


PUBLIC REVIEW DRAFT

Feasibility Study

Seattle DOT Dexter Parcel

615 Dexter Avenue North
Seattle, Washington

Prepared for
SLP 615 Dexter LLC

November 2, 2021
0202740-000 (19409-04)

HARTCROWSER
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MARISSA KAY GOODMAN
STATE OF WASHINGTON
20123344
REGISTERED PROFESSIONAL ENGINEER
11/2/21

Marissa Goodman, PE
Senior Project Environmental Engineer
Marissa.Goodman@hartcrowser.com

Julie K. W. Wukelic
Senior Principal Engineer
Julie.Wukelic@hartcrowser.com

3131 Elliott Avenue, Suite 600
Seattle, Washington 98121
206.324.9530

EXECUTIVE SUMMARY

On behalf of SLP 615 Dexter LLC (SLP), Hart Crowser, a division of Haley & Aldrich (Hart Crowser), has prepared this Feasibility Study (FS) Report to develop and evaluate viable cleanup action alternatives and recommend the preferred and most appropriate cleanup action alternative to address existing contamination and potential risk to receptors at the Seattle DOT Dexter Parcel site (Site). The Site consists primarily of the real property located at 615 Dexter Avenue North in Seattle, Washington (Property). The 0.56-acre Property is currently owned by the City of Seattle. SLP is seeking to purchase the Property pursuant to a Prospective Purchaser Consent Decree (PPCD) with the State of Washington.

The purpose of the FS Report is to develop and evaluate cleanup action alternatives that will enable a cleanup action to be selected for the Site. This FS Report was developed based on the guidance included in the *Feasibility Study Checklist Guidance,* Washington State Department of Ecology (Ecology), and the requirements of Washington Administrative Code (WAC) 173-340-350.

As described in the Remedial Investigation (RI) Report, soil and groundwater on and near the Property is impacted by contamination from historical on-site sources; specifically on and near the southeast corner of the Property where there are localized petroleum-related soil and groundwater impacts, likely related to operations of a former gas/service station. Proposed cleanup standards—consisting of the established cleanup levels for hazardous substances present at the Site, the location where these cleanup levels must be met, and the other regulatory requirements that are applicable to the Site—and cleanup action objectives (CAOs) have been presented in this FS Report to address this contamination.

The Property is planned to be redeveloped, which will include two levels of below-grade parking resulting in excavation and removal of the impacted soil within the Property boundary. Three cleanup action alternatives were developed in the FS Report to address residual soil and groundwater contamination outside the planned excavation boundary required for construction of the new building.

Based on the evaluations and disproportionate cost analysis (DCA) conducted in this FS Report, Alternative 1 was selected as the preferred cleanup action alternative. Alternative 1 will be implemented during and following Property redevelopment, which consists of: (1) excavating impacted soil and groundwater within the redevelopment excavation area and disposing off-site; (2) applying oxygen-release compound to enhance biodegradation of off-Property residual contamination; (3) implementing monitored natural attenuation (MNA); (4) installing a passive vapor barrier; (5) implementing institutional controls; and (6) performing compliance monitoring and maintenance.

As described in this FS Report, Alternative 1 meets the minimum requirements for cleanup actions as described in WAC 173-340-360(2) and implementation of this cleanup action alternative will address the CAOs for the Site and protect receptors from exposure to constituents of concern (COCs). The evaluations in this FS Report are sufficient to complete a Draft Cleanup Action Plan (DCAP) to describe the planned cleanup action in more detail.

Contents

TABLES

FIGURES

LIST OF ACRONYMS

µg/L	Microgram per liter
µg/m^3	Microgram per cubic meter
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAO	Cleanup action objective
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
CLARC	Cleanup Levels and Risk Calculation
COC	Constituent of Concern
COPC	Constituent of Potential Concern
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CSM	Conceptual Site Model
CSWGP	Construction Stormwater General Permit
CUL	Cleanup level
CVOC	Chlorinated Volatile Organic Compound
CWA	Clean Water Act
DAHP	Washington Department of Archaeology and Historic Preservation
DCA	Disproportionate Cost Analysis
DCAP	Draft Cleanup Action Plan
DO	Dissolved oxygen
DRO	Diesel-range petroleum hydrocarbons
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GAC	Granular activated carbon
GRO	Gasoline-range petroleum hydrocarbons
HO	Heavy oil-range petroleum hydrocarbons
ISCO	*In situ* Chemical Oxidation
ISEB	*In situ* Enhanced Bioremediation
KCC	King County Code
KCIW	King County Industrial Waste Program
MCL	Maximum Contaminant Level
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
MNA	Monitored Natural Attenuation
MTCA	Model Toxics Control Act
mV	Millivolt
NAPL	Non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
O&M	Operation and Maintenance
ORC-A	Oxygen Release Compound Advanced
ORP	Oxidation reduction potential
OSHA	Occupational Safety and Health Act

PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
POC	Point of Compliance
PPCD	Prospective Purchaser Consent Decree
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	Remedial Investigation
SEPA	State Environmental Policy Act
SMC	Seattle Municipal Code
SVOC	Semi-volatile Organic Compound
TPH	Total Petroleum Hydrocarbons
UIC	Underground Injection Controls
U.S.	United States
USC	United States Code
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

Feasibility Study

Seattle DOT Dexter Parcel

615 Dexter Avenue North
Seattle, Washington

1.0 INTRODUCTION

On behalf of SLP 615 Dexter LLC (SLP), Hart Crowser, a division of Haley & Aldrich (Hart Crowser), has prepared this Feasibility Study (FS) Report to develop and evaluate viable cleanup action alternatives and recommend the preferred and most appropriate cleanup action alternative to address existing contamination and potential risk to receptors at the Seattle DOT Dexter Parcel site (Site). The Site consists primarily of the real property located at 615 Dexter Avenue North in Seattle, Washington (Property), and includes any areas where contamination originating on or from the Property has come to be located. The Property vicinity is shown on Figure 1-1.

The 0.56-acre Property is currently owned by the City of Seattle. SLP is seeking to purchase the Property pursuant to a Prospective Purchaser Consent Decree (PPCD) with the State of Washington. The Washington State Department of Ecology (Ecology) has listed the Site on its confirmed and suspected contaminated sites list with Cleanup Site ID No. 14785.

The purpose of the FS Report is to develop and evaluate cleanup action alternatives that will enable a cleanup action to be selected for the Site. This FS Report was developed subsequent to the Remedial Investigation (RI) Report (Hart Crowser 2021), which characterized the nature and extent of environmental contamination associated with the Site. The FS Report was developed in accordance with the Model Toxics Control Act (MTCA) regulations—Washington Administrative Code (WAC) 173-340-350. The results of this FS will be used to prepare a Draft Cleanup Action Plan (DCAP). The cleanup action outlined in the DCAP, upon approval by Ecology and after public comment, will be implemented during and following redevelopment of the Property.

2.0 SUMMARY OF REMEDIAL INVESTIGATION

The following sections summarize the Property setting and history and results of the RI. The RI Report (Hart Crowser 2021) includes more detail on the Site background, RI procedures, and analytical results.

2.1 Site Description and History

The Property is located in the South Lake Union neighborhood in Seattle, Washington. The Property is bound by Roy Street to the north, an alley and 601 Dexter Avenue North to the south, Aurora Avenue to the west, and Dexter Avenue North to the east. The elevation[1] of the Property ranges from approximately 70 feet on the west to 56 feet on the east. The Property currently contains one warehouse-style building

[1] All elevations in this FS Report are referenced to the North American Vertical Datum of 1988 (NAVD88).

and two parking lots. The current building and adjacent parking lot sit at a higher elevation than the lower, eastern parking area. These topographic features, surface structures, and other current conditions of the Property and nearby parcels are shown on Figure 2-1.

The Property is planned to be redeveloped with an 18-story tower and a below-grade parking garage that will encompass the entire footprint of the Property. Two levels of below-grade parking are planned, resulting in a lowest finished floor elevation of approximately 40 feet (approximately 30 feet below ground surface [bgs]) on the west half of the Property and 35.5 feet elevation (approximately 21 feet bgs) on the east half. The foundation for the building will require approximately 2 feet of excavation below the finished floor elevation, resulting in a bottom of excavation ranging from approximately elevation 38 feet (32 feet bgs) to elevation 33.5 feet (23 feet bgs). The building will be a multi-family residential tower and will include a mix of units including market rate and income-restricted units ranging from 60 to 85 percent Area Median Income. Redevelopment is expected to begin in 2022 and is expected to be completed by 2024.

As outlined in detail in the RI Report, from approximately the end of the 19th century to between 1917 and 1936, residential dwellings were present on the Property. In 1926, the southern half of the existing building was constructed. A small gasoline station was located on the eastern portion of the Property from approximately 1930 to the mid-1940s. In approximately 1946, the northern half of the existing building and an additional building adjoining to the east were constructed. The existing building and adjoining building to the east have been occupied by a variety of commercial businesses since then. In 2005, a fire destroyed the eastern building, which was then replaced with a surface parking lot. Currently, the Property is occupied by Copiers Northwest for storage and parking.

Potential on- and off-Property historical contaminant sources for the Site that were investigated during the RI include several gasoline and service stations, underground storage tanks (USTs), coated wall board manufacturing, and laundry and dry-cleaning facilities (Hart Crowser 2021).

2.2 Site Geology and Hydrogeology

The following summary of the subsurface geology and hydrogeology conditions at the Property is based on the extensive data collected and analyzed as part of the RI. For a more detailed analysis and the interpretation of recent and historical borings completed on the Property and in the surrounding area (shown on Figure 2-2), refer to the RI Report. Subsurface conditions described below are shown on cross-sections (Figures 2-3a and 2-3b).

2.2.1 Stratigraphy

Soil encountered beneath the Property consists of fill and glacial deposits consistent with previous studies in the area (SoundEarth Strategies 2016; PES Environmental 2018). Brief summaries of the identified geological units are presented below, and geologic cross-sections are provided in Figures 2-3a and 2-3b.

Fill. Fill is comprised of poorly graded sand with gravel, silty sand, silty sand with gravel, some silt, all with variable gravel and cobbles. Fill also contains brick, concrete, and glass debris. Fill depths of up to 8 feet bgs, corresponding to approximately elevation 48 feet, were observed at the Property.

Silty Sand and Silty Gravel. Deposits comprised of glacial till and ice-contact deposits were observed underlying the Property. The deposits are composed of dense to very dense silty sand to silty sand with gravel. Interbedded in these deposits are layers of poorly graded sand, sandy silt, and silt. Varying degrees of gravel and cobbles were observed. All explorations at the Property were advanced in this material to the bottom of the borings—ranging from 10 to 70.3 feet bgs (approximately 49 to -8 feet elevation).

Silt and/or Clay with or without Sand. Silt and clay deposits comprised of silt and clay units with and without sand were observed in borings on the west and east portions of the Property. The deposits consisted of silt, sandy silt, and silt with sand intermitted with poorly graded sand, silty sand, silty gravel, and/or clean sand/gravel.

Clean Sand and/or Gravel. Clean sand and gravel deposits were observed intermittently and minimally throughout the subsurface of the Property. The deposits are composed of loose to very dense poorly graded sand or poorly graded gravel and are interbedded with silty sand, silty gravel, silt, and clay units. The deposits are described as moist to wet and range in color from brown to gray.

2.2.2 Hydrogeology

The hydrogeology of the Property consists of discontinuous water-bearing zones in the glacial till deposits, and a deeper water-bearing zone in ice-contact and other glacial outwash deposits.

