleanup Action Alternatives 1 through 3 are as follows:

- Cleanup Action Alternative 1, $701,000 (Table 3)
- Cleanup Action Alternative 2, $1,181,000 (Table 4)
- Cleanup Action Alternative 3, $1,719,000 (Table 5)

As indicated above, the present worth cost of Cleanup Action Alternative 1 is less than Cleanup Action Alternatives 2 and 3 and also scores higher in benefits than the other two alternatives. Chart 1 plots the relative cost and ranking scores, and Chart 2 plots the cost–to-benefit ratios for the three alternatives in order to illustrate the relative cost and benefits afforded by each alternative. The charts clearly demonstrate that Cleanup Action Alternative 1 exhibits the lowest cost-to-benefit ratio.

4.7 RECOMMENDED CLEANUP ACTION ALTERNATIVE

After performing the comparative analysis and ranking of alternatives in accordance with the MTCA evaluation criteria, Cleanup Action Alternative 1 is the recommended alternative. Cleanup Action Alternative 1, which entails excavation with off-site landfill disposal to remediate COPCs at the Site, is the recommended alternative because it achieves the RAOs, meets the requirements set forth in WAC 173-340-360(3) and 173-340-370, and is favorable with respect to the established evaluation and ranking criteria. Cleanup Action Alternative 1 also exhibits the lowest cost-to-benefit ratio compared to the competing alternatives, as discussed in Section 4.6, Disproportionate Cost Analysis.

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6.0 LIMITATIONS

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

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

FIGURES

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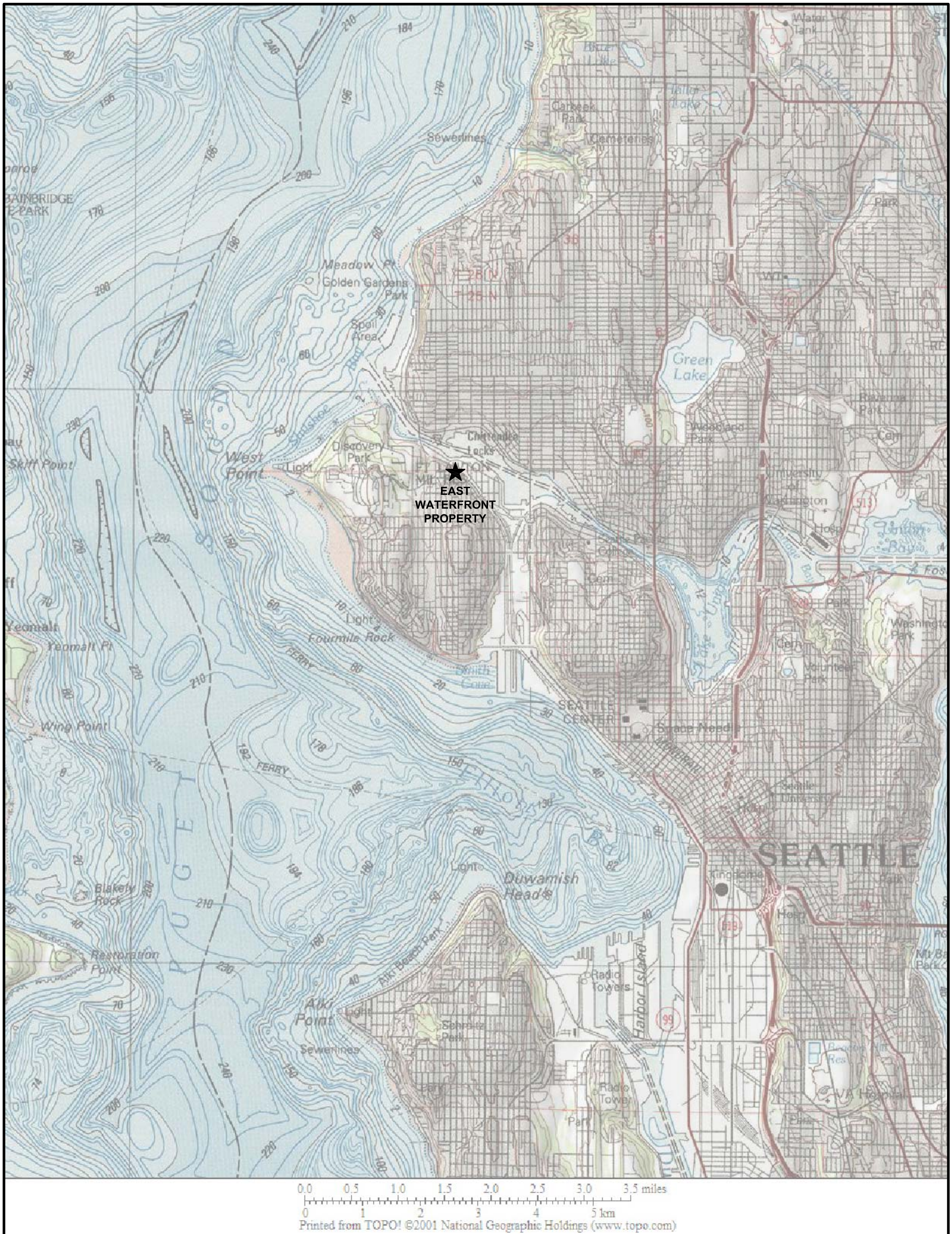

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DATE: 05/13/14
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CHECKED BY: PJK/TSB
CAD FILE: 0600_FIG1_VICINITY_EWA

PROJECT NAME: EAST WATERFRONT PROPERTY
PROJECT NUMBER: 0440-004
STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

FIGURE 1
PROPERTY LOCATION MAP

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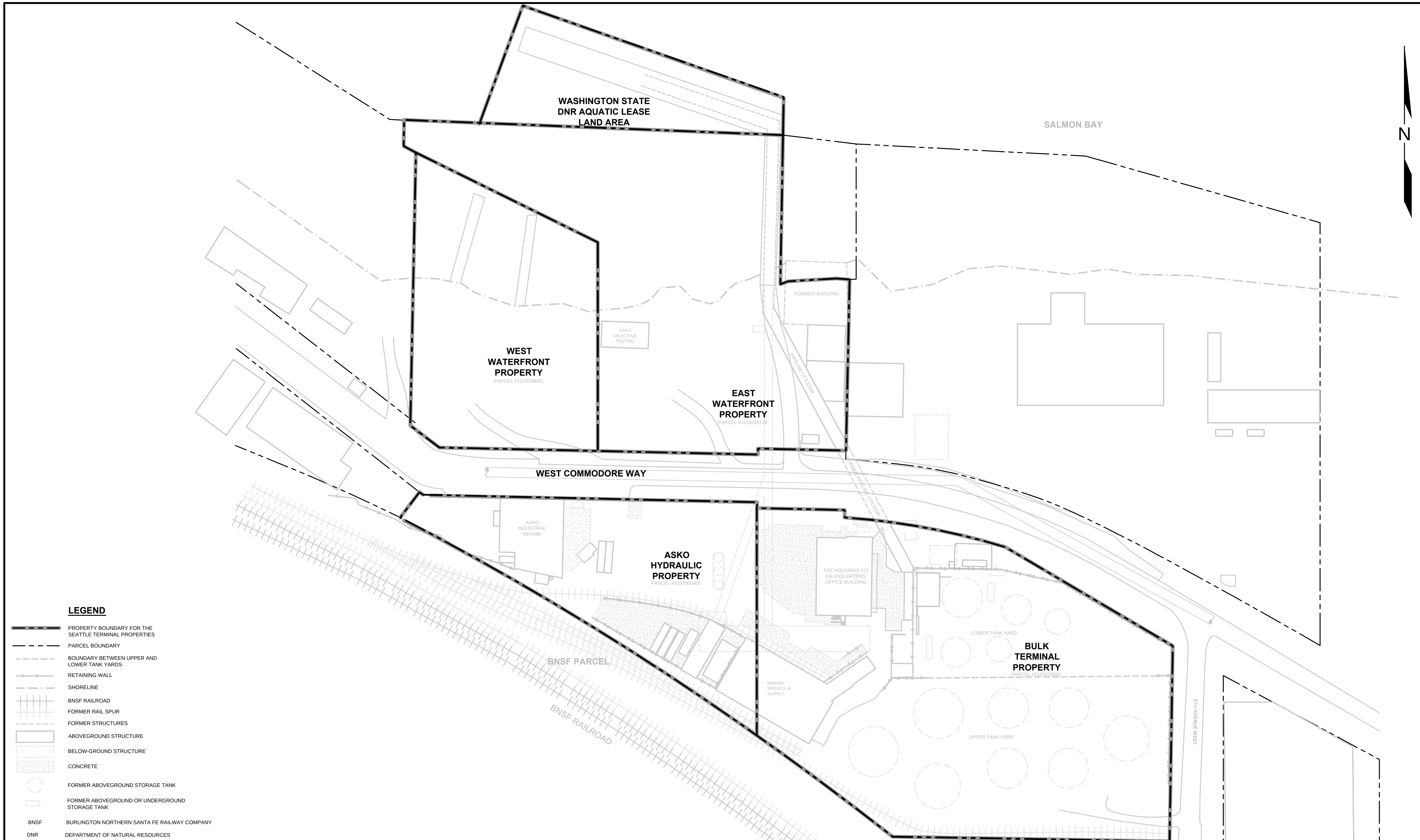

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PROJECT NAME: TOC HOLDINGS CO. SEATTLE TERMINAL PROPERTIES
PROJECT NUMBER: 0440-004
STREET ADDRESS: 2737, 2750, 2800, AND 2805 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 30 60 120 240
APPROXIMATE SCALE IN FEET