Groundwater encountered at the Site has been relatively shallow, generally found to depths of approximately 21 to 33 feet bgs (approximately elevation 27 to 40 feet) and is unconfined in the fill and upper portion of the glacial till/ice-contact deposits (referred to in this report as shallow depth groundwater). Groundwater encountered at depths to approximately 23 to 44 feet bgs (approximately elevation 26 to 36 feet) is in a dense to very dense, unconfined water-bearing zone in the glacial till/ice-contact deposits (referred to in this report as intermediate depth groundwater).[2]

The data from the synoptic measurement events demonstrate a general groundwater flow direction to the east and southeast. The inferred groundwater flow direction is consistent with topographic gradient and the flow direction observed in adjacent sites (SoundEarth Strategies 2013; PES Environmental 2018). Figures 2-4a and 2-4b show groundwater elevation contours and horizontal flow directions based on groundwater levels measured in March 2020 and May 2020.[3] The water level measurement data from the

[2] MW-307, which was installed by PES as part of the American Linen site investigation, is significantly deeper than the other wells at the Site and its groundwater depth is excluded from this summary and other discussions on groundwater depth in this report. Additionally, some wells (e.g., DMW-10S through DMW-13S) monitor water quality conditions in the lower part of the shallow zone and the upper part of the intermediate zone because their screens span both zones. We used professional judgment to assign wells DMW-10S and DMW-11S to the shallow zone and DMW-12S and DMW-13S to the intermediate zone because their water levels were most consistent with nearby wells assigned to the same unit. DMW-14S was incorrectly labeled as a shallower well but represents the intermediate groundwater.

[3] Figures 2-4a and 2-4b show groundwater elevations separately for wells screened at shallower depths within the aquifer and those screened deeper. This is necessary to meaningfully portray groundwater flow directions in situations where there are significant vertical gradients as at this site. Well MW-307, which was installed by PES

Site and adjacent sites show that groundwater elevation generally increases from fall to spring and decreases from spring to fall. All water level measurements except for two measurements in March 2019 from DMW-1S were collected while temporary construction dewatering was occurring at nearby sites—including 700 Dexter Avenue North (700 Dexter), approximately 120 feet northeast of the Property, from June 2019 to July 2020; and Block 38 West, generally located at 500 to 536 Westlake Avenue North and approximately 1,100 feet southeast of the Property, from January 2020 to March 2021. Although dewatering may affect groundwater levels and flow direction, the effects of construction dewatering at 700 Dexter and Block 38 West (if any) cannot be distinguished from seasonal variation.

Vertical hydraulic gradients are interpreted to be downward across the Property. Vertical hydraulic gradients were derived from groundwater elevations in grouped wells near the northeast corner of the Property (MW-305, MW-306, and MW-307), and show groundwater flows downward, from shallow depths toward deeper depths. Vertical gradient values vary from 0.11 foot per foot (ft/ft) to 0.47 ft/ft between the shallow and intermediate well depths. While there are no other well pairs or groups on the Site, comparison of inferred groundwater elevation contours (Figures 2-4a and 2-4b) suggest that a downward gradient is present throughout the eastern portion of Property. There is no water level data from the western part of the Property; however, given the small size of the parcel, we suspect there is a downward gradient there as well.

2.3 Environmental Investigations

Between 1970 and 2020, multiple investigations were completed on and adjacent to the Property in support of both geotechnical and environmental studies for the Property and adjacent properties. A chronological list of the environmental investigations considered in the RI is provided in Table 2-1 and relevant information is summarized below. The RI Report and the original reports that are referenced in the summaries below contain detailed information on the previous investigations, including detected analytes and their concentrations. The locations of explorations relevant to the RI are provided on Figure 2-2 and the explorations are summarized in Table 2-2.

- A comprehensive foundation investigation for the proposed property redevelopment, conducted by Shannon & Wilson from March 1970 to February 1971 (Shannon & Wilson, 1971). Two borings are close enough to be relevant to the Site and were advanced to depths ranging from 48 to 50 feet bgs or 12 to 9 feet elevation. There is no record of chemical analysis from this investigation; however, this investigation was relevant to the RI to evaluate subsurface geologic conditions on and near the Property in order to prepare geologic cross-sections.

- A Phase II Environmental Site Assessment (Phase II) for the Denny Way/Lake Union Combined Sewer Overflow (CSO) project to document environmental conditions in the vicinity of the then-planned underground CSO infrastructure, conducted by Black & Veatch from June to November 1997 (Black & Veatch, 1998). One monitoring well is close enough to be relevant to the Site and was advanced to

Environmental as part of the American Linen site investigation, is significantly deeper than the other wells at the Site and so is not used to construct groundwater contours on Figures 2-4a and 2-4b.

60 feet bgs or -3 feet elevation. One soil sample was collected and analyzed for total petroleum hydrocarbons (TPH). One groundwater sample was collected and analyzed from this monitoring well for TPH and volatile organic compounds (VOCs).

- An investigation to document environmental conditions in the vicinity of the then-planned Mercer Corridor project, conducted by Shannon & Wilson from April to May 2012 (Shannon & Wilson, 2012). Six borings are close enough to be relevant to the Site and were advanced to depths ranging from 9 to 19 feet bgs or 62 to 39 feet elevation. Fourteen soil samples were collected and analyzed for TPH, VOCs, and/or metals. No groundwater samples were collected from these borings.

- A remedial investigation to delineate the nature and extent of contamination from past releases of dry-cleaning solvent and petroleum from the American Linen Supply Co Dexter Ave site (Cleanup Site ID No. 12004), herein referred to as the American Linen site, conducted by SoundEarth Strategies from July 2012 to March 2013 (SoundEarth Strategies, 2013). One monitoring well is close enough to be relevant to the Site and was advanced to 55 feet bgs or 2 feet elevation. Five soil samples were collected and analyzed for select VOCs, including chlorinated volatile organic compounds (CVOCs[4]). Two groundwater samples were collected and analyzed from this monitoring well for TPH and/or VOCs.

- A limited Phase II to characterize environmental conditions on the Property for future redevelopment, conducted by Shannon & Wilson in April and May 2017 (Shannon & Wilson, 2018). Seven soil borings were advanced to depths ranging from 15 to 30 feet bgs or 51 to 36 feet elevation. Ten soil samples were collected and analyzed for TPH, metals, VOCs, and/or semi-volatile organic compounds (SVOCs). Three grab groundwater samples were collected and analyzed for TPH, total and dissolved metals, and/or VOCs.

- An investigation to continue to delineate the nature and extent of contamination from the nearby American Linen site, conducted by PES Environmental from August 2017 to October 2019 (PES Environmental 2019 and PES Environmental 2020). Three monitoring wells are close enough to be relevant to the Site and were advanced to depths ranging from 35 to 85 feet bgs or 25 to -25 feet elevation. Seventeen soil samples were collected and analyzed for VOCs. Nine groundwater samples were collected and analyzed from these wells for gasoline-range petroleum hydrocarbons (GRO) and VOCs.

- A Phase II on the alley and the parcel (601 Dexter Avenue North) to the south of the Property to support future redevelopment, conducted by Hart Crowser in April 2019 (Hart Crowser 2019). One monitoring well and five soil borings were advanced to depths ranging from 16 to 50 feet bgs or 46 to 10 feet elevation. Twenty-five soil samples were collected and analyzed for TPH, VOCs, polycyclic

[4] For purposes of this FS Report, we use the term CVOCs to refer to the volatile compound tetrachloroethene and its degradation products—trichloroethene, cis- and trans-1,2-dichloroethene, and vinyl chloride. We use the term BTEX to refer to the volatile aromatic compounds benzene, toluene, ethylbenzene, and xylenes. All other volatile organic compounds, including chlorinated compounds such as 1,1,1-trichloroethane and 1,1-dichloroethane, are referred to as VOCs.

aromatic hydrocarbons (PAHs), metals, and/or polychlorinated biphenyls (PCBs). One grab and one monitoring well groundwater sample was collected and analyzed for TPH, VOCs, PAHs, and/or total and dissolved metals.

- An RI to characterize the nature and extent of contamination at the Site, conducted by Hart Crowser in March 2019 and February, March, October, and November 2020 (Hart Crowser 2021). Ten soil borings and fourteen monitoring wells were advanced to depths ranging from 10 to 70 feet bgs or 56 to -9 feet elevation. A total of 139 soil samples and one field duplicate sample were collected and analyzed for GRO, diesel- and heavy oil-range petroleum hydrocarbons (DRO and HO, respectively), VOCs, SVOCs, PCBs, and/or metals. Five grab groundwater samples, sixteen monitoring well groundwater samples, and two field duplicates were collected and analyzed for GRO, DRO, HO, VOCs, SVOCs, total and/or dissolved metals, and/or total suspended solids.

2.4 Nature and Extent of Contamination

This section summarizes the nature and extent of contamination at the Site. The RI Report contains detailed information. Section 2.4.1 describes the process to identify proposed constituents of concern (COCs), Sections 2.4.2 and 2.4.3 describe the distribution of proposed COCs in soil and groundwater, respectively, and Section 2.4.4 presents the conceptual site model (CSM).

2.4.1 Constituents of Concern

This section summarizes the screening process and reviews how proposed COCs—those constituents that are to be addressed by the cleanup action—for the Site were selected, with more detailed information presented in the RI Report. A three-step process was utilized to determine proposed COCs: identification of detected constituents; identification of constituents of potential concern (COPCs); and identification of proposed COCs.

For the first step, those constituents that were never detected were screened out from further consideration.

The second step, identification of COPCs, involved comparing the maximum concentrations of the detected constituents to conservative (protective), risk-based screening levels. Those constituents whose maximum concentration in any sample exceeded their corresponding screening levels were identified as COPCs. Screening levels for each medium and constituent reflect concentrations that are protective for the possible exposure pathways identified in the preliminary CSM developed in the RI Report, including exposure via cross-media transport and natural background levels, where applicable. Screening levels were based on values provided by Ecology on November 17, 2020.

For the third step, those COPCs that contributed little or nothing to the overall risk to human health and the environment were screened out from consideration and the remaining constituents were identified as proposed COCs for purposes of defining site cleanup requirements. Factors that we considered when identifying proposed COCs included a constituent's toxicity, mobility in the environment, natural background concentration, and prevalence at the Site (e.g., frequency of detection).

Tables 2-3a and 2-3b present the evaluations that resulted in the identification of proposed COCs in soil and groundwater, respectively. These evaluations are also summarized in detail in the RI report.

Based on the evaluations presented above, the proposed Site COCs are:

- Soil:
  - GRO
- Groundwater:
  - GRO
  - DRO
  - Benzene

2.4.2 Distribution of COCs in Soil

This section presents the distribution of proposed COCs in soil at the Site. As noted in Section 2.4.1, GRO is the only proposed COC identified for soil. Its distribution is shown in the plan view on Figure 2-5.

GRO impacts in soil that exceed screening levels are limited to a localized area in the southeast corner of the Property and extending south beneath the east end of the alley (Figure 2-5). In this area, GRO concentrations exceeded the screening level of 30 milligrams per kilogram (mg/kg) in five borings (DMW-1S, DMW-2S, DMW-4S, 21417-GP4, and HC-1) at depths ranging between approximately 10 and 15 feet bgs (elevations 46 to 41 feet) on the Property and slightly deeper beneath the alley at approximately 25 feet bgs (elevation 37 feet). The exceedances range from 35 to 1,200 mg/kg. The observed impacts are attributed to historical releases from the former gas and auto repair station that existed in this area of the Property.

The northern extent of GRO exceeding the screening level in soil is defined by the samples in borings DGW-1 (at 10 feet bgs or 46 feet elevation; 12.5 feet bgs or 43.5 feet elevation; 15 feet bgs or 41 feet elevation; and 25 feet bgs or 31 feet elevation) and DMW-3IA (at 10 feet bgs or 46 feet elevation; 15 feet bgs or 41 feet elevation; and 20 feet bgs or 36 feet elevation).

The eastern extent of GRO exceeding the screening level in soil is bound by the samples in borings DMW-8S (at 10 feet bgs or 48.5 feet elevation; 15 feet bgs or 43.5 feet elevation; and 20 feet bgs or 38.5 feet elevation) and DMW-9S (at 10 feet bgs or 49 feet elevation; 15 feet bgs or 44 feet elevation; 20 feet bgs or 39 feet elevation; and 25 feet bgs or 34 feet elevation).

The southern extent of GRO exceeding the screening level in soil is bound by the samples in borings DMW-10S (at 15 feet bgs or 44.5 feet elevation; 20 feet bgs or 39.5 feet elevation; and 25 feet bgs or 34.5 feet elevation) and DMW-11S (at 15 feet bgs or 46 feet elevation; 20 feet bgs or 41 feet elevation; and 25 feet bgs or 36 feet elevation).

The western extent of GRO exceeding the screening level in soil is bound by the samples in borings DMW-12S (at 20 feet bgs or 46 feet elevation; 25 feet bgs or 41 feet elevation; and 30 feet bgs or 36 feet elevation), DGW-3 (at 12.5 feet bgs or 43.5 feet elevation), and DGW-1 (at 10 feet bgs or 46 feet elevation; 12.5 feet bgs or 43.5 feet elevation; 15 feet bgs or 41 feet elevation; and 25 feet bgs or 31 feet elevation).

The vertical extent of GRO exceeding the screening level in soil is defined by the samples in borings DMW-1S (at 20 feet bgs or 36 feet elevation), DMW-2S (at 15 feet bgs or 41 feet elevation), DMW-4S (at 30 feet bgs or 32 feet elevation), and HC-1 (at 30 feet bgs or 32 feet elevation).

2.4.3 Distribution of COCs in Groundwater

This section presents the distribution of proposed COCs in groundwater at the Site. As noted in Section 2.4.1, the proposed COCs identified for groundwater include GRO, DRO, and benzene. This information is shown in the plan view on Figure 2-6.

Proposed COCs in groundwater that exceed screening levels are limited to a localized area in and near the southeast corner of the Property, encompassing four sampling locations: DMW-1S, DMW-4S, HC-1, and 21417-GP4 (Figure 2-6).

GRO concentrations exceed the screening level in the well sample from DMW-1S in March 2020 (well screen from 17 to 27 feet bgs or 39 to 29 feet elevation), the grab sample from 21417-GP4 in April 2017 (well screen from 10 to 15 feet bgs or 46 to 41 feet elevation), and the grab sample from HC-1 in April 2019 (well screen from 21.5 to 31.5 feet bgs or 41 to 31 feet elevation). The GRO exceedances ranged from 1,800 to 6,900 micrograms per liter (µg/L), compared to the screening level of 800 µg/L. This area corresponds with the localized area of gasoline-related soil impacts described above in Section 2.4.3. These impacts are attributed to releases from the former gas and auto repair station that once occupied this area of the Property.

The other proposed COCs exceeding screening levels are co-located with (or in close proximity to) the GRO exceedances and are likely related to the same petroleum releases:

- DRO exceeded the screening level of 500 µg/L in the March 2020 well sample from DMW-1S at a concentration of 580 µg/L, and in the well sample from DMW-4S in March 2020 (well screen from 23 to 33 feet bgs or 39 to 29 feet elevation) at a concentration of 790 µg/L. DMW-4S is located next to HC-1 in the southern portion of the plume.

- Benzene exceeded the screening level of 2.4 µg/L in the March 2020 well sample from DMW-1S at a concentration of 2.9 µg/L.

The boundary of this groundwater plume is defined by samples collected from boring DGW-1 (well screen from 20 to 30 feet bgs or 36 to 26 feet elevation), and monitoring wells DMW-2S (well screen from 25 to 35 feet bgs or 31 to 21 feet elevation), DMW-8S (well screen from 27 to 37 feet bgs or 31.5 to 21.5 feet elevation), DMW-9S (well screen from 23 to 33 feet bgs or 36 to 26 feet elevation), DMW-11S (well screen from 30 to 50 feet bgs or 31 to 11 feet elevation), and DMW-12S (well screen from 30 to 50 feet bgs or 36 to 16 feet elevation).

While COC concentrations at DGW-3, which is located between DMW-12S and the exceedance locations, were all non-detect at the laboratory reporting limits, groundwater from this location was sampled from a much deeper elevation (i.e., approximately 20 feet deeper) than the shallower zone of contamination, so it is not used for defining the western extent of the plume. For similar reasons, the groundwater data for monitoring well DMW-10S, which showed COC concentrations less than the screening levels, was not used to define the southern extent of the plume.

The data for the bounding locations establishes that the groundwater contaminant plume is largely limited in extent to within the Property and alley boundaries (Figure 2-6).

2.4.4 Conceptual Site Model

This section summarizes the CSM for the Site. The CSM identifies sources of contamination, contaminant transport pathways, and current and potential human and ecologic exposure pathways. The CSM for the Site is discussed below and illustrated in the diagram presented in Figure 2-7.

2.4.4.1 Contaminant Sources

The source of petroleum hydrocarbon contamination at the Site is petroleum in soil that resulted from historical releases from past uses of the Property including the former gasoline and service station on the east portion of the Property.

2.4.4.2 Transport Pathways

Petroleum hydrocarbon contamination is transported to potential receptors through leaching and volatilization pathways. Leaching of contaminated soil by recharge results in dissolved-phase petroleum hydrocarbons in groundwater. Volatile constituents are transported via volatilization from unsaturated soil and shallow groundwater into soil gas, which could migrate to the ambient air or overlying structures.

2.4.4.3 Receptors and Exposure Pathways

Current and future receptors at the Site include construction workers, workers and patrons of commercial and retail facilities, and area residents. Receptors and associated exposure pathways are:

- Any person in contact with contaminated soil.
- Any person that incidentally ingests contaminated soil.
- Any future building occupant breathing potentially contaminated air impacted from volatile compounds in vadose-zone soil and/or shallow groundwater.
- Any person ingesting contaminated groundwater.

Terrestrial ecological receptors are not a concern for the Site based on the planned future land use, as discussed in more detail in the RI Report.

3.0 CLEANUP STANDARDS

Cleanup actions must comply with cleanup standards set forth in WAC 173-340-700 through 173-340-760. Cleanup standards include cleanup levels (CULs) for hazardous substances present at the Site, the location where these CULs must be met (i.e., point of compliance [POC]), and other regulatory requirements that apply to the Site because of the type of cleanup action and/or location of the Site (i.e., applicable state and federal laws). The proposed CULs and POCs are presented in Section 3.1, and applicable state and federal laws are presented in Section 3.2.

3.1 Proposed Cleanup Levels and Points of Compliance

CULs are concentrations of hazardous substances that are determined by Ecology to be protective of human health and the environment under specified exposure conditions. The MTCA regulations (WAC 173-340-350[9][a]) require that CULs be established for hazardous substances in each medium (soil, groundwater, and indoor air) and for each exposure pathway where a release has occurred. For the Site, proposed CULs have been developed for soil, groundwater, and indoor air to address the exposure pathways identified in Section 2.4.4.3.

In general, standard MTCA Method B CULs have been proposed for this Site, which are applicable to all sites and are developed with default formulas, assumptions, and procedures (WAC 173-340-705[1] and [2]). We selected the minimum CUL (most protective) for all applicable exposure pathways, as discussed in more detail in Sections 3.1.1 through 3.1.3.

The POC is the point or location on a site where CULs must be attained and is summarized for each proposed COC in Tables 3-1a through 3-1c below.

3.1.1 Soil

The POC for soil is pathway-dependent, as outlined in WAC 173-340-740(6)(b-d) and summarized below:

- Soils throughout the Site for soil CULs based on the protection of groundwater.
- Soils throughout the Site from the ground surface to the uppermost groundwater saturated zone for soil CULs based on protection from vapors.
- Soils throughout the Site from the ground surface to 15 feet bgs for soil CULs based on human exposure via direct contact.

As discussed in WAC 173-340-740(6)(f), for cleanup actions that involve containment of hazardous substances, the soil CULs will typically not be met at the POCs listed above. In these cases, the cleanup action may be determined to comply with cleanup standards if:

- The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360.
- The cleanup action is protective of human health.
- The cleanup action is demonstrated to be protective of terrestrial ecological receptors.[5]

[5] Terrestrial ecological receptors are not a concern for the Site based on the planned future land use, as discussed in more detail in the RI Report.

- Institutional controls are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system.

- Compliance monitoring under WAC 173-340-410 and periodic review under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system.

- The types, levels, and amount of hazardous substances remaining on site and the measures that will be used to prevent migration and contact with those substances are specified in the DCAP.

We selected the lowest soil CUL (most protective) for the following two exposure pathways:

- Protection of direct contact, based on Ecology's Model Remedies for Sites with Petroleum Contaminated Soils (Ecology 2017).

- Leaching from soil to groundwater protective of a full-time residential user of groundwater as a drinking water source for the appropriate soil zone (saturated or vadose). The MTCA Method A CUL was used, which was developed using the four-phase partitioning model in accordance with WAC 173-340-747(6) using the default parameters.

The proposed soil CUL for GRO is 30 mg/kg. Its basis and associated POC are listed in Table 3-1a.

3.1.2 Groundwater

We propose to use the standard POC for groundwater, which is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site (WAC 173-340-720[8][b]).

We selected the lowest groundwater CUL (most protective) for the following two exposure pathways:

- Protection of drinking water.

    - For benzene, the protection of drinking water CUL was developed by identifying the maximum contaminant level (MCL) and calculating levels per MTCA Equations 720-1 and 720-2 (WAC 173-340-720[4][b][iii][A] and -720[4][b][iii][B]) using the toxicity values in Ecology's online cleanup levels and risk calculation (CLARC) database (Ecology 2021). The ratio of the minimum MCL to the Equation 720-1 value does not exceed 1, so the hazard quotient associated with the MCL does not exceed 1 and the MCL requires no adjustment. Furthermore, the ratio of the minimum MCL to the Equation 720-2 value does not exceed 10, so the cancer risk associated with the MCL does not exceed 1E-5 and the MCL requires no adjustment. Therefore, the MCL was used as the protection of drinking water CUL.

    - For GRO and DRO, the MTCA Method A CULs were used, which are based on protection from noncarcinogenic effects for drinking water use.

- Protection of ambient air, calculated per Ecology guidance for vapor intrusion (Ecology 2018a and 2018b).

The proposed groundwater CULs are 800 µg/L for GRO, 500 µg/L for DRO, and 2.4 µg/L for benzene. The basis of the proposed CULs and their associated POCs are listed in Table 3-1b.

3.1.3 Indoor Air

We propose to use the standard POC for air, which is ambient air throughout the Site (WAC 173-340-750[6]).

We selected the air CUL based on the inhalation exposure pathway. For benzene, we used the lower (more protective) of the CULs calculated using MTCA Equations 750-1 and 750-2 (WAC 173-340-750[3][b][ii]). For TPH, the CUL is based on Ecology guidance on petroleum vapor intrusion (Ecology 2018b).