FIGURE 2
SEATTLE TERMINAL PROPERTIES
PROPERTY PLAN

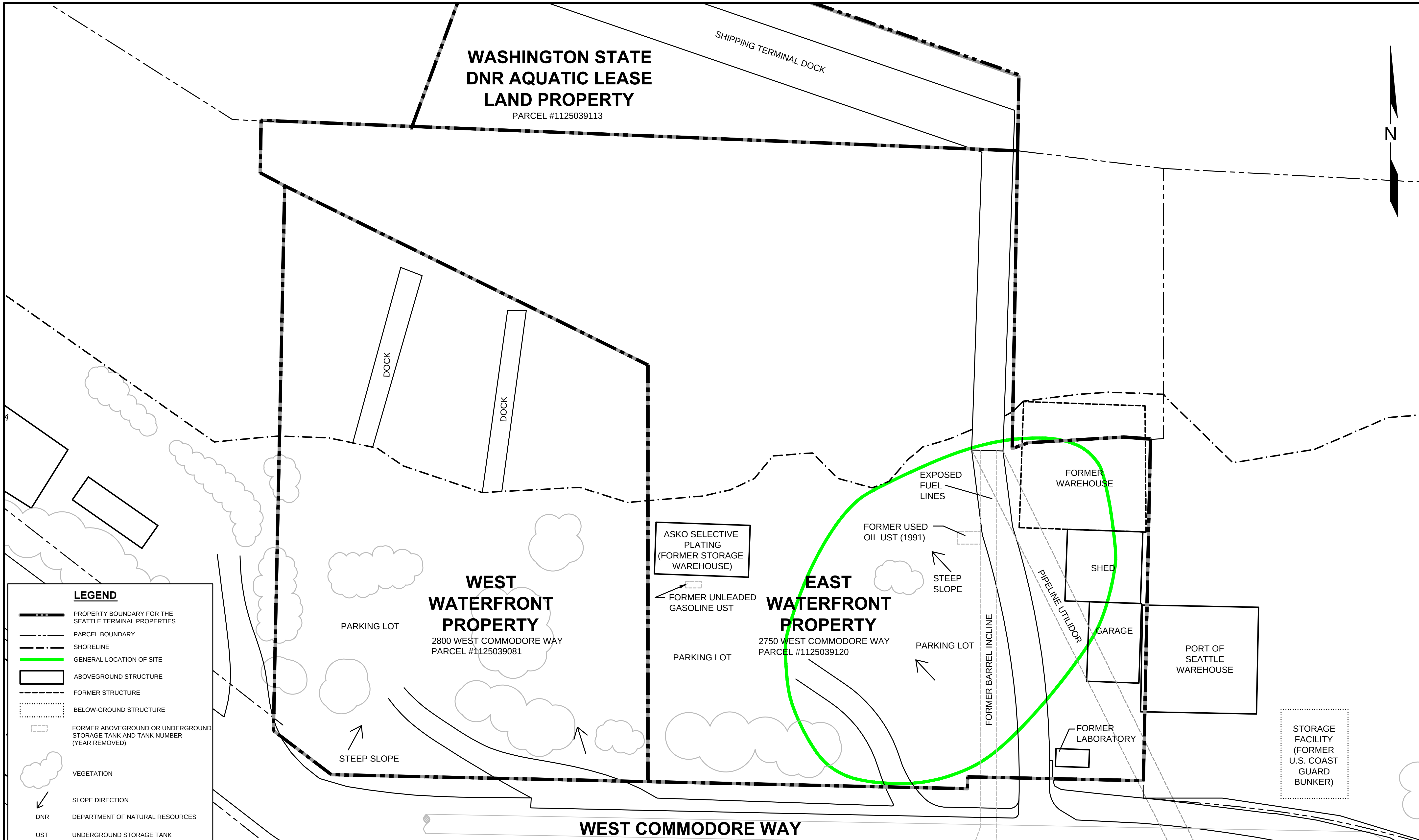

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FIGURE 3
SITE LOCATION MAP

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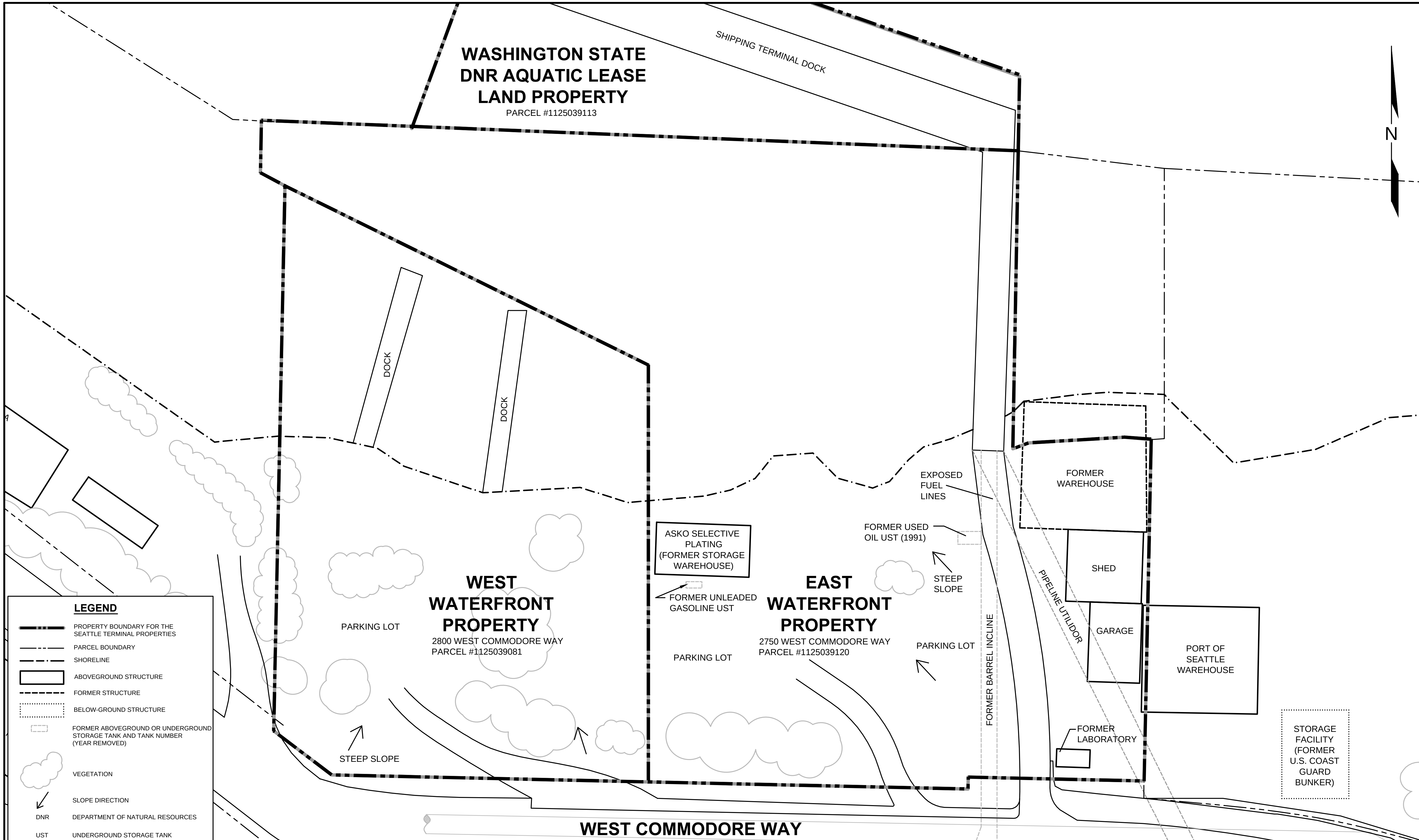

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PROJECT NUMBER: 0440-004
STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 30 60 120
APPROXIMATE SCALE IN FEET

FIGURE 4
HISTORICAL FEATURES

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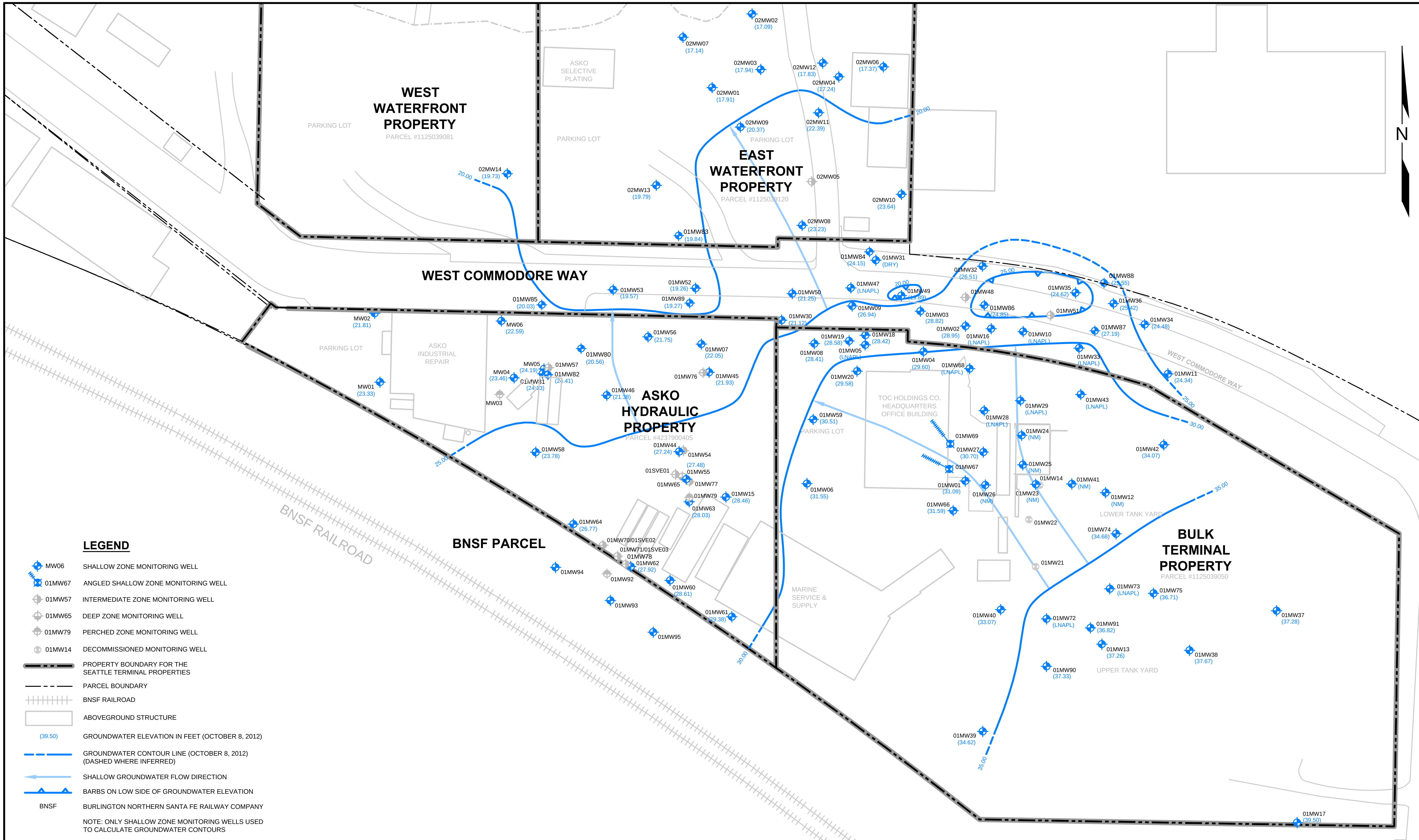

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PROJECT NUMBER: 0440-004
STREET ADDRESS: 2737, 2750, 2800, AND 2805 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 40 80 160
APPROXIMATE SCALE IN FEET

FIGURE 5
SEATTLE TERMINAL PROPERTIES
GROUNDWATER CONTOUR MAP
SHALLOW WATER-BEARING ZONE
(OCTOBER 8, 2012)