The proposed air CULs are 140 micrograms per cubic meter (µg/m^3) for TPH and 0.32 µg/m^3 for benzene. The basis of the proposed CULs and their associated POCs are listed in Table 3-1c.

3.2 Applicable or Relevant and Appropriate Requirements

This section identifies potential applicable or relevant and appropriate requirements (ARARs) to be used in assessing and implementing cleanup actions at the Site. The potential ARARs focus on federal, state, or local statutes, regulations, criteria, and guidelines. The types of potential ARARs evaluated for the Site were contaminant-, location-, and action-specific, as defined in the following paragraphs. Each type of potential ARAR is evaluated in Table 3-2, and applicable ARARs are listed below.

In general, only the substantive requirements of ARARs are applied to MTCA cleanup sites being conducted under a legally binding agreement with Ecology (WAC 173-340-710[9][b]). Thus, cleanup actions under a formal agreement with Ecology are generally exempt from the procedural requirements specified in certain state and federal laws.[6] This exemption also applies to permits or approvals required by local governments.

Contaminant-specific ARARs. Contaminant-specific ARARs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that regulatory agencies generally recognize as protective of human health and the environment.

Applicable contaminant-specific ARARs include:

- Washington MTCA (Revised Code of Washington [RCW] 70A.305; Chapter 173-340 WAC) regulating soil, groundwater, and indoor air cleanup levels.

[6] The exemption applies to the following Washington State laws: Clean Air Act (RCW 70A.15), Solid Waste Management (RCW 70A.205), Hazardous Waste Management (RCW 70A.300), Construction Projects in State Waters (RCW 77.55), Water Pollution Control (RCW 90.48), and Shoreline Management Act (RCW 90.58). Exemption does not apply if Ecology determines that it would result in loss of approval from a federal agency necessary for the state to administer any federal law.

Action-specific ARARs. Action-specific ARARs are pertinent to particular remediation methods and technologies, and to actions conducted to support cleanup. Action-specific ARARs are requirements that may need to be satisfied during the performance of specific cleanup actions because they prescribe how certain activities (e.g., treatment and disposal practices, and media monitoring programs) must occur. Typically, action-specific ARARs are not fully defined until a preferred response action has been selected and the corresponding cleanup action can be more completely refined. However, preliminary consideration of the range of potential action-specific ARARs may help focus the process of selecting a preferred cleanup action alternative.

Applicable action-specific ARARs include:

- United States (U.S.) Clean Air Act (42 United States Code [USC] § 7401 et seq. and 40 Code of Federal Regulations [CFR] Part 50) and Washington Clean Air Act and Implementing Regulations (RCW 70A.15; Chapter 173-400 WAC) to protect ambient air quality by limiting air emissions and taking reasonable precautions to prevent fugitive dust from becoming airborne, which are applicable to cleanup action alternatives involving construction.

- U.S. Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.), Subtitle D—Managing Municipal and Solid Waste (40 CFR Parts 257 and 258), and Washington Solid Waste Handling Standards (RCW 70A.205; Chapter 173-350 WAC) to establish guidelines and criteria for management of non-hazardous solid waste, which are applicable to cleanup action alternatives involving off-site disposal of contaminated soil and/or groundwater designated as non-hazardous waste.

- U.S. Occupational Safety and Health Act (OSHA) (29 CFR Parts 1904, 1910, and 1926) and Washington Industrial Safety and Health Act (WISHA) (RCW 49.17; Title 296 WAC) to establish site worker and visitor health and safety requirements during implementation of the cleanup action.

- Washington Underground Injection Controls (UIC) Program (Chapter 173-218 WAC) to protect groundwater quality, which is applicable to cleanup action alternatives that include injection of biological or chemical oxidants into injection wells or trenches.

- Washington State Environmental Policy Act (SEPA) (RCW 43.21C; Chapter 197-11 WAC) to identify and analyze environmental impacts associated with the selected cleanup action.

- King County Stormwater Runoff and Surface Water and Erosion Control (King County Code [KCC] Chapter 9.04), King County Water Quality (KCC Chapter 9.12), and Seattle Stormwater Code (Seattle Municipal Code [SMC] Title 22, Subtitle VIII) to establish guidelines for erosion control and construction stormwater management, which are applicable to cleanup action alternatives involving construction.

- Seattle Grading Code (SMC Chapter 22.170) to establish guidelines for grading, which is applicable to cleanup action alternatives involving an excavation and filling volume greater than 500 cubic yards.

- Washington Noise Control (RCW 70A.20; Chapter 173-60 WAC) and Seattle Noise Control (SMC Chapter 25.08) to minimize noise impacts during implementation of the selected cleanup action.

- U.S. Federal Water Pollution Control Act—National Pollutant Discharge Elimination System (NPDES) (Clean Water Act [CWA]; 33 USC § 1342, Section 402) and Implementing Regulations and Washington Waste Discharge General Permit Program (RCW 90.48; Chapter 173-226 WAC) to establish requirements for point source discharges, including stormwater runoff, which are applicable to cleanup action alternatives involving point source discharge of stormwater.

- Washington Minimum Standards for Construction and Maintenance of Wells (RCW 18.104; Chapter 173-160 WAC) to establish standards for constructing and decommissioning monitoring wells, which is applicable to cleanup action alternatives involving drilling or decommissioning wells.

Location-specific ARARs. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of special locations are floodplains, wetlands, historic sites, and sensitive ecosystems or habitats.

There are no applicable location-specific ARARs.[7]

4.0 CLEANUP ACTION ALTERNATIVES

This section identifies the cleanup action objectives (CAOs), describes the screening of potential remediation technologies for the Site, and describes the cleanup action alternatives for further evaluation.

4.1 Cleanup Action Objectives

CAOs were developed to identify goals that should be accomplished by the cleanup action alternatives to meet the minimum requirements of the MTCA regulations and provide adequate protection of human health and the environment. The CAOs consider the applicable receptors and exposure pathways for the affected media (Section 2.4.4.3).

The CAOs are listed below.

1. Prevent any person from direct contact with contaminated soil.
2. Protect groundwater from being contaminated by impacted soil.
3. Mitigate the potential for future building indoor air to be impacted by contaminated soil and groundwater.
4. Prevent any person from ingesting contaminated groundwater.

Each CAO will be achieved by terminating the associated exposure pathway. These objectives can be achieved through contaminant removal or treatment to meet constituent- and media-specific cleanup

[7] Although the building on the Property is 75 to 95 years old, the Washington Department of Archaeology and Historic Preservation (DAHP) website indicates the building does not warrant inclusion in the National Register of Historic Places (NRHP) due to a lack of historic or architectural significance (DAHP 2021).

standards (cleanup levels at points of compliance; Section 3.1) that are based on the specific exposure pathways and preventing exposure through containment with associated institutional controls.

4.2 Remediation Technology Screening

Candidate remedial technologies were identified and screened (Tables 4-1a through 4-1c) to develop potential cleanup action alternatives for further evaluation in this FS Report. The remediation technologies retained, and the cleanup action alternatives selected for evaluation and comparison, address the CAOs identified in Section 4.1. The screening process for technologies applicable to soil, groundwater, and indoor air remediation considered available methodologies that could address constituents in the various media based on their expected implementability, reliability, relative cost, and compatibility with redevelopment plans. Physical conditions at the Site that limit or support particular technologies, and constituent characteristics that limit the effectiveness or feasibility of a technology, were also considered.

The implementability of a technology—that is, the relative ease of installation and the time required to achieve a given level of performance—is assessed according to Site conditions. Implementability considers: (1) the technology's constructability (ability to build, construct, or implement the technology under actual Site conditions); (2) the time required to achieve the required level of performance as defined by the CULs and POCs; (3) the technology's ability to be permitted; (4) the availability of the technology; and (5) other technology-specific factors.

The U.S. Environmental Protection Agency (EPA) states that to assess the reliability of prospective technologies, an evaluator should identify each technology's level of development, performance record, and inherent construction, operation, and maintenance problems. Technologies that are not fully demonstrated, perform poorly, or are unreliable should be eliminated (EPA 1985).

Relative costs of technologies and process options are used to distinguish between similar technologies with similar expected effectiveness. The cleanup action alternatives retained for more detailed evaluation are intended to be the most cost-effective applications of the remedial technologies that are most appropriate for addressing the Site conditions.

Phytoremediation was not retained because it is incompatible with the planned redevelopment design and schedule. The other remediation technologies are compatible with redevelopment.

Tables 4-1a through 4-1c summarize the screening assessment process and indicate which technologies were retained for further evaluation as cleanup action alternatives, and which were eliminated from consideration based on implementability, reliability, cost, or incompatibility with redevelopment plans. The following technologies were retained for potential implementation in one or more cleanup action alternatives:

- Institutional controls.
- *In situ* enhanced bioremediation (ISEB).
- *In situ* chemical oxidation (ISCO).
- Soil removal and land disposal.
- Monitored natural attenuation (MNA).

- Passive vapor barrier.
- Maintenance of paved surface (i.e., building, hardscape, or alley) as cap.
- Monitoring.

4.3 Cleanup Action Alternative Descriptions

The technologies retained in the screening process were used to develop three cleanup action alternatives (Alternatives 1 through 3) for further evaluation. The conceptual components of the cleanup action alternatives developed for the Site are summarized below and shown in the plan view on Figures 4-1 through 4-3 and in the cross-section view on Figures 4-4a and 4-4b. The specific details of cost estimates for each cleanup action alternative are provided in Tables 4-2a through 4-2c.

All cleanup action alternatives included the following assumptions and requirements:

- All cleanup action alternatives include compliance monitoring to meet WAC 173-340-410.

- Costs were estimated using bid estimates from vendors and general contractors and recent Hart Crowser experience with similar items on other projects.

- Excavation and off-site disposal of all soil throughout the entire Property to elevations ranging from approximately 38 feet (approximately 32 feet bgs) to 33.5 feet (approximately 23 feet bgs) will occur as part of Property redevelopment. As such, all three cleanup action alternatives include the same proposed remedial excavation areas and depths within the Property boundary.

- Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, and building slab) are common elements across all three cleanup action alternatives, and they have been excluded from our cost estimate and cleanup action alternative comparisons.

4.3.1 Alternative 1

Alternative 1 consists of the following components:

- Excavate contaminated soil within the Property boundary to an elevation ranging from approximately 38 to 33.5 feet (approximately 23 to 32 feet bgs) for disposal at permitted receiving facilities.

- Conduct ISEB by applying Oxygen Release Compound Advanced® (ORC-A) to residual contamination off-Property in the alley.

- Implement MNA for contaminated soil off-Property in the alley and contaminated groundwater on-Property below the building excavation and/or off-Property in the alley. The future building, paved alley, and surrounding hardscape will serve as a cap to limit groundwater recharge and migration until MNA reduces COC concentrations to below CULs.

- Install passive vapor barrier.

- Implement institutional controls, such as an environmental covenant.

- Perform compliance monitoring and maintenance.

More detailed information on each of the components in Alternative 1 is presented below.

Excavate and Dispose Soil Off-Site. The planned redevelopment excavation required for construction of the new building will remove all known COC-contaminated soil on the Property (vertical extent ranging from approximately 7.5 to 17.5 feet bgs or elevations 48.5 to 38.5 feet). As shown in the plan view on Figure 4-1 and in the cross-section view on Figures 4-4a and 4-4b, the planned redevelopment excavation extends laterally across the entire Property. The vertical excavation extent ranges from approximately elevation 38 (approximately 32 feet bgs) to elevation 33.5 feet (approximately 23 feet bgs).

For purposes of this FS, the assumed excavation of COC-contaminated soil on the Property is a 33-by-33-foot area, from 7.5 to 17.5 feet bgs (Figures 4-1, 4-4a, and 4-4b). Using a conversion factor of 1.35 from bank cubic yards to truck cubic yards, and 1.4 from truck cubic yards to tonnage, this FS assumes an estimated 770 tons of COC-contaminated soil on the Property will be excavated and disposed of off-site. It is assumed that excavated COC-contaminated soil can be characterized as non-hazardous and will be sent off-site for disposal at a regulated Subtitle D landfill facility or other permitted landfill or treatment facility. Erosion control, site stabilization measures, and dewatering (including properly treating and/or disposing of impacted construction dewatering water as discussed in the next paragraph) will be implemented during construction activities to prevent adverse impact to human health and the environment.

The planned redevelopment excavation will remove some shallow groundwater contamination on the Property (e.g., GRO, DRO, and benzene in the southeast corner above approximate elevation 31.5 feet) during temporary construction dewatering. The dewatering system is anticipated to include localized sumps within the excavation footprint and/or well points. The groundwater table will be maintained approximately 2 feet below the bottom of the excavation. Construction dewatering will be required for the duration of excavation activities and will continue until the foundation and parking garage structure are completed to above the adjacent ground surface.

Collected water will be conveyed to a water treatment system prior to being discharged to either the combined sewer or storm sewer under the King County Industrial Waste Program (KCIW) or Construction Stormwater General Permit (CSWGP) issued by Ecology, respectively. The dewatering treatment system is anticipated to consist of particulate removal technologies (e.g., sedimentation) and/or granular activated carbon (GAC). Treatment, discharge monitoring, and reporting will be conducted in accordance with the permits issued by KCIW or Ecology.

Implement ISEB. ISEB is the injection or addition of nutrients and/or electron acceptors to stimulate microbial growth and breakdown of contaminant mass in soil and groundwater. Alternative 1 considers injection as a delivery method for these nutrients and/or electron acceptors.

ISEB will be implemented off-Property in the east side of the alley (Figure 4-1) to reduce concentrations of GRO in soil and GRO, DRO, and benzene in groundwater and to decrease the time frame for MNA to achieve cleanup standards.

For cost estimating purposes, we have assumed the ISEB program would include injections of Regenesis ORC-A through temporary injection points using a sonic drill rig. The treatment fluids would be injected within the impacted zone at depths from approximately 20 to 35 feet bgs. It is assumed that three injection points would be advanced on the east side of the alley in one application.

Implement MNA. Natural attenuation involves monitoring the reduction of contaminant mass in soil and groundwater through physical, chemical, and/or biological processes. Migration and releases of hazardous substances are minimized by biodegradation, dispersion, dilution, sorption, volatilization, chemical stabilization, and/or biological stabilization. MNA relies on these natural processes to decrease (or “attenuate”) concentrations of contaminants in soil and groundwater.

MNA will be implemented to reduce concentrations of GRO, DRO, and benzene in groundwater in the southeast corner of the Property below the planned redevelopment excavation and/or off-Property in the east side of the alley and GRO in soil off-Property in the east side of the alley (Figure 4-1).

MNA is most effective when the contaminant source has been removed and only small amounts of contaminants remain in the soil and/or groundwater. Natural attenuation is considered an appropriate remedy if requirements set out in WAC 173-340-370(7) are met. The explanations as to how these requirements are met are as follows:

1. *Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable.* The source will be removed to the maximum extent practicable as described previously in the “Excavate and Dispose Soil Off-Site” paragraph.

2. *Leaving contaminants on-site during the restoration time frame does not pose an unacceptable threat to human health or the environment.* During the restoration time frame, potential receptors will be protected by a vapor barrier to mitigate the potential for future building indoor air to be impacted by residual contaminated groundwater, as described later in the “Install Passive Vapor Barrier” paragraph, and by institutional controls to prevent the use of groundwater as drinking water, as described later in the “Implement Institutional Controls” paragraph.

3. *There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site.* This criterion is determined by the following factors:

    a. *The status of the groundwater plume; if the plume is stable or shrinking, the restoration time frame will be shortened, and the plume will not continue to migrate and potentially impact other media or receptors.* The residual area of petroleum contamination is unlikely to expand because it has been over 70 years since the petroleum would have been released. The gasoline and service station that was the source of contamination stopped operating in approximately the mid-1940s.

    The plume is also unlikely to expand or continue to migrate because there is no evidence that petroleum free product (i.e., non-aqueous phase liquid [NAPL]) is present based on observations and analytical data. NAPL has not been observed in any of the wells or borings at the Site. According to Ecology’s Guidance for Remediation of Petroleum Contaminated Sites (Ecology

2016), the solubility limit is 100,000 µg/L for GRO; less than 1,000 to 5,000 µg/L for middle distillates; and less than 1,000 to 6,300 µg/L for heavy fuels/oils. The highest concentration of DRO is 790 µg/L and the highest concentration of GRO is 6,900 µg/L, which are less than the solubility limits, indicating that NAPL is unlikely to be present. The highest GRO concentration in soil is 1,200 mg/kg, less than residual saturation levels for gasoline ranging from 1,697 mg/kg (in coarse sand and gravel) to 10,000 mg/kg (in silt to fine sand) (Brost and DeVaull 2000), which is another line of evidence that NAPL is unlikely to be present.

b. *Destructive mechanisms of natural attenuation (i.e., chemical or biological degradation) are occurring and are substantial contributors to contaminant reductions observed at the Site.* According to Ecology's Guidance on Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation (Ecology 2005), geochemical indicators and physical observations of a reduced contaminant plume can be used to determine if natural attenuation will be effective. Dissolved oxygen (DO) and oxidation reduction potential (ORP) are good indicators as to whether biodegradation is occurring. When oxygen is present in groundwater, aerobic bacteria will dominate, utilizing oxygen as the electron acceptor until all the oxygen has been depleted. Once the oxygen is depleted, the bacteria utilize alternative electron receptors with a sequential preference in order of decreasing ORP.

   In the plume area, DO concentrations ranged between approximately 1.61 to 4.97 milligrams per liter (mg/L) and ORP ranged from approximately 103 to 245 millivolts (mV) (Table 4-3). A pre-remedial design investigation will be performed in conjunction with preparation of the Engineering Design Report to further define geochemical parameters in the plume area.

   The fact that the dissolved plume is limited to a small, localized area in the alley is another line of evidence that natural attenuation is occurring at the Site. Given the age of the contamination, without *in situ* biodegradation, the length of the dissolved plume would be on the order of hundreds of feet long. However, the current extent of the plume is only approximately 20 feet long, indicating that *in situ* biodegradation is occurring. Because the groundwater condition in the alley is expected to remain aerobic, biodegradation is expected to continue to limit the dissolved plume in the alley to the current extent.

4. *Appropriate monitoring requirements are conducted to ensure that the natural attenuation process is taking place, and that human health and the environment are protected.* A monitoring plan will be prepared with sampling procedures, locations, frequency, and analyses (see Perform Compliance Monitoring and Maintenance paragraph below for more details).

Install Passive Vapor Barrier. A passive vapor barrier will be installed below the slab and along the perimeter foundation walls of the new building structure to prevent potential vapor intrusion by physically blocking the entry of vapors. The barrier would be sealed to the foundation and all penetrations. Smoke testing of the foundation seal, seams, and penetrations would be conducted to confirm the barrier is installed according to the manufacturer's specifications. The estimated lateral extent of the passive vapor barrier is shown on Figure 4-1. As discussed further in the Perform Compliance Monitoring and

Maintenance paragraph below, air monitoring would be conducted to evaluate the vapor barrier's continued effectiveness in reducing human health risks.

Implement Institutional Controls. Institutional controls will be implemented in areas where COC concentrations in soil and/or groundwater remain above the CULs. The known such areas include the southeast corner of the Property and/or the alley.

Institutional controls include filing an environmental covenant, and implementing administrative land use and activities restrictions for the areas with residual soil and/or groundwater contamination. The environmental covenant/administrative land use and activities restrictions are expected to place limitations on the use of the Property and surrounding areas (i.e., prohibit extraction of groundwater and compromising the cap); require that engineering controls (i.e., vapor barrier) remain in place and be monitored appropriately; and/or stipulate that cleanup actions must occur if existing structures or pavements are removed or disturbed. The requirements of the environmental covenant are presented in WAC 173-340-440(9).

Perform Compliance Monitoring and Maintenance. Monitoring, such as dust monitoring during excavation, will be conducted during implementation of the cleanup action to confirm that human health and the environment are adequately protected during construction. Soil, groundwater, and indoor air monitoring would be conducted, as necessary, to meet regulatory compliance, to assess the occurrence of natural attenuation at the Site, and to confirm the cleanup action has attained cleanup standards. Monitoring will also be conducted to assess the integrity and long-term effectiveness of the cap and passive vapor barrier, and maintenance of the cap will be conducted as necessary.

A Sampling and Analysis Plan, Quality Assurance Project Plan, and Operation and Maintenance (O&M) Plan will be prepared to summarize compliance sampling procedures, locations, frequency, and analyses and the long-term monitoring and maintenance activities, respectively. These plans will be submitted to Ecology for review and approval in conjunction with the Engineering Design Report.

The estimated net present value cost for Alternative 1 is $1,668,000 (Table 4-2a).

4.3.2 Alternative 2

Alternative 2 consists of the following components:

- Excavate contaminated soil within the Property boundary to an elevation ranging from approximately 38 to 33.5 feet (approximately 23 to 32 feet bgs), and off-Property in the alley to an approximate elevation of 35 feet (approximately 27.5 feet bgs) for disposal at permitted receiving facilities.

- Implement MNA for contaminated groundwater on-Property below the building excavation and/or off-Property in the alley. The future building, paved alley, and surrounding hardscape will serve as a cap to limit groundwater recharge and migration until MNA reduces COC concentrations to below CULs.

- Install passive vapor barrier.

- Implement institutional controls, such as an environmental covenant.
- Perform compliance monitoring and maintenance.

More detailed information on each of the components in Alternative 2 is presented below.

Excavate and Dispose Soil Off-Site. Alternative 2 includes excavation and off-site disposal of soil within the Property boundary as described in Alternative 1. See excavation description in Section 4.3.1 for details.

However, Alternative 2 also includes excavation of all soil above CULs off-Property, including the GRO in the east side of the alley (Figure 2-5). Exact lateral and vertical excavation limits will be based on the observed extent of soil contamination as determined by performance monitoring results. Excavation will continue within the alley until CULs are attained. Estimated lateral and vertical excavation limits of soil above CULs removed in Alternative 2 are shown in the plan view on Figure 4-2. The estimated excavation area and depth are based on the inferred lateral and vertical extents of contaminated soil based on soil samples evaluated in the RI. For planning and cost estimating purposes, the approximate estimated lateral excavation limit in the alley is 37 feet by 17 feet and the estimated vertical excavation limit is 22.5 to 27.5 feet bgs (elevation 40 to 35 feet). Soil above 22.5 feet bgs (elevation 40 feet) is assumed to have concentrations of GRO below CULs based on data evaluated in the RI, and for cost estimating purposes is assumed to be able to be excavated, temporarily stockpiled separately from contaminated soil, and reused as backfill.