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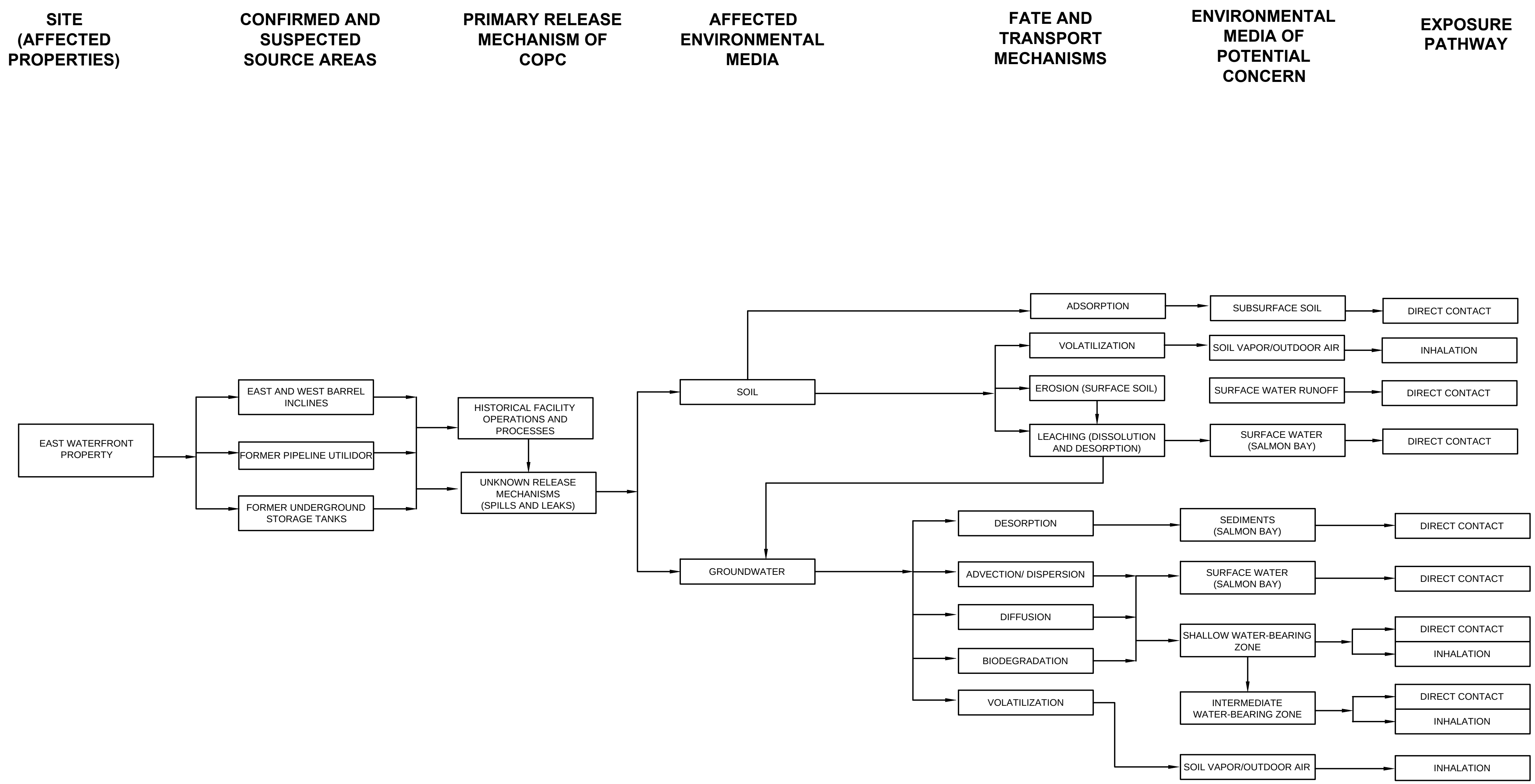


Environmental Media of Potential Concern	Exposure Pathway	HUMAN: Workers	HUMAN: Recreational	HUMAN: Drinking Water	HUMAN: Fish and Shellfish Consumption	ECOLOGICAL: Terrestrial	ECOLOGICAL: Aquatic Biota
Subsurface Soil	Direct Contact	●	X	NA	X	●	X
Soil Vapor/Outdoor Air	Inhalation	●	X	NA	X	●	X
Surface Water Runoff	Direct Contact	X	X	NA	X	X	X
Surface Water (Salmon Bay)	Direct Contact	X	X	X	X	X	X
Sediments (Salmon Bay)	Direct Contact	X	X	X	X	X	X
Surface Water (Salmon Bay)	Direct Contact					X	
Shallow Water-Bearing Zone	Direct Contact	●	X	●	X	X	X
Shallow Water-Bearing Zone	Inhalation	●	X	●	X	X	X
Intermediate Water-Bearing Zone	Direct Contact		X		X	X	X
Intermediate Water-Bearing Zone	Inhalation		X		X	X	X
Soil Vapor/Outdoor Air	Inhalation	●	X	X	X	●	X

LEGEND

●	EXPOSURE PATHWAY COMPLETE FOR POTENTIAL RECEPTOR
(blank box)	EXPOSURE PATHWAY COULD BE COMPLETE, BUT THE POTENTIAL RECEPTOR IS UNLIKELY
X	EXPOSURE PATHWAY INCOMPLETE
NA	NOT APPLICABLE
UST	UNDERGROUND STORAGE TANK
COPC	CHEMICALS OF POTENTIAL CONCERN

NOTE: DIRECT CONTACT INCLUDES DERMAL AND INGESTION

SoundEarth Strategies
WWW.SOUNDEARTHINC.COM

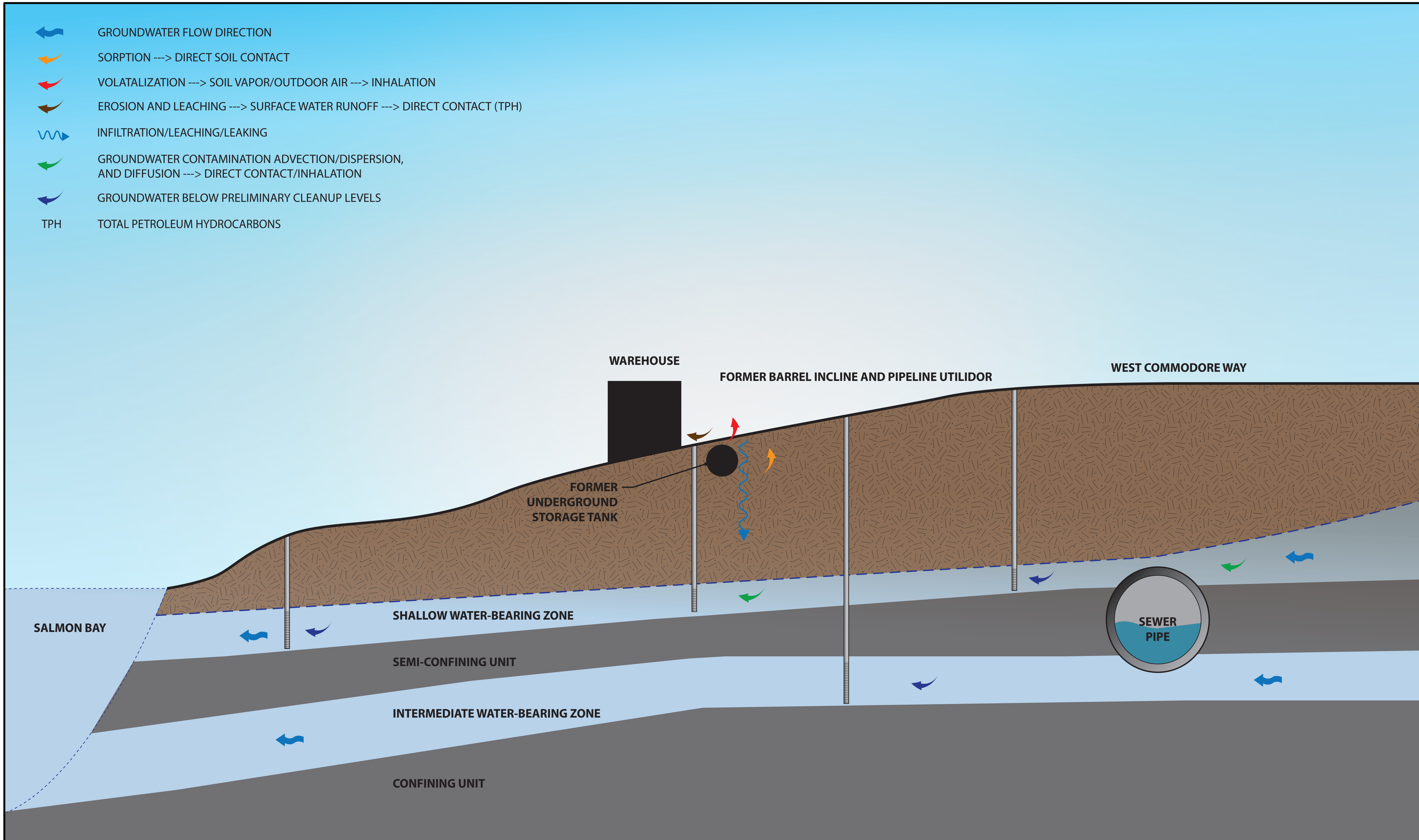
DATE: 05/12/13
DRAWN BY: JAB
CHECKED BY: PJK/TSB
CAD FILE: 01-600_2014FS_CSM

PROJECT NAME: TOC HOLDINGS CO. EAST WATERFRONT PROPERTY
SES PROJECT NUMBER: 0440-004
STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