Similar to excavation and off-site disposal on the Property discussed in Section 4.3.1, excavated COC-contaminated soil within the alley is assumed to be non-hazardous and will be sent off-site for disposal at a regulated Subtitle D landfill facility or other permitted landfill or thermal treatment facility. Erosion control, site stabilization measures, and dewatering (including properly treating and/or disposing of impacted construction dewatering water as discussed in Section 4.3.1) will be implemented during construction activities to prevent adverse impact to human health and the environment.

Implement MNA. Alternative 2 includes MNA for contaminated groundwater as described in Alternative 1. See MNA description in Section 4.3.1 for details. This alternative does not include conducting ISEB because all of the contaminated soil will be removed.

Install Passive Vapor Barrier. Alternative 2 includes a passive vapor barrier as described in Alternative 1. See vapor barrier description in Section 4.3.1 for details.

Implement Institutional Controls. Alternative 2 includes institutional controls as described in Alternative 1. See institutional controls description in Section 4.3.1 for details.

Perform Compliance Monitoring and Maintenance. Alternative 2 includes compliance monitoring and maintenance as described in Alternative 1. See compliance monitoring and maintenance description in Section 4.3.1 for details.

The estimated net present value cost for Alternative 2 is $2,107,000 (Table 4-2b).

4.3.3 Alternative 3

Alternative 3 consists of the following components:

- Excavate contaminated soil within the Property boundary to an elevation ranging from 38 to 33.5 feet (approximately 23 to 32 feet bgs) for disposal at permitted receiving facilities.
- Conduct ISCO of contaminated soil off-Property in the alley and contaminated groundwater on-Property below the building excavation and/or off-Property in the alley. The future building, paved alley, and surrounding hardscape will serve as a cap to limit groundwater recharge and migration until ISCO reduces COC concentrations to below CULs.
- Install passive vapor barrier.
- Implement institutional controls, such as environmental covenant.
- Perform compliance monitoring and maintenance.

More detailed information on each of the components in Alternative 3 is presented below.

Excavate and Dispose Soil Off-Site. Alternative 3 includes excavation and off-site disposal of soil within the Property boundary as described in Alternative 1. See excavation description in Section 4.3.1 for details.

Implement ISCO. ISCO is the injection or addition of reagent amendments that target specific contaminants in the subsurface environment to degrade or destroy contaminants in place. Alternative 3 considers injection as a delivery method for these amendments.

ISCO will be implemented to reduce concentrations of GRO, DRO, and benzene in groundwater in the southeast corner of the Property below the planned redevelopment excavation and/or off-Property in the east side of the alley (Figure 4-3). ISCO would also be implemented to reduce concentrations of GRO in soil in the east side of the alley.

The remedial program would be designed based on the nature of the contaminant, the target groundwater matrix, distribution, and the availability of any existing infrastructure (monitoring wells). For cost estimating purposes, we have assumed the ISCO program would include injections of Regenesis PersulfOx™ through temporary injection points using a sonic drill rig.

For purposes of this FS, this alternative assumes the following ISCO injection points and frequency, advanced to an elevation of approximately 23 feet on the Property and 27 feet in the adjacent alley:

- Seven injection points would be advanced on the Property at the bottom of the excavation (approximately 10 feet below bottom of excavation) on one occasion before the building slab is placed;
- Three injection points would be advanced within the western portion of the contaminated area in the alley on one occasion (approximately 35 feet bgs); and

- Five injection points would be advanced within the eastern portion of the contaminated area in the alley on two occasions (approximately 35 feet bgs).

Install Passive Vapor Barrier. Alternative 3 includes a passive vapor barrier as described in Alternative 1. See vapor barrier description in Section 4.3.1 for details.

Implement Institutional Controls. Alternative 3 includes institutional controls as described in Alternative 1. See institutional controls description in Section 4.3.1 for details.

Perform Compliance Monitoring and Maintenance. Alternative 3 includes compliance monitoring and maintenance as described in Alternative 1. See compliance monitoring and maintenance description in Section 4.3.1 for details.

The estimated net present value cost for Alternative 3 is $1,809,000 (Table 4-2c).

5.0 EVALUATION OF CLEANUP ACTION ALTERNATIVES

As described in WAC 173-340-360(2) (and presented in the subsections below), four threshold requirements need to be met for an alternative to be considered for selection as a final remedy. Three other requirements are then used to further evaluate the alternatives that satisfy the threshold criteria. Finally, several action-specific requirements—which vary depending on the nature of the Site and the alternatives being considered—are used to further refine the remedy selection if applicable.

Sections 5.1 through 5.3 describe the MTCA evaluation criteria and summarize how all three alternatives meet these criteria. Alternatives that meet threshold requirements are then assessed to determine which use permanent solutions to the maximum extent practicable. This assessment is conducted by performing a disproportionate cost analysis (DCA), which is summarized in Section 5.4.

5.1 MTCA Threshold Criteria

Threshold requirements required for cleanup actions are defined in WAC 173-340-360(2)(a). Requirements include protection of human health and the environment, compliance with MTCA cleanup standards and applicable state and federal laws, and provisions for compliance monitoring. All three alternatives meet the MTCA threshold requirements as described as follows.

5.1.1 Protect Human Health and the Environment

All three alternatives eliminate exposure pathways and provide for overall protection of human health and the environment.

All three alternatives prevent human exposure by removing soil on the Property with COC concentrations above the CULs, and by preventing exposure to soil and groundwater with COC concentrations above the CULs. Additionally, all three alternatives include a vapor barrier to mitigate vapor intrusion to protect building occupants until groundwater COC concentrations are reduced below CULs.

5.1.2 Comply with Cleanup Standards

The selected cleanup action alternative must comply with cleanup standards (cleanup levels and the points of compliance where such cleanup levels must be met) as established in WAC 173-340-700 through 173-340-760. All three alternatives comply with cleanup standards, as proposed in Section 3.1.

All three alternatives comply with soil cleanup standards by removing and permanently disposing of, treating via ISEB and MNA, and/or treating via ISCO soil with COC concentrations above the CULs. All three alternatives comply with groundwater cleanup standards by treating (through MNA, ISEB, and/or ISCO) groundwater with COC concentrations above the CULs. Additionally, all three alternatives include a vapor barrier to comply with indoor air cleanup standards.

5.1.3 Comply with Applicable State and Federal Laws

The alternative must comply with both applicable requirements and requirements determined to be relevant and appropriate, as defined through WAC 173-340-710. Additionally, the alternative must address local, state, and federal laws related to environmental protection, health and safety, transportation, and disposal.

All three alternatives will attain and comply with all applicable ARARs, which are summarized in Table 3-2 and listed in Section 3.2.

5.1.4 Provide for Compliance Monitoring

The alternative must provide for compliance monitoring, as established under WAC 173-340-410 and WAC 173-340-720 through 173-340-760. There are three types of compliance monitoring: protection, performance, and confirmational. Protection monitoring is designed to protect human health and the environment during the construction and O&M phases of the cleanup action. Performance monitoring confirms that the cleanup action has met cleanup and/or performance standards. Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been met or other performance standards have been attained.

All three alternatives would meet requirements for compliance monitoring, as they require varying levels of all three types of compliance monitoring as described in Sections 4.3.1 through 4.3.3.

5.2 Other Requirements

Other requirements required for cleanup actions are defined in WAC 173-340-360(2)(b). Requirements include using permanent solutions to the maximum extent practicable, providing for a reasonable restoration time frame, and considering public concerns. All three alternatives meet the other requirements as described as follows.

5.2.1 Use Permanent Solutions to the Maximum Extent Practicable

As outlined in WAC 173-340-360(3), evaluation of this requirement involves conducting a DCA, wherein the costs and benefits of each alternative are assessed, as defined by several evaluation criteria. The specific criteria that must be evaluated and the results of the DCA are discussed in Section 5.4.

5.2.2 Provide for a Reasonable Restoration Time Frame

Cleanup actions must provide for a reasonable restoration time frame. As laid out in WAC 173-340-360(4), determining whether an alternative provides for a reasonable restoration time frame involves balancing risks against the practicability of achieving a shorter time frame. A longer restoration time frame may be selected if the remedy has a greater degree of long-term effectiveness. However, extending the restoration time frame cannot be used as a substitute for active remedial measures when such actions are practicable. The factors considered in evaluating whether the restoration time frame is reasonable are listed in WAC 173-340-360(4)(b) and include:

- The potential risks posed by the Site to human health and the environment.
- The practicability of achieving a shorter restoration time frame.
- Current uses of the Site, surrounding areas, and associated resources that are or may be affected by releases from the Site.
- Potential future uses of the Site, surrounding areas, and associated resources that are or may be affected by releases from the Site.
- Availability of alternative water supplies.
- Likely effectiveness and reliability of institutional controls.
- Ability to control and monitor migration of hazardous substances from the Site.
- Toxicity of the hazardous substances.
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar site conditions.

For purposes of this FS, the restoration time frames are assumed to be 20, 10, and 5 years for Alternatives 1 through 3, respectively. All three alternatives provide for a reasonable restoration time frame.

The time frame to mitigate direct-contact exposure risks from impacted soil (CAO #1) and vapor intrusion exposure risks (CAO #3) is during redevelopment of the Property, which is approximately 2 years.

The time frame to protect groundwater from impacted soil (CAO #2) and to protect future drinking water users from ingesting contaminated groundwater (CAO #4) is longer than the time frame to address the other CAOs, but is still reasonable based on the factors listed above. Specifically, the restoration time frame is reasonable based on the low risk posed by the small volume of residual contaminated soil and groundwater at the Site to human health and the environment, the current and future uses of the Site and surrounding areas (i.e., paved, urban area with no reasonable expectation that groundwater would be used for domestic water supply), and the availability of alternative water supplies (i.e., as is currently provided by the Seattle Public Utilities municipal water system). The high effectiveness and reliability of institutional controls, the ability to monitor migration of hazardous substances from the Site, the low toxicity of the residual hazardous substances expected to remain after excavation (i.e., low concentrations expected after source removal on the Property), and the natural processes that reduce concentrations of petroleum compounds under similar site conditions (i.e., biodegradation is occurring at the Site based on the fact that the dissolved plume is limited to a small, localized area) also indicate that the restoration time frame is reasonable.

Alternative 3 has the shortest restoration time frame due to the addition of amendments to rapidly increase the rate of contaminant degradation. Natural attenuation processes, used in Alternatives 1 and 2, will reduce concentrations of contaminants more slowly. Alternative 2 is expected to have a shorter restoration time frame than Alternative 1 because it includes additional source removal of impacted soil in the alley.

5.2.3 Consideration of Public Concerns

Consideration of public concerns is mandated under the MTCA cleanup regulation for a cleanup action led by Ecology or a potentially liable person under an Agreed Order or Consent Decree. For this cleanup, Ecology will provide a mandatory public review and comment period on the DCAP and PPCD. All public comments and concerns will be taken into consideration when finalizing the Cleanup Action Plan (CAP). Because public comments have not yet been received, consideration of public concerns regarding the cleanup action alternatives is preliminarily included in this document.

All three alternatives are anticipated to meet public concerns because they all include meeting CULs within a reasonable restoration time frame. All alternatives include source removal by excavating and disposing of soil on the Property with COC concentrations above the CULs and treatment (through MNA, ISEB, and/or ISCO) of groundwater with COC concentrations above the CULs. All alternatives also include installing a vapor barrier and implementing institutional controls to remove the potential inhalation and groundwater ingestion exposure pathways until the groundwater treatment has reduced COC concentrations to below CULs. Additionally, the public will be protected from residual impacted soil in the alley by ISEB and MNA (Alternative 1), excavation and disposal (Alternative 2), or ISCO (Alternative 3).