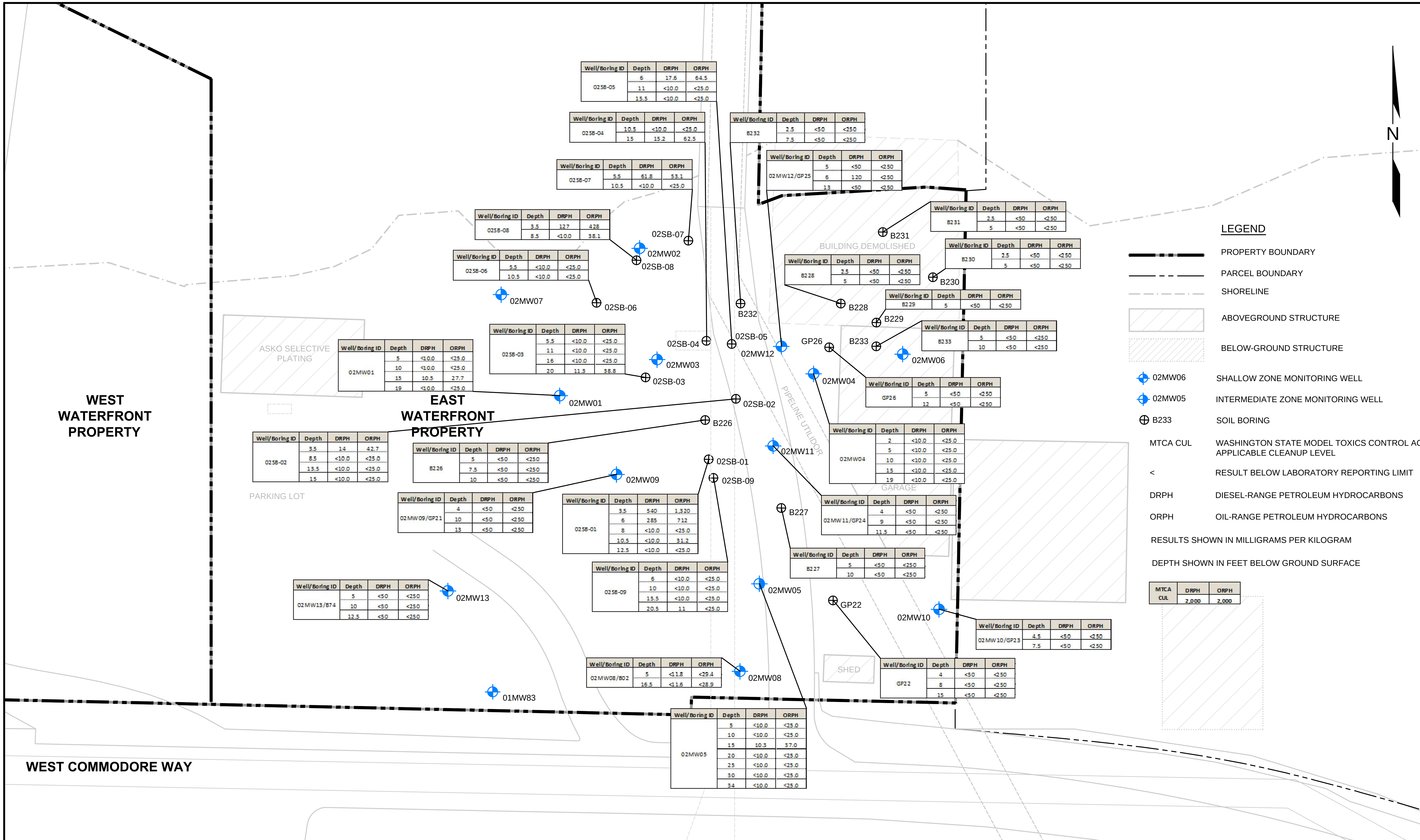
REGION:

NOT TO SCALE

FIGURE 6
PRELIMINARY EXPOSURE ASSESSMENT
CONCEPTUAL SITE MODEL
EAST WATERFRONT PROPERTY



SoundEarth Strategies WWW.SOUNDEARTHINC.COM	DATE: 07/25/13 DRAWN BY: NAC CHECKED BY: PJK/TSB CAD FILE: EWF-CSM	PROJECT NAME: TOC HOLDINGS CO. EAST WATERFRONT PROPERTY PROJECT NUMBER: 0440-004 STREET ADDRESS: 2750 WEST COMMODORE WAY CITY, STATE: SEATTLE, WASHINGTON	REGION:	NO SCALE	**FIGURE 7** CONCEPTUAL SITE MODEL



MTCA CUL	DRPH	ORPH
	2,000	2,000

Well/Boring ID	Depth	DRPH	ORPH
02SB-05	6	17.6	64.5
	11	<10.0	<25.0
	15.5	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02SB-04	10.5	<10.0	<25.0
	15	15.2	62.5

Well/Boring ID	Depth	DRPH	ORPH
02SB-07	5.5	61.8	53.1
	10.5	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02SB-08	3.5	127	428
	8.5	<10.0	38.1

Well/Boring ID	Depth	DRPH	ORPH
02SB-06	5.5	<10.0	<25.0
	10.5	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
B232	2.5	<50	<250
	7.5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02MW12/GP25	5	<50	<250
	6	120	<250
	13	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B231	2.5	<50	<250
	5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B230	2.5	<50	<250
	5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B228	2.5	<50	<250
	5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B229	5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B233	5	<50	<250
	10	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
GP26	5	<50	<250
	12	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02SB-03	5.5	<10.0	<25.0
	11	<10.0	<25.0
	16	<10.0	<25.0
	20	11.3	38.8

Well/Boring ID	Depth	DRPH	ORPH
02MW01	5	<10.0	<25.0
	10	<10.0	<25.0
	15	10.5	27.7
	19	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02SB-02	3.5	14	42.7
	8.5	<10.0	<25.0
	13.5	<10.0	<25.0
	15	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
B226	5	<50	<250
	7.5	<50	<250
	10	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02MW04	2	<10.0	<25.0
	5	<10.0	<25.0
	10	<10.0	<25.0
	15	<10.0	<25.0
	19	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02MW09/GP21	4	<50	<250
	10	<50	<250
	13	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02SB-01	3.5	540	1,320
	6	285	712
	8	<10.0	<25.0
	10.5	<10.0	31.2
	12.5	<10.0	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02MW11/GP24	4	<50	<250
	9	<50	<250
	11.5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
B227	5	<50	<250
	10	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02SB-09	6	<10.0	<25.0
	10	<10.0	<25.0
	15.5	<10.0	<25.0
	20.5	11	<25.0

Well/Boring ID	Depth	DRPH	ORPH
02MW13/B74	5	<50	<250
	10	<50	<250
	12.5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02MW10/GP23	4.5	<50	<250
	7.5	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02MW08/B02	5	<11.8	<29.4
	16.5	<11.6	<28.9

Well/Boring ID	Depth	DRPH	ORPH
GP22	4	<50	<250
	8	<50	<250
	15	<50	<250

Well/Boring ID	Depth	DRPH	ORPH
02MW05	5	<10.0	<25.0
	10	<10.0	<25.0
	15	10.3	37.0
	20	<10.0	<25.0
	25	<10.0	<25.0
	30	<10.0	<25.0
	34	<10.0	<25.0

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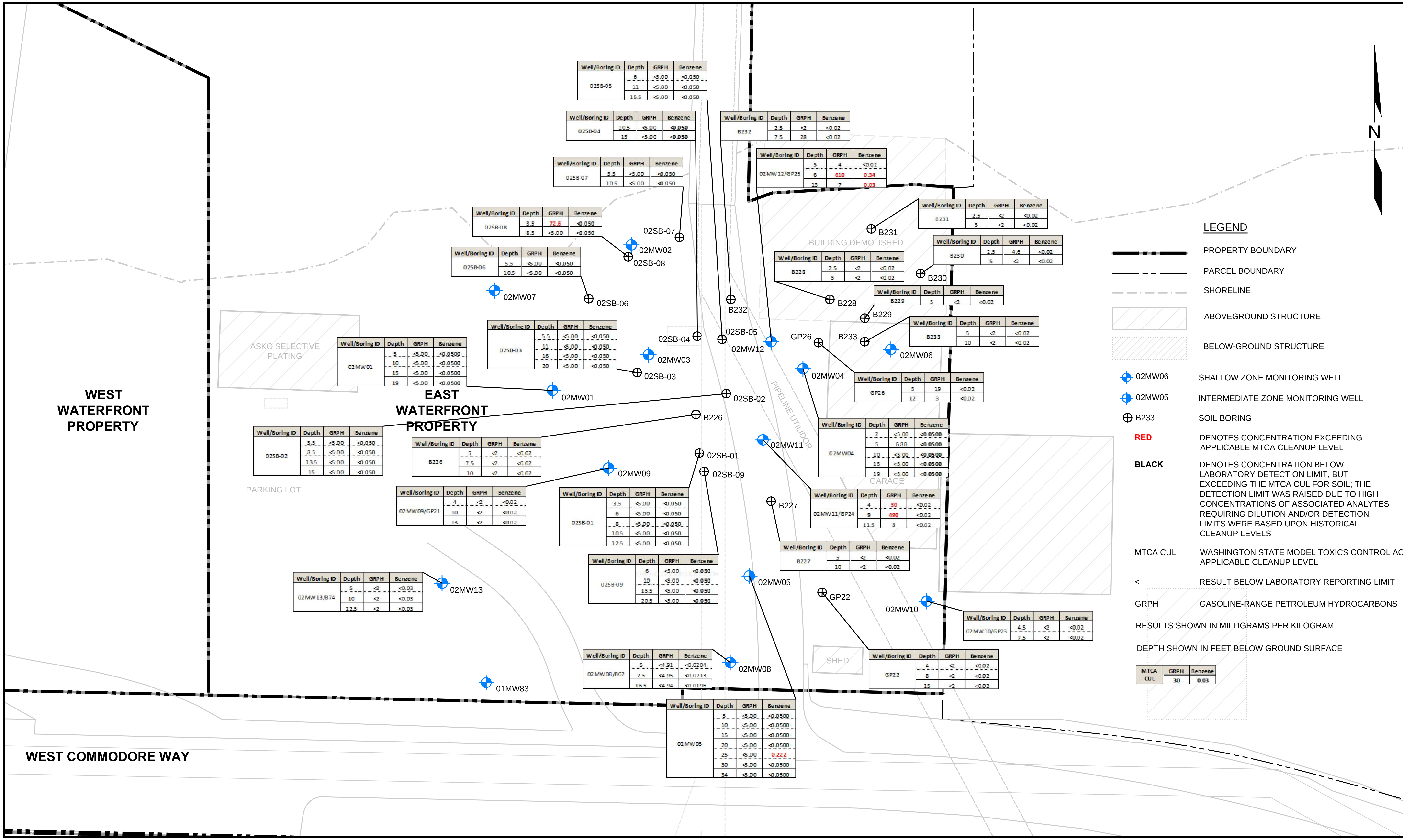
PROJECT NUMBER: 0440-004
STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 20 40 80
APPROXIMATE SCALE IN FEET

FIGURE 8
SOIL ANALYTICAL RESULTS FOR DRPH AND ORPH



Well/Boring ID	Depth	GRPH	Benzene
02SB-05	6	<5.00	<0.050
	11	<5.00	<0.050
	15.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02SB-04	10.5	<5.00	<0.050
	15	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02SB-07	5.5	<5.00	<0.050
	10.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02SB-08	3.5	72.6	<0.050
	8.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02SB-06	5.5	<5.00	<0.050
	10.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
B232	2.5	<2	<0.02
	7.5	28	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02MW12/GP25	5	4	<0.02
	6	610	0.34
	13	7	0.03

Well/Boring ID	Depth	GRPH	Benzene
B231	2.5	<2	<0.02
	5	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
B230	2.5	4.6	<0.02
	5	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
B228	2.5	<2	<0.02
	5	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
B229	5	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
B233	5	<2	<0.02
	10	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02SB-03	5.5	<5.00	<0.050
	11	<5.00	<0.050
	16	<5.00	<0.050
	20	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02MW01	5	<5.00	<0.0500
	10	<5.00	<0.0500
	15	<5.00	<0.0500
	19	<5.00	<0.0500

Well/Boring ID	Depth	GRPH	Benzene
GP26	5	19	<0.02
	12	3	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02SB-02	3.5	<5.00	<0.050
	8.5	<5.00	<0.050
	13.5	<5.00	<0.050
	15	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
B226	5	<2	<0.02
	7.5	<2	<0.02
	10	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02MW04	2	<5.00	<0.0500
	5	6.88	<0.0500
	10	<5.00	<0.0500
	15	<5.00	<0.0500
	19	<5.00	<0.0500

Well/Boring ID	Depth	GRPH	Benzene
02MW09/GP21	4	<2	<0.02
	10	<2	<0.02
	13	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02SB-01	3.5	<5.00	<0.050
	6	<5.00	<0.050
	8	<5.00	<0.050
	10.5	<5.00	<0.050
	12.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02MW11/GP24	4	30	<0.02
	9	490	<0.02
	11.5	8	<0.02

Well/Boring ID	Depth	GRPH	Benzene
B227	5	<2	<0.02
	10	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02SB-09	6	<5.00	<0.050
	10	<5.00	<0.050
	15.5	<5.00	<0.050
	20.5	<5.00	<0.050

Well/Boring ID	Depth	GRPH	Benzene
02MW13/B74	5	<2	<0.03
	10	<2	<0.03
	12.5	<2	<0.03

Well/Boring ID	Depth	GRPH	Benzene
02MW10/GP23	4.5	<2	<0.02
	7.5	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02MW08/B02	5	<4.91	<0.0204
	7.5	<4.95	<0.0213
	16.5	<4.94	<0.0196

Well/Boring ID	Depth	GRPH	Benzene
GP22	4	<2	<0.02
	8	<2	<0.02
	15	<2	<0.02

Well/Boring ID	Depth	GRPH	Benzene
02MW05	5	<5.00	<0.0500
	10	<5.00	<0.0500
	15	<5.00	<0.0500
	20	<5.00	<0.0500
	25	<5.00	0.222
	30	<5.00	<0.0500
	34	<5.00	<0.0500

LEGEND

PROPERTY BOUNDARY

PARCEL BOUNDARY

SHORELINE

ABOVEGROUND STRUCTURE

BELOW-GROUND STRUCTURE

02MW06 SHALLOW ZONE MONITORING WELL

02MW05 INTERMEDIATE ZONE MONITORING WELL

B233 SOIL BORING

RED DENOTES CONCENTRATION EXCEEDING APPLICABLE MTCA CLEANUP LEVEL

BLACK DENOTES CONCENTRATION BELOW LABORATORY DETECTION LIMIT, BUT EXCEEDING THE MTCA CUL FOR SOIL; THE DETECTION LIMIT WAS RAISED DUE TO HIGH CONCENTRATIONS OF ASSOCIATED ANALYTES REQUIRING DILUTION AND/OR DETECTION LIMITS WERE BASED UPON HISTORICAL CLEANUP LEVELS

MTCA CUL WASHINGTON STATE MODEL TOXICS CONTROL ACT APPLICABLE CLEANUP LEVEL

< RESULT BELOW LABORATORY REPORTING LIMIT

GRPH GASOLINE-RANGE PETROLEUM HYDROCARBONS

RESULTS SHOWN IN MILLIGRAMS PER KILOGRAM

DEPTH SHOWN IN FEET BELOW GROUND SURFACE

MTCA CUL	GRPH	Benzene
	30	0.03

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APPROXIMATE SCALE IN FEET

FIGURE 9
SOIL ANALYTICAL RESULTS FOR GRPH AND BENZENE

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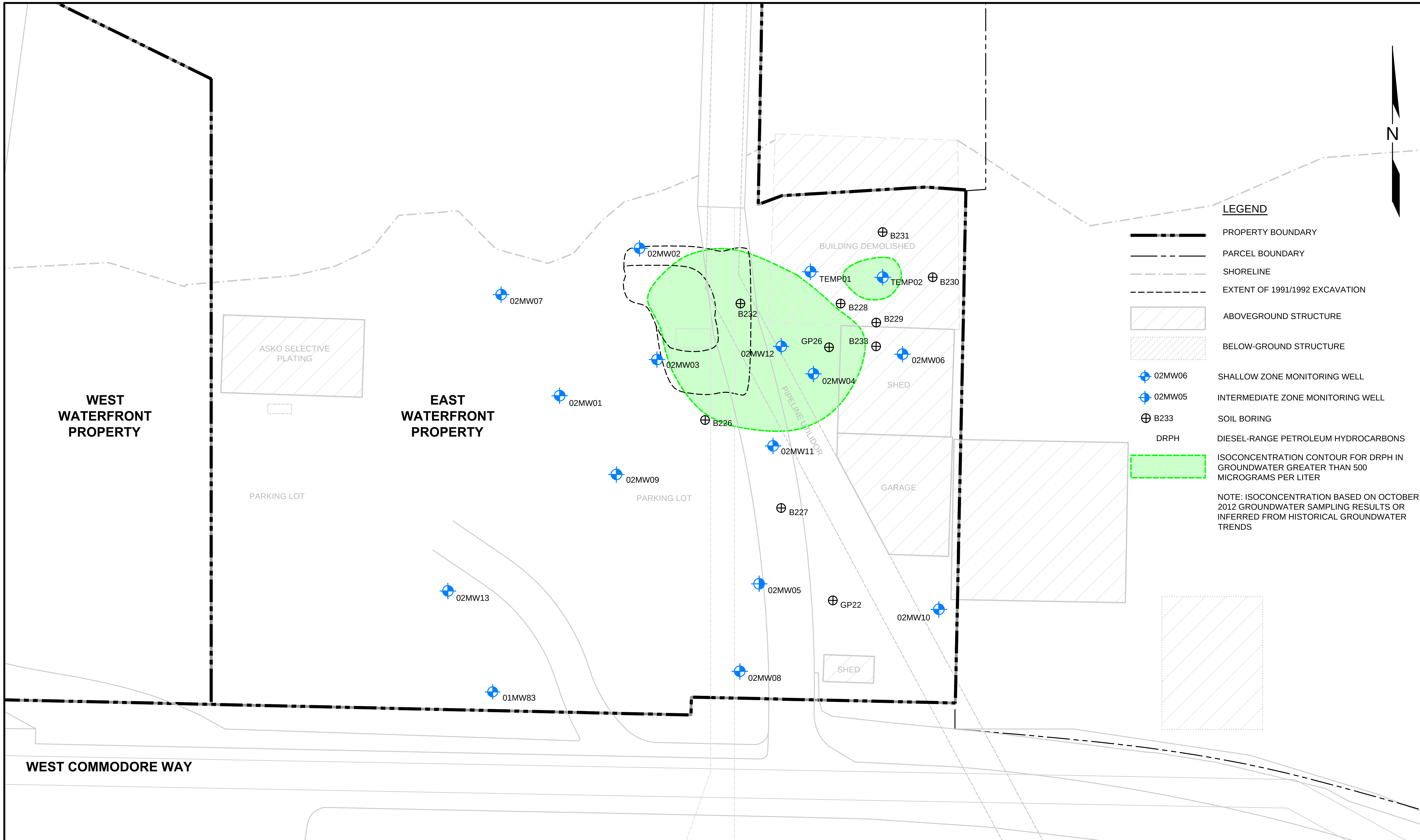

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FIGURE 10
DRPH ISOCONCENTRATION MAP
(OCTOBER 2012)

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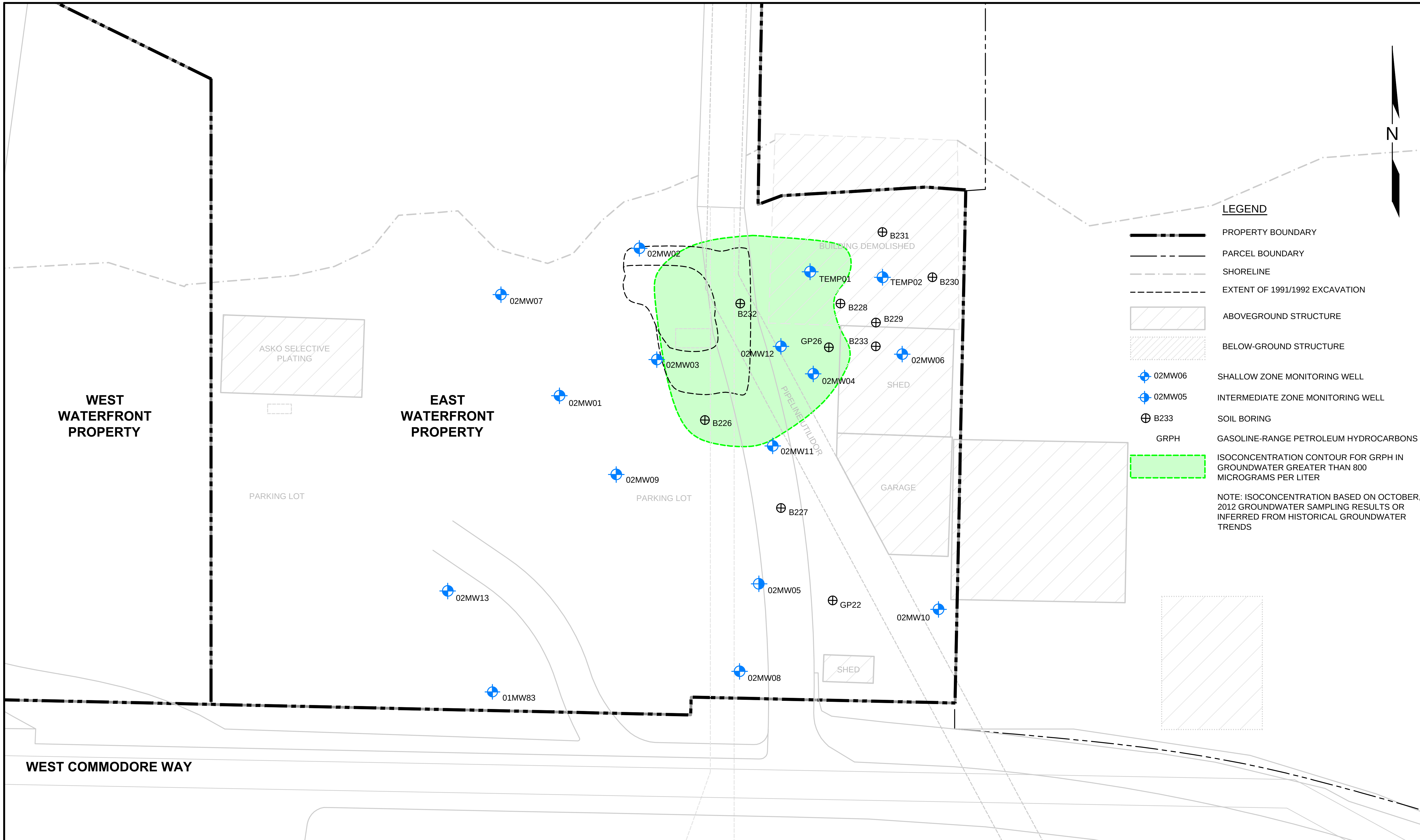