5.3 Action-Specific Requirements

Action-specific requirements for cleanup actions are defined in WAC 173-340-360(2)(c) through (h). Requirements vary depending on the nature of the Site and the alternatives being considered. All three alternatives meet the action-specific requirements, if applicable, as described as follows.

5.3.1 Groundwater Cleanup Actions

This requirement states that a permanent cleanup action shall be used to achieve the CULs for groundwater at the standard POCs where a permanent cleanup action is practicable or determined by the department to be in the public interest (WAC 173-340-360[2][c]). All three alternatives meet this requirement because they are permanent cleanup actions that will meet CULs at the standard POCs.

5.3.2 Soil at Current or Potential Future Residential Areas and Childcare Centers

Specific requirements pertaining to soil cleanup at current or potential future residential areas and childcare centers are found in WAC 173-340-360(2)(d). These requirements are applicable based on the planned future use of the Property. All three alternatives comply with this requirement because all soils exceeding CULs will be removed and disposed of off-site or treated via MNA, ISEB, and/or ISCO.

5.3.3 Institutional Controls

Institutional controls must comply with the specific requirements of WAC 173-340-440 and should demonstrably reduce risks to ensure a protective cleanup action. A cleanup action should not rely primarily on institutional controls and monitoring where it is technically possible to implement a more permanent cleanup action for all or part of a Site. For complete details, see WAC 173-340-360(2)(e).

This requirement is applicable because all three alternatives include institutional controls to maintain the cap and passive vapor barrier, and place limitations on the use of groundwater until COC concentrations are reduced to below CULs. All three alternatives meet this requirement because they do not primarily rely on institutional controls and monitoring.

5.3.4 Releases and Migration

The regulations state that cleanup actions should prevent or minimize present and future releases and migration of hazardous substances in the environment (WAC 173-340-360[2][f]). All three alternatives meet this requirement.

Specifically, releases and migration of hazardous substances are prevented by removing soil with concentrations of COCs above CULs on the Property and contaminant sources (i.e., USTs), if any are still present on the Property. Migration of hazardous substances in residual impacted groundwater is minimized by maintaining the paved right-of-way and building slab as a cap until MNA, ISEB, and/or ISCO reduces concentrations to below CULs.

5.3.5 Dilution and Dispersion

The regulations state that cleanup actions should not rely primarily on dilution and dispersion unless the incremental costs of any active remedial measures over the costs of dilution and dispersion grossly exceed the incremental degree of benefits of active remedial measures over the benefits of dilution and dispersion (WAC 173-340-360[2][g]).

All three alternatives meet this requirement because they do not rely primarily on dilution and dispersion.

5.3.6 Remediation Levels

Remediation levels are defined as the particular concentration of a hazardous substance in any media above which a particular cleanup action component will be required as part of a cleanup action at the Site (WAC 173-340-200). Specific requirements pertaining to use of remediation levels are in WAC 173-340-360(2)(h).

The three alternatives being considered in this FS Report do not involve use of remediation levels; therefore, this requirement is not relevant.

5.4 Disproportionate Cost Analysis

Alternatives that meet threshold requirements for cleanup actions are assessed to determine which use permanent solutions to the maximum extent practicable per WAC 173-340-360(3). This assessment is conducted by performing a DCA.

A DCA was conducted for all three alternatives since all alternatives meet the threshold requirements, as described in Sections 5.1 through 5.3. The criteria that must be evaluated in a DCA and the DCA procedure are described in Section 5.4.1 and the DCA evaluation is summarized in Section 5.4.2.

5.4.1 DCA Criteria and Procedure

The alternatives are compared by evaluating the following criteria: protectiveness, permanence, cost, effectiveness over the long term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. These evaluation criteria are defined below.

- **Protectiveness:** The overall protectiveness provided by the alternative to human health and the environment, including: the degree to which existing risks are reduced; the time required to reduce risk at the Site and attain cleanup standards; the on-site and off-site risks resulting from implementing the alternative; and the improvement of the overall environmental quality provided by the alternative, are evaluated against this criterion.

- **Permanence:** This criterion evaluates the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including: the adequacy of the alternative in destroying the hazardous substances; the reduction or elimination of hazardous substance releases and sources of releases; the degree of irreversibility of waste treatment processes; and the characteristics and quantity of treatment residuals generated.

- **Cost:** This criterion evaluates the costs associated with the alternative, including: direct capital costs (e.g., construction, equipment, land, services); indirect capital costs (e.g., engineering, supplies, contingency); long-term monitoring costs; O&M costs; and periodic costs. This evaluation is necessary so that the relative cost of each alternative can be evaluated to help identify the most practicable cleanup action alternative using the DCA procedures presented in WAC 173-340-360(3)(e).

  One of the primary goals in developing cost estimates for alternative evaluation is to ensure that costing procedures and assumptions are consistent between alternatives to reduce the potential for bias in one alternative assumption compared to other alternative assumptions. This approach presents a level playing field when evaluating the cost of one alternative versus costs for other alternatives, and is appropriate for FS costs. However, because of the conservative approach to estimating mass and area, FS cost estimates are not appropriate for use in other applications.

- **Effectiveness over the long term:** Long-term effectiveness includes: the degree of certainty that the alternative will be successful; the reliability of the alternative during the period of time hazardous substances are expected to remain on site at concentrations that exceed cleanup levels; the magnitude of residual risk with the alternative in place; and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components are preferred in descending order, when assessing the relative degree of long-term effectiveness:

    - Reuse or recycling.
    - Destruction or detoxification.
    - Immobilization or stabilization.
    - On-site or off-site disposal in an engineered, lined, and monitored facility.
    - On-site isolation or containment with attendant engineering controls.
    - Institutional controls and monitoring.

- **Management of short-term risks:** This criterion evaluates the risk to human health and the environment associated with the alternative during construction and the effectiveness of measures taken to manage such risks.

- **Technical and administrative implementability:** This criterion assesses the ability of the alternative to be implemented, including: consideration of whether the alternative is technically possible; availability of necessary off-site facilities, services, and materials; administrative and regulatory requirements; scheduling; size; complexity; monitoring requirements; access for construction operations and monitoring; and integration with existing site operations and other current or potential cleanup actions.

- **Consideration of public concerns:** This criterion evaluates community concerns regarding the alternatives, if any, and the extent to which the alternatives address those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site.

As stated in WAC 173-340-360(3)(e)(ii)(C):

> *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met.*

We used our professional judgement to score the alternatives on a scale of 1 (lowest) to 10 (highest) against the six non-cost DCA criteria outlined above.

The non-cost DCA criteria were weighted accordingly:

- Protectiveness—30 percent. This weighting factor of 30 percent is the greatest value of all categories, which is justified based on its overarching importance relative to the ultimate goal of environmental cleanup and protection of human health and the environment.

- Permanence—20 percent. This weighting factor is second highest because permanence, along with long-term effectiveness, is of second-greatest importance to remediation of the Site. A high level of permanence will reduce the need for future cleanup actions.

- Long-term effectiveness—20 percent. This weighting factor is second highest because it represents the need for a high level of confidence that the remedy will be successful to reduce the need for future cleanup actions.

- Management of short-term risk—10 percent. This weighting factor is lower based on the limited temporal aspect associated with the short-term risks and therefore, the reduced risk to human health and the environment. Short-term risks are less important at this Site to select an alternative because each alternative can be easily modified to reduce the short-term risk.

- Technical/administrative implementability—10 percent. This weighting factor is lower because implementability is less important at this Site to select an alternative because each alternative may be able to be modified to improve implementability.

- Consideration of public concerns—10 percent. This weighting factor takes into account the importance of public concerns and the breadth of stakeholders for this Site.

A total weighted benefits score is obtained for each alternative by multiplying the six non-cost scores by their corresponding weighting factors and summing the weighted values. The total weighted benefits score of each alternative is divided by the alternative's estimated cost to obtain a benefit/cost ratio, which is a relative measure of the cost effectiveness of the alternative.

When assessing whether a cleanup action uses permanent solutions to the maximum extent practicable, the test used (WAC 173-340-360[3][e][i]) is as follows:

> *Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative.*

The alternative with the highest benefit/cost ratio is considered permanent to the maximum extent practicable and is selected as the preferred cleanup action alternative.

5.4.2 DCA Evaluation

The evaluation of the DCA criteria for each alternative is summarized below and in Table 5-1.

- **Protectiveness:** Alternative 2 is judged to be the most protective due to the excavation and removal of all COC-contaminated soil on the Site, which will meet cleanup standards for soil in the shortest amount of time. Alternative 3 is slightly more protective than Alternative 1 because ISCO will attain cleanup standards more quickly than ISEB and MNA.

- **Permanence:** Alternative 2 is judged to be the most permanent because the additional permanent soil removal off-Property will further reduce contaminant mobility. Alternatives 1 and 3 are tied for the second greatest degree of permanency.

- **Cost:** The net present value costs of implementing Alternatives 1 through 3 are estimated to total approximately $1,668,000; $2,107,000; and $1,809,000, respectively, assuming a feasibility study accuracy range of -30 to +50 percent (EPA 2000). The components of these costs and assumptions made in the estimates are detailed in Tables 4-2a through 4-2c.

- **Effectiveness over the long term:** Alternative 2 is the most effective over the long term because there is a higher degree of certainty that it will be successful in attaining cleanup standards than the other alternatives due to the excavation and removal of all COC-contaminated soil on the Site. Alternative 3 is more effective over the long term than Alternative 1 because there is a higher degree of certainty that ISCO will be successful in attaining cleanup standards than ISEB and MNA.

- **Management of short-term risks:** Alternative 1 has the least short-term risks because there are very few risks associated with ISEB and MNA. Alternative 2 has marginally more short-term risks than Alternative 1 because of the additional excavation of soil off-Property and associated structural requirements. Alternative 3 has the most short-term risks because there are moderate short-term risks associated with amendment handling and injection for ISCO, particularly when multiple injections are required and when on-Property injections would need to be conducted at the bottom of the excavation during construction.

- **Technical and administrative implementability:** Alternative 1 is judged to be the most implementable because MNA has less regulatory requirements, access and scheduling restraints, and complexity than ISCO. Alternative 1 is also more implementable than Alternative 2 because the excavation of additional soil off-Property would add complexity and access and scheduling concerns.

- **Consideration of public concerns:** Alternatives 2 and 3 are judged to meet anticipated public concerns the most because Alternative 2 is expected to attain soil cleanup standards the fastest and Alternative 3 is expected to attain groundwater cleanup standards the fastest. Both Alternatives 2 and 3 are anticipated to have about the same public disruption in the alley from excavation and off-site disposal (Alternative 2), and ISCO injections (Alternative 3). Alternative 1 is also anticipated to meet public concerns, but to a slightly lesser degree than Alternatives 2 and 3 because ISEB and MNA are expected to attain cleanup standards more slowly than excavation and MNA or ISCO.

As noted in Table 5-1, the total weighted benefit score ranged from 7.2 for Alternative 3 to 8.6 for Alternative 2. The benefit/cost ratios for the cleanup action alternatives are presented at the bottom of Table 5-1 and shown in Figure 5-1. Alternative 1 has the highest benefit/cost ratio (4.44), followed by Alternative 2 (4.08), and Alternative 3 (3.98).