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APPROXIMATE SCALE IN FEET

FIGURE 11
GRPH ISOCONCENTRATION MAP
(OCTOBER 2012)

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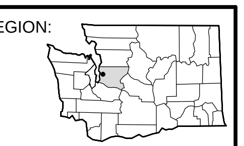
CITY, STATE: SEATTLE, WASHINGTON

REGION:



0 20 40 80
APPROXIMATE SCALE IN FEET

FIGURE 12
CLEANUP ACTION ALTERNATIVE 1
EXCAVATION WITH
OFF-SITE DISPOSAL

P:\0440 TOC HOLDINGS CO\01-600 SEATTLE TERMINAL\TECHNICAL\CAD\2014\EWPIFS\01-600_2014FS_CA1.DWG
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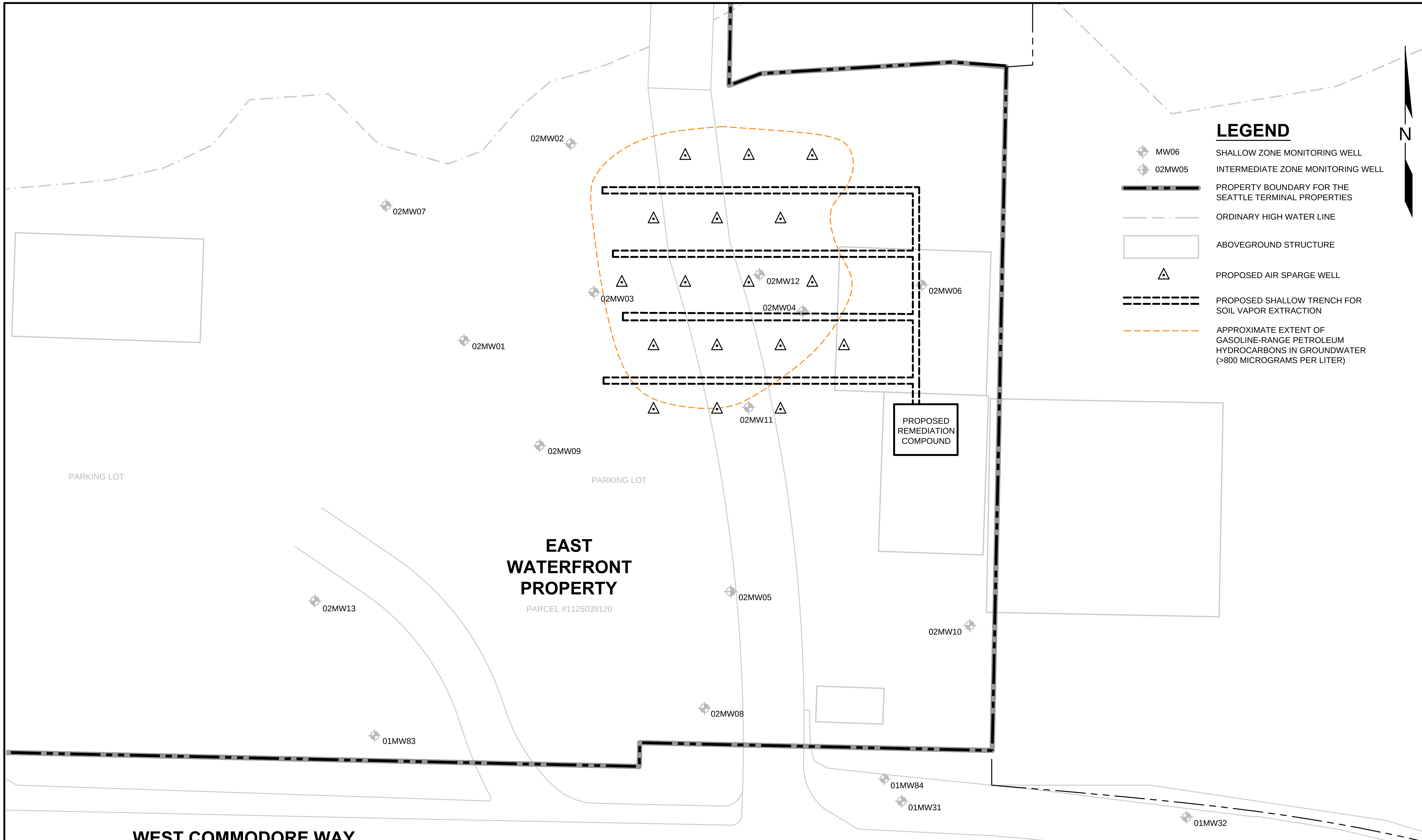

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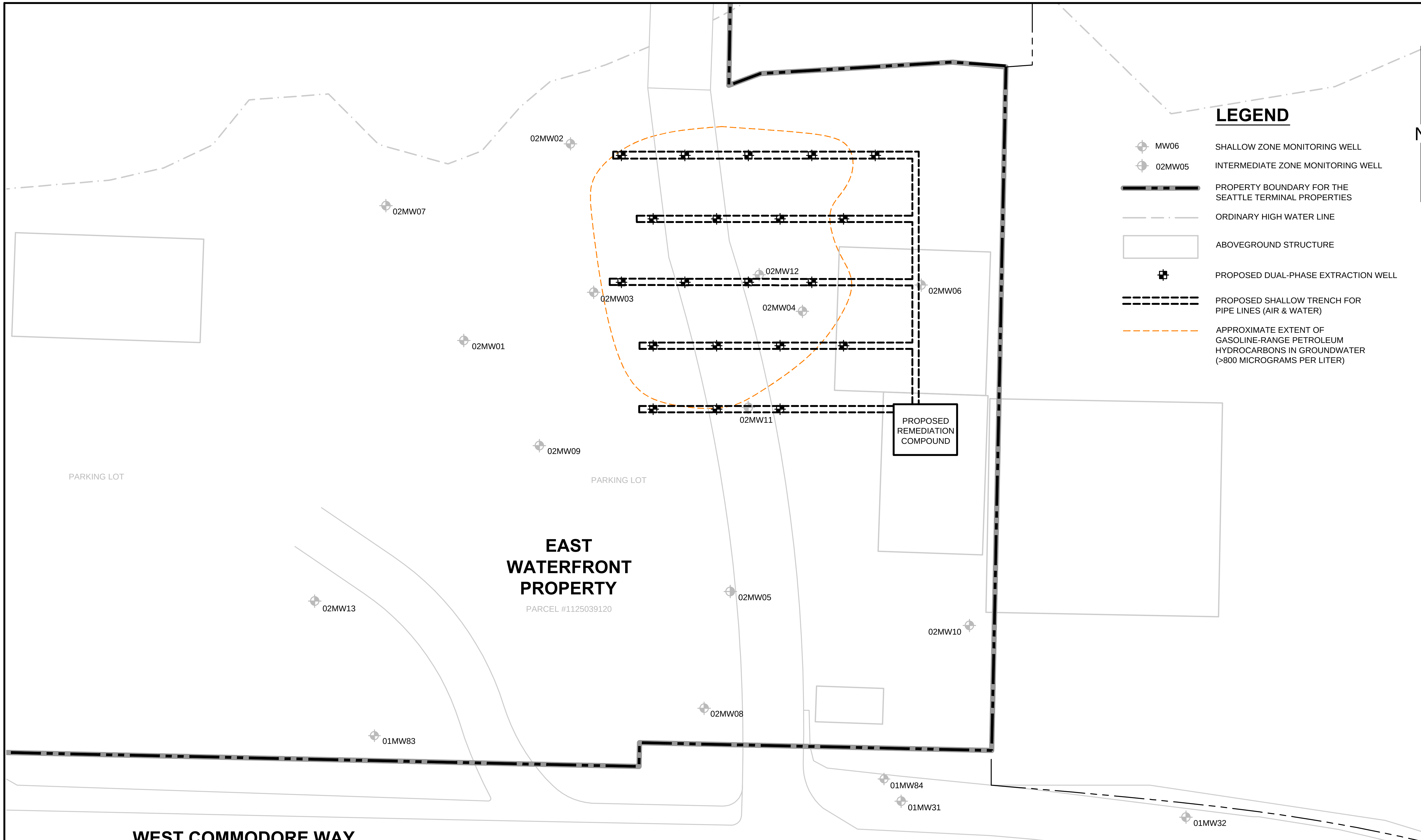
PROJECT NUMBER: 0440-004
STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

0 20 40 80
APPROXIMATE SCALE IN FEET

FIGURE 13
CLEANUP ACTION ALTERNATIVE 2
AIR SPARGING WITH
SOIL VAPOR EXTRACTION

P:\0440 TOC HOLDINGS CO\01-600 SEATTLE TERMINAL\TECHNICAL\CAD\2014\EWP\FS\01-600_2014FS_CA2.DWG 5/15/2014



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STREET ADDRESS: 2750 WEST COMMODORE WAY
CITY, STATE: SEATTLE, WASHINGTON

REGION:

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APPROXIMATE SCALE IN FEET

FIGURE 14
CLEANUP ACTION ALTERNATIVE 3
DUAL-PHASE EXTRACTION

P:\0440 TOC HOLDINGS CO\01-600 SEATTLE TERMINAL\TECHNICAL\CAD\2014\EWP\FS\01-600_2014FS_CA3.DWG
5/15/2014

TABLES

Table 1
Preliminary Cleanup Levels
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Commodore Way
Seattle, Washington

SOIL	
Chemicals of Potential Concern	**Cleanup Levels** (mg/kg)
Gasoline-Range Petroleum Hydrocarbons	30[1]
Diesel-Range Petroleum Hydrocarbons	2,000[1]
Oil-Range Petroleum Hydrocarbons	2,000[1]
Benzene	0.03[1]
Ethylbenzene	6[1]

GROUNDWATER	
Chemicals of Potential Concern	**Cleanup Levels** (µg/L)
Gasoline-Range Petroleum Hydrocarbons	800[2]
Diesel-Range Petroleum Hydrocarbons	500[2]
Oil-Range Petroleum Hydrocarbons	500[2]
Benzene	5[2]
Ethylbenzene	700[2]
Total Xylenes	1,000[2]

AIR	
Chemicals of Potential Concern	**Cleanup Levels** (µg/m^3)
Gasoline-Range Petroleum Hydrocarbons	NE
Diesel-Range Petroleum Hydrocarbons	NE
Oil-Range Petroleum Hydrocarbons	NE
Benzene	0.32[4]
Ethylbenzene	460[5]
Total Xylenes	46[5]

NOTES:

[1]MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses, Table 740-1 of Section 900 of Chapter 173-340 of the Washington Administrative Code, revised November 2007.

[2]MTCA Method A Cleanup Levels for Ground Water, Table 720-1 of Section 900 of Chapter 173-340 of the Washington Administrative Code, revised November 2007.

[3]CLARC, Surface Water, Method B, Carcinogen, Standard Formula Value, CLARC website <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

[4]MTCA Cleanup Regulation, CLARC, Air, Method B, Carcinogen, Stadard Formula Value, CLARC website <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

[5]MTCA Cleanup Regulation, CLARC, Air, Method B, Non-Carcinogen, Stadard Formula Value, CLARC website <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

µg/L = micrograms per liter
µg/m^3 = micrograms per meter cubed
CLARC = Cleanup Levels and Risk Calculation
mg/kg = milligrams per kilogram
MTCA = Washington State Model Toxics Control Act
NE = not established

Table 2
Remedial Component Screening Matrix
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Comodore Way
Seattle, Washington

Component Group	Component Options	Retained for Inclusion in Cleanup Action Alternatives?	Rationale for Inclusion or Exclusion
Passive Remediation			
	No Further Action	No	Not retained because the current Site conditions pose unacceptable risks that require remediation.
	Monitored Natural Attenuation	Yes	Retained as a component of all cleanup action alternatives. Not retained for use as a sole administrative or engineering control.
	Low Permeability Containment Cap	No	Not retained because the existence of a cap is not compatible with prospective future land uses.
	Environmental Covenant	No	Not retained because does not meet current remedial action objectives to comply with ARARs and Site-specific cleanup standards to demonstrate compliance and obtain an NFA determination from Ecology for unrestricted land uses.
	Passive Treatment Wall (Activated Carbon/Permeable Reactive Barrier)	No	Technology is temporarily effective for COCs in groundwater but does not address soil contamination.
In Situ Physical Treatment			
	Soil Vapor Extraction	Yes	Retained because SVE is a demonstrated technology for remediation of COPCs in soil and Site conditions are favorable for effective use of this technology.
	Air Sparging	Yes	Retained because air sparging is a demonstrated technology for the remediation of COPCs and the Site conditions are favorable for effective use of this technology.
	Surfactant Washing	No	Not retained as this technology is mediated in the saturated zone and is not effective in treating unsaturated zone soil contamination.
	Cosolvent Washing	No	Not retained as this technology is mediated in the saturated zone and is not effective in treating unsaturated zone soil contamination.
	Pump and Treat	No	Not retained as this technology is mediated in the saturated zone and is not effective in treating unsaturated zone soil contamination.
	Dual-Phase Extraction	Yes	Retained because technology is demonstrated to be effective for remediation of COPCs and Site conditions are favorable for use of this technology.
In Situ Thermal			
	Resistive Thermal with SVE	No	Although these in situ thermal technologies generally satisfy all of the Washington State Model Toxics Control Act threshold and modifying evaluation criteria, none are retained because they are difficult to implement and are not cost competitive with other technologies when implemented at this scale. These technologies also present increased short-term risks during their installation and operation.
	Conductive Thermal with SVE	No	
	Radio Frequency/Electromagnetic Thermal with SVE	No	
	Steam Injection with SVE and Groundwater Extraction	No	
	Hot Air Injection with SVE	No	
	Hot Water Injection with SVE and Groundwater Extraction	No	
Source Removal			
	Excavation without Shoring	Yes	Retained because excavation is demonstrated to be effective for remediation of COPCs and Site conditions are favorable for use of this technology.
	Excavation with Shoring	No	Not retained because excavation with shoring is not necessary to implement due to planned sloping on sidewalls.
	Secant Pile Wall - Impervious Wall	No	Not considered necessary - an impervious shoring system is not needed at the Site due to the planned use of a dewatering system.
	Sheet Pile Wall - Impervious Wall	No	Not considered necessary - an impervious shoring system is not needed at the Site due to the planned use of a dewatering system.
	Soldier Pile Wall - Non-Impervious Wall	No	Not considered necessary - excavation sidewalls will be sloped at a 1 Horizontal:1 Vertical.

Table 2
Remedial Component Screening Matrix
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Comodore Way
Seattle, Washington

Component Group	Component Options	Retained for Inclusion in Cleanup Action Alternatives?	Rationale for Inclusion or Exclusion
Ex Situ Source Treatment			
	Surfactant Washing	No	Not retained because these components are not cost competitive with other technologies at this scale and would result in another waste stream requiring disposal.
	Cosolvent Washing	No	
	Chemical Oxidation	No	
	Landfill Disposal with Thermal Desorption	No	Not retained as Land Disposal is more cost-competitive.
	Landfill Disposal	Yes	Retained for petroleum-contaminated soil. This technology is more cost-competitive because there are more available permitted land disposal facilities. It is assumed that the waste stream will be designated as non-hazardous waste.
In Situ Chemical Oxidation			
	Sodium Persulfate	No	Not retained as in situ chemical oxidation because this technology typically treats COPCs in groundwater and success in the unsaturated zone is limited.
	Hydrogen Peroxide	No	
	Permanganate	No	This oxidant is not effective for treating the COPCs.
	Ozone	No	Not retained as in situ chemical oxidation typically treats COPCs in groundwater and success in the unsaturated zone is limited.
	Fenton's Reagent	No	
Containment/Immobilization			
	Bituminization	No	Not retained because these technologies reduce the mobility of hazardous substances but not their toxicity or volume. The technologies are typically implemented ex situ.
	Emulsified Asphalt	No	
	Modified Sulfur Cement	No	
	Polyethylene Extrusion	No	Not retained because this technology is not well developed.
	Pozzolan/Portland Cement	No	technology is typically implemented ex situ.
	Vitrification/Molten Glass	No	Not retained because it is not cost competitive with our technologies in this group and is difficult to implement. This technology also presents an increased short-term risk of injury during installation and operation.
	Slurry Wall Containment	No	Not retained because these technologies reduce the mobility of hazardous substances but not their toxicity or volume. The technologies are typically implemented ex situ.
	Sheet Pile Wall Containment	No	
	Pump and Treat for Hydraulic Containment	No	Not retained as this component will not address soil contamination.
Phytoremediation			
	Hydraulic Control	No	Not retained because implementation of these technologies is not compatible with the future land use at the Site, nor do these components result in a reasonable restoration time frame.
	Phyto-Degradation	No	
	Phyto-Volatilization	No	
	Phyto-Accumulation	No	
	Phyto-Stabilization	No	
	Enhanced Rhizosphere Biodegradation	No	
In Situ Bioremediation			
	Aerobic Bioremediation	Yes	Retained in conjunction with SVE for treatment of contaminated media.
	Anaerobic Bioremediation	No	Not as effective as aerobic bioremediation in treating COPCs.

NOTES:
COPC = chemical of potential concern
NFA = no further action
SVE = soil vapor extraction

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Table 3
Cleanup Action Alternative 1
Feasibility Level Cost Estimate
Excavation with Off-Site Disposal
East Waterfront Property
2750 West Commodore Way
Seattle, Washington

PRESENT CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
Direct Capital					
Remedial Excavation					
Geotechnical Oversight	1	ls	$ 25,000	$ 25,000	
Well Abandonment	5	ea	$ 500	$ 2,500	
Site controls (fencing)	400	lf	$ 7.50	$ 3,000	
Temporary Dewatering	1	ls	$ 25,000	$ 25,000	
Excavation, Handling, and Segregation of PCS	2,723	ton	$ 24	$ 65,340	
Transportation of PCS	2,723	ton	$ 25	$ 68,070	
Disposal of PCS	2,723	ton	$ 38	$ 103,460	
Backfill and Compaction of Clean Fill	2,360	lcy	$ 20	$ 47,190	
Large Diameter Auger Drill Rig	1	ls	$ 25,000	$ 25,000	
Remedial Excavation Subtotal					$ 364,560
Compliance Monitoring					
Well installation for Quarterly Groundwater Monitoring	4	ea	$ 2,500	$ 10,000	
Compliance Monitoring Subtotal					$ 10,000
Subtotal Direct Capital					$ 374,560
Indirect Capital (as percentage of Direct Capital)					
Design, Permitting, and Work Plans (10%)				$ 37,460	
Mobilization (2%)				$ 7,500	
Professional Labor for Construction Oversight (15%)				$ 56,190	
Field Equipment and Supplies (1%)				$ 3,750	
Laboratory Testing (Field Verification and Waste Profiling) (5%)				$ 18,730	
Site Restoration and Demobilization (2%)				$ 7,500	
Regulatory Reporting (10%)				$ 37,460	
Subtotal Indirect Capital					$ 168,590
Total Capital					$ 543,150
FUTURE O&M AND OTHER DIRECT COST ITEMS[1]	**ANNUAL COST[2]**		**PRESENT WORTH OF ANNUAL AND FUTURE CAPITAL COST**		
	Discount Rate = -1.4%		n (years) = 3		
Quarterly Groundwater Monitoring and Reporting and MNA Parameters	$ 50,000			$ 154,300	
Decommission Groundwater Monitoring Wells (8 @ $500 ea)				$ 4,000	
Present Worth Cost of Annual and Future Capital Cost					$ 158,300
TOTAL PRESENT WORTH COST (Sum of Total Capital and Present Worth of Annual and Future Capital Cost)[3][4][5]					$ 701,000

NOTES:

[1]Additional direct costs such as project management, regulatory communications and reporting, and other technical support services not specifically listed are not included in any future annual costs.

[2]Annual cost is year 2013 cost.

[3]This feasibility level cost should not be considered a design cost estimate or guaranteed cost.

[4]Excludes electrical costs for all systems.

[5]Cost rounded up to nearest $1,000.

ea = each
lcy = loose cubic yards
lf = linear feet
ls = lump sum
MNA = monitored natural attenuation
n = number of years of operation and maintenance
O&M = operation and maintenance
PCS = petroleum-contaminated soil
QTY = quantity
ton = number of bank cubic yards x 1.65 ton/bank cubic yard

Table 4
Cleanup Action Alternative 2
Feasibility Level Cost Estimate
Air Sparging with Soil Vapor Extraction
East Waterfront Property
2750 West Commodore Way
Seattle, Washington

PRESENT CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
Direct Capital					
Air Sparging and Soil Vapor Extraction					
Air Sparge Wells, Installed	17	ea	$ 3,500	$ 59,500	
Trenching for AS/SVE Including Piping, Fittings, and Backfill	1	ls	$ 51,000	$ 51,000	
Asphalt Cap	1	ls	$ 105,000	$ 105,000	
Remediation Equipment, Enclosure, and Controls	1	ls	$ 125,000	$ 125,000	
Electrical and Control Installation	1	ls	$ 20,000	$ 20,000	
Transportation of Trench Cuttings	207	tons	$ 25	$ 5,180	
Disposal of Trench Cuttings	207	tons	$ 38	$ 7,870	
Air Sparging and Soil Vapor Extraction Subtotal					$ 373,550
Subtotal Direct Capital					$ 373,550
Indirect Capital (as percentages of Direct Capital)					
Design, Permitting, and Work Plans (15%)				$ 56,040	
Mobilization (1%)				$ 3,740	
Professional Labor for Construction Oversight (15%)				$ 56,040	
Field Equipment and Supplies (2%)				$ 7,480	
Laboratory Testing (Field Verification and Waste Profiling) (5%)				$ 18,680	
Site Restoration and Demobilization (2%)				$ 7,480	
Regulatory Reporting (10%)				$ 37,360	
Subtotal Indirect Capital					$ 186,820
Total Capital					$ 560,370
FUTURE O&M AND OTHER DIRECT COST ITEMS[1]	**ANNUAL COST[2]**		**PRESENT WORTH OF ANNUAL AND FUTURE CAPITAL COST**		
	Discount Rate =	-0.4%	n (years) = 7		
Quarterly Groundwater Monitoring and Reporting	$ 40,000			$ 284,500	
Monthly Operation and Maintenance and Reporting (6 years)	$ 45,000			$ 273,800	
Post-Remediation Confirmation Soil Sampling				$ 25,000	
Decommission GW and AS wells (25 wells @ $500 each)				$ 12,500	
Decommission AS/SVE System				$ 25,000	
Present Worth Cost of Annual and Future Capital Cost					$ 620,800
TOTAL PRESENT WORTH COST (Sum of Total Capital and Present Worth of Annual and Future Capital Cost)[3][4][5]					$ 1,181,000

NOTES:

[1]Additional direct costs such as project management, regulatory communications and reporting, and other technical support services not specifically listed are not included in any future annual costs.

[2]Annual cost is year 2013 cost.

[3]This feasibility level cost should not be considered a design cost estimate or guaranteed cost.

[4]Excludes electrical costs for all systems.

[5]Cost rounded up to nearest $1,000.

AS/SVE = air sparge/soil vapor extraction
DFCR = Preliminary Draft for Client Review
ea = each
GW = groundwater
ls = lump sum
n = number of years of operation and maintenance
O&M = operation and maintenance
QTY = quantity
ton = number of bank cubic yards x 1.5 ton/bank cubic yard

Table 5
Cleanup Action Alternative 3
Feasibility Level Cost Estimate
Dual-Phase Extraction
East Waterfront Property
2750 West Commodore Way
Seattle, Washington

PRESENT CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
Direct Capital					
Dual-Phase Extraction					
Dual-Phase Extraction Wells, Installed	20	ea	$ 4,000	$ 80,000	
Total Fluids Pumps	20	ea	$ 2,800	$ 56,000	
Trenches for DPE Including Piping, Fittings, and Backfill	1	ls	$ 80,000	$ 80,000	
Asphalt Cap	1	ls	$ 105,000	$ 105,000	
Remediation Equipment, Enclosure, and Controls	1	ls	$ 150,000	$ 150,000	
Electrical and Control Installation	1	ls	$ 20,000	$ 20,000	
Transportation of Trench Cuttings	240	tons	$ 25	$ 6,000	
Disposal of Trench Cuttings	240	tons	$ 38	$ 9,120	
Subtotal Dual-Phase Extraction					$ 506,120
Subtotal Direct Capital					$ 506,120
Indirect Capital (as percentages of Direct Capital)					
Design, Permitting, and Work Plans (15%)				$ 75,920	
Mobilization (1%)				$ 5,070	
Professional Labor for Construction Oversight (15%)				$ 75,920	
Field Equipment and Supplies (2%)				$ 10,130	
Laboratory Testing (Field Verification and Waste Profiling) (5%)				$ 25,310	
Site Restoration and Demobilization (2%)				$ 10,130	
Regulatory Reporting (10%)				$ 50,620	
Subtotal Indirect Capital					$ 253,100
Total Capital					$ 759,220
FUTURE O&M AND OTHER DIRECT COST ITEMS[1]	**ANNUAL COST**[2]		**PRESENT WORTH OF ANNUAL AND FUTURE CAPITAL COST**		
	Discount Rate =	0.1%		n (years) = 10	
Quarterly Groundwater Monitoring and Reporting	$ 40,000			$ 397,810	
Monthly Operations and Maintenance and Reporting (9 years)	$ 55,000			$ 492,500	
Post-Remediation Confirmation Soil Sampling				$ 25,000	
Well Decommissioning (20 DPE wells and 8 MWs @ $500 each)				$ 14,000	
Decommission DPE System				$ 30,000	
Present Worth Cost of Annual and Future Capital Cost					$ 959,310
TOTAL PRESENT WORTH COST (Sum of Total Capital and Present Worth of Annual and Future Capital Cost)[3][4][5]					$ 1,719,000

NOTES:

[1]Additional direct costs such as project management, regulatory communications and reporting, and other technical support services not specifically listed are not included in any future annual costs.

[2]Annual cost is year 2013 cost.

[3]This feasibility level cost should not be considered a design cost estimate or guaranteed cost.

[4]Excludes electrical costs for all systems.

[5]Cost rounded up to nearest $1,000.

DPE = dual-phase extraction
ea = each
ls = lump sum
MW = monitoring well
n = number of years of operation and maintenance
O&M = operation and maintenance
QTY = quantity
ton = number of bank cubic yards x 1.5 ton/bank cubic yard

Table 6
Cleanup Action Alternatives Screening Summary
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Comodore Way
Seattle, Washington

Remedial Alternatives	Remedial Details	Washington State Department of Ecology Evaluation Criteria/Relative Ranking (1 = Low 10 = High)						Ranking Score[1]	Estimated Present Worth Cost ($1,000)
		Protectiveness	Permanence	Effectiveness over the Long Term	Management of Short-Term Risks	Technical and Administrative Implementability	Consideration of Public Concerns		
Cleanup Action Alternative 1 - Excavation with Off-Site Disposal	Remove sources of gasoline-range petroleum hydrocarbons by excavating soil to a maximum depth of 13 feet. Import clean fill and backfill and compact to starting grade. Remediate groundwater by monitored natural attenuation.	8	9	8	5	7	N/A	**37**	701
Cleanup Action Alternative 2 - Air Sparging with Soil Vapor Extraction	Install air sparge wells and shallow pipe trenches for soil vapor extraction to remediate gasoline range petroleum hydrocarbons in soil and groundwater. Life cycle estimated to be 7 years.	7	5	7	8	8	N/A	**35**	1,181
Cleanup Action Alternative 3 - Dual-Phase Extraction	Install dual-phase extraction wells to remediate gasoline range petroleum hydrocarbons in soil and groundwater. Life cycle estimated to be 10 years.	7	5	7	6	8	N/A	**33**	1,719

NOTES:
[1]Ranking score is the sum of the individual criterion ranking scores.
N/A = not applicable

CHARTS

Chart 1
Cost-to-Benefit Ratio for Cleanup Action Alternatives
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Commodore Way
Seattle, Washington

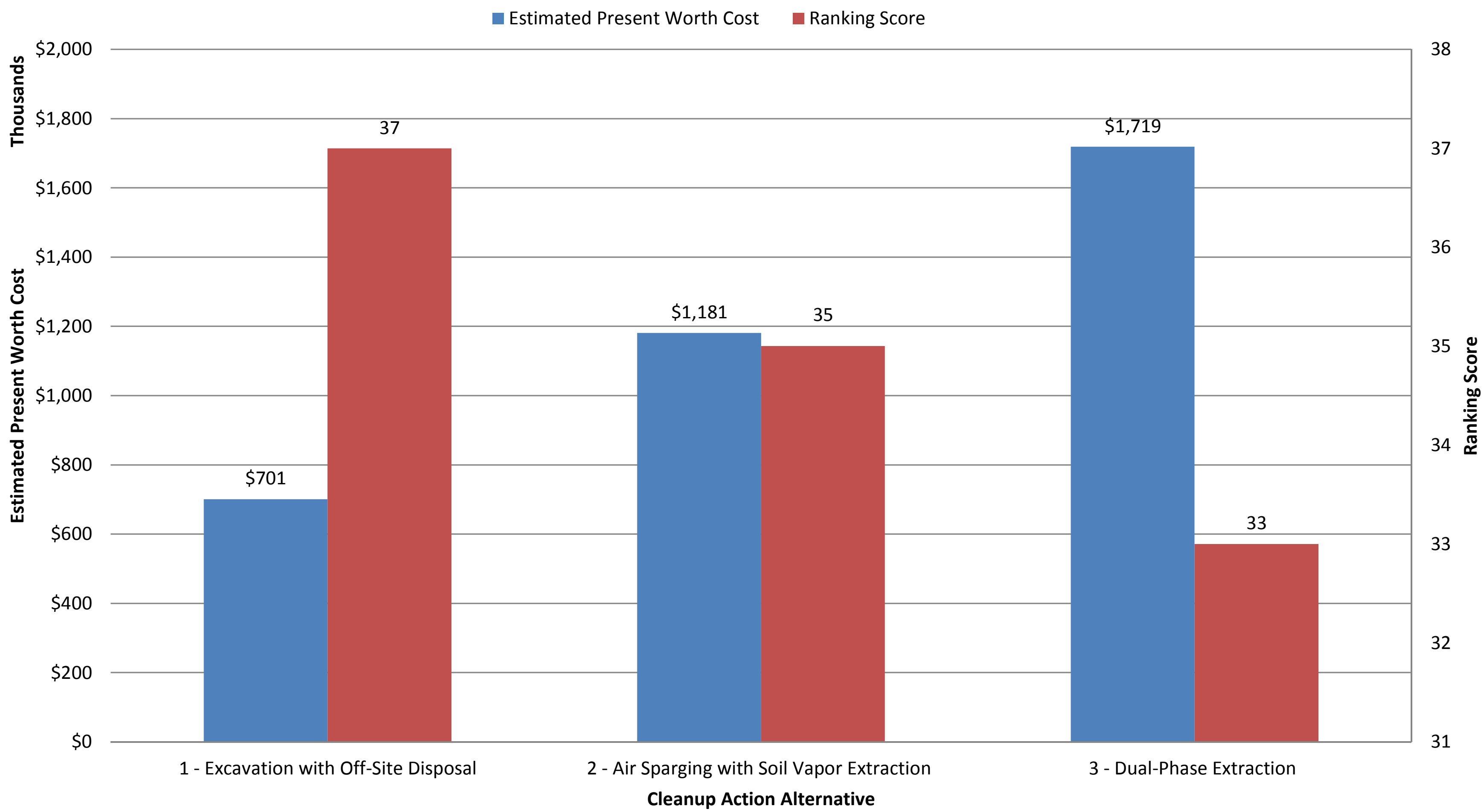

Chart 2
Cost-to-Benefit Ratio for Cleanup Action Alternatives
TOC Holdings Co. Facility No. 01-600
East Waterfront Property
2750 West Commodore Way
Seattle, Washington