6.0 SELECTED CLEANUP ACTION ALTERNATIVE

Alternative 1 is the selected cleanup action alternative because it is permanent to the maximum extent practicable, as determined by the DCA. Alternative 1 consists of: (1) excavating impacted soil and groundwater within the redevelopment excavation area and disposing off-site, (2) applying ORC-A to enhance biodegradation of off-Property residual contamination, (3) implementing MNA, (4) installing a passive vapor barrier, (5) implementing institutional controls, and (6) performing compliance monitoring and maintenance. Implementation of this cleanup action alternative will address the CAOs for the Site. The selected cleanup action alternative will be documented in more detail in the forthcoming DCAP.

7.0 REFERENCES

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TABLE 2-1
CHRONOLOGICAL LIST OF ENVIRONMENTAL INVESTIGATIONS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Investigation	Prepared By	Dates of Field Work	Location of Investigation	Summary of Field Work	Boring/Well IDs
Comprehensive Foundation Investigation[k]	Shannon & Wilson	March 1970 to February 1971	Rights-of-Way North and South of Property	• 2 relevant soil borings[a]	B-309, B-320
Phase II Environmental Site Assessment[g]	Black and Veatch	June to November 1997	Right-of-Way East of Property	• 1 relevant monitoring well[b]	BB-10
Limited Environmental Explorations Report[l]	Shannon & Wilson	April to May 2012	Right-of-Ways West & East of Property	• 6 relevant soil borings[c]	GP-7, GP-8, GP-9, GP-14, GP-17, GP-20
Remedial Investigation[n]	SoundEarth Strategies	July 2012 to March 2013	Right-of-Way East of Property	• 1 relevant monitoring well[d]	MW-117
Limited Phase II Environmental Site Assessment[m]	Shannon & Wilson	April to May 2017	Property-Wide and in Alley	• Drilled 7 soil borings • Collected 3 grab groundwater samples	21417-GP1 to 21417-GP7
Remedial Investigation[i,j]	PES Environmental	August 2017 to October 2019	Right-of-Way Northeast of Property	• 3 relevant monitoring wells[e]	MW-305, MW-306, MW-307
Final Phase II Environmental Site Assessment[h]	Hart Crowser	April 2019	601 Dexter Parcel - East side of Parcel and Alley and in Building	• Drilled 6 soil borings and completed 1 as a monitoring well[f] • Collected 1 grab groundwater sample and 1 monitoring well groundwater sample	HC-1, HC-2, HC-3, HC-4, HC-5, MW-1
Remedial Investigation[o]	Hart Crowser	March 2019 and February, March, October, and November 2020	Property-Wide, 601 Dexter Parcel, Alley, and in Right-of-Way East of Property	• Drilled 24 explorations and completed 14 as monitoring wells • Collected 5 grab groundwater samples and 16 monitoring well groundwater samples • Conducted slug testing on 4 monitoring wells	DGW-1, DGW-2, DGW-3, DGW-4, DMW-1S, DMW-2S, DMW-3IA, DMW-4S, DMW-5IA, DMW-6, DMW-7S, DMW-8S, DMW-9S, DMW-10S, DMW-11S, DMW-12S, DMW-13S, DMW-14S, DPP-1, DPP-2, DPP-3, DPP-4, DPP-5, DPP-6

Notes:

a. The RI report considers data from 2 of the borings near the Property. Additional borings were advanced for geotechnical purposes, but are not shown on Figure 2-3. Refer to the Shannon & Wilson 1971 report for additional information.

b. The RI report considers data from 1 monitoring well near the Property. Additional explorations were advanced for geotechnical and environmental purposes as part of the design of the combined sewer overflow (CSO) project. Other explorations are not shown on Figure 2-3; refer to the Black & Veatch 1998 report for additional information.

c. The RI report considers data from 6 borings on and near the Property. Additional explorations were advanced as part of a larger investigation to document environmental conditions in the vicinity of the planned Mercer Corridor project. Other explorations are not shown on Figure 2-3; refer to the Shannon & Wilson 2012 report for additional information.

d. The RI report considers data from 1 monitoring well near the Property. Additional work was conducted as part of a larger investigative, remedial, and monitoring effort of the regional chlorinated volatile organic compound groundwater plume from the American Linen site. Other explorations are not shown on Figure 2-3; refer to the SoundEarth Strategies 2013 report for additional information.

e. The RI report considers data from 3 monitoring wells near the Property. Additional work was conducted as part of a larger investigative, remedial, and monitoring effort of the regional chlorinated volatile organic compound groundwater plume from the American Linen site. Other explorations are not shown on Figure 2-3; refer to the PES Environmental 2019 and PES Environmental 2020 reports for additional information.

f. The RI report considers data from 5 soil borings and 1 monitoring well near the Property. Sub-slab soil vapor and indoor air samples were collected to support future redevelopment at the 601 Dexter Avenue North property, but are not shown on Figure 2-3. Refer to the Hart Crowser 2019 report for additional information.

References:

g. Black & Veatch 1998.
h. Hart Crowser 2019.
i. PES Environmental 2019.
j. PES Environmental 2020.
k. Shannon & Wilson 1971.
l. Shannon & Wilson 2012.
m. Shannon & Wilson 2018.
n. SoundEarth Strategies 2013.
o. Hart Crowser 2021.

TABLE 2-2
SUMMARY OF EXPLORATIONS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Boring/ Well ID	Logs?[a]	Well Tag	Northing	Easting	Date Completed	Elevation		Well Screen				Bottom of Boring		Well Casing Diameter (in)	Grab GW?[a]	Report Reference
						Surface (ft)	TOC (ft)	Top of Screen Depth (ft)	Bottom of Screen Depth (ft)	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	Depth (ft)	Elevation (ft)			
SOIL BORINGS																
21417-GP1	Y	-	231750.7	1268112.4	04/21/17	69.53	-	20.0	25.0	49.53	44.53	30.00	39.53	1	Y	Shannon & Wilson 2018
21417-GP2	Y	-	231687.4	1268160.6	04/21/17	66.53	-	-	-	-	-	19.00	47.53	-	N	Shannon & Wilson 2018
21417-GP3	Y	-	231726.2	1268238.6	04/21/17	55.86	-	10.0	20.0	45.86	35.86	20.00	35.86	1	Y	Shannon & Wilson 2018
21417-GP4	Y	-	231647.0	1268238.3	04/21/17	55.82	-	10.0	15.0	45.82	40.82	15.00	40.82	1	Y	Shannon & Wilson 2018
21417-GP5	Y	-	231630.0	1268205.6	05/19/17	66.20	-	-	-	-	-	16.00	50.20	-	N	Shannon & Wilson 2018
21417-GP6	Y	-	231631.3	1268141.7	05/19/17	66.09	-	-	-	-	-	20.00	46.09	-	N	Shannon & Wilson 2018
21417-GP7	Y	-	231632.6	1268109.8	05/19/17	66.49	-	-	-	-	-	15.00	51.49	-	N	Shannon & Wilson 2018
B-309	Y	-	231760.0	1268253.0	04/02/70	59.63	-	-	-	-	-	48.00	11.63	-	N	Shannon & Wilson 1971
B-320	Y	-	231498.6	1268195.7	04/14/71	59.13	-	-	-	-	-	50.00	9.13	-	N	Shannon & Wilson 1971
DGW-1	Y	-	231659.6	1268242.7	03/06/19	55.98	-	20.0	30.0	35.98	25.98	31.50	24.48	2	Y	Hart Crowser 2021
DGW-2	Y	-	231693.1	1268182.1	03/07/19	66.25	-	20.0	30.0	46.25	36.25	31.50	34.75	2	Y	Hart Crowser 2021
DGW-3	Y	-	231642.2	1268215.3	03/06/19	56.08	-	35.0	45.0	21.08	11.08	45.00	11.08	2	Y	Hart Crowser 2021
DGW-4	Y	-	231632.9	1268076.2	03/04/19	69.87	-	30.0	40.0	39.87	29.87	51.50	18.37	2	Y	Hart Crowser 2021
DPP-1	Y	-	231743.4	1268128.3	03/04/19	68.80	-	-	-	-	-	20.00	48.80	-	N	Hart Crowser 2021
DPP-2	Y	-	231647.8	1268189.8	03/04/19	66.24	-	-	-	-	-	10.00	56.24	-	N	Hart Crowser 2021
DPP-3	Y	-	231737.5	1268253.6	03/05/19	55.98	-	20.0	30.0	35.98	25.98	30.50	25.48	2	Y	Hart Crowser 2021
DPP-4	Y	-	231645.1	1268167.8	03/04/19	66.25	-	-	-	-	-	22.50	43.75	-	N	Hart Crowser 2021
DPP-5	Y	-	231736.6	1268179.4	03/04/19	66.26	-	-	-	-	-	20.00	46.26	-	N	Hart Crowser 2021
DPP-6	Y	-	231697.7	1268235.5	03/05/19	55.92	-	-	-	-	-	19.50	36.42	-	N	Hart Crowser 2021
GP-7	Y	-	231566.4	1268321.0	05/14/12	58.53	-	-	-	-	-	11.00	47.53	-	-	Shannon & Wilson 2012
GP-8	Y	-	231600.2	1268321.4	05/14/12	58.33	-	-	-	-	-	12.00	46.33	-	-	Shannon & Wilson 2012
GP-9	Y	-	231641.5	1268303.4	05/14/12	58.00	-	-	-	-	-	19.00	39.00	-	-	Shannon & Wilson 2012
GP-14	Y	-	231527.2	1267968.0	04/03/12	69.74	-	-	-	-	-	13.50	56.24	-	-	Shannon & Wilson 2012
GP-17	Y	-	231522.7	1267998.2	04/04/12	70.39	-	-	-	-	-	17.00	53.39	-	-	Shannon & Wilson 2012
GP-20	Y	-	231522.7	1268032.3	04/05/12	71.02	-	-	-	-	-	9.00	62.02	-	-	Shannon & Wilson 2012
HC-1	Y	-	231626.3	1268246.9	04/11/19	62.33	-	21.5	31.5	40.83	30.83	31.50	30.83	2	Y	Hart Crowser 2019
HC-2	Y	-	231612.8	1268199.2	04/11/19	62.47	-	-	-	-	-	16.50	45.97	-	N	Hart Crowser 2019
HC-3	Y	-	231577.9	1268194.8	04/11/19	62.39	-	-	-	-	-	31.50	30.89	-	N	Hart Crowser 2019
HC-5	Y	-	231605.1	1268245.5	04/11/19	60.70	-	-	-	-	-	16.50	44.20	-	N	Hart Crowser 2019
MW-1	Y	-	231595.3	1268222.9	04/11/19	61.72	-	-	-	-	-	31.50	30.22	-	N	Hart Crowser 2019

TABLE 2-2
SUMMARY OF EXPLORATIONS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Boring/ Well ID	Logs?[a]	Well Tag	Northing	Easting	Date Completed	Elevation		Well Screen				Bottom of Boring		Well Casing Diameter (in)	Grab GW?[a]	Report Reference
						Surface (ft)	TOC (ft)	Top of Screen Depth (ft)	Bottom of Screen Depth (ft)	Top of Screen Elevation (ft)	Bottom of Screen Elevation (ft)	Depth (ft)	Elevation (ft)			
MONITORING WELLS																
BB-10	Y	-	231732.0	1268341.6	11/13/97	57.40	-	29.0	39.0	28.4	18.4	60.5	-3.1	2	N	Black & Veatch 1998
DMW-1S	Y	BLR921	231651.7	1268247.3	03/05/19	55.94	55.76	17.0	27.0	38.94	28.94	30.20	25.74	2	N	Hart Crowser 2021
DMW-2S	Y	BME933	231661.0	1268261.7	03/02/20	56.03	55.74	25.0	35.0	31.03	21.03	40.40	15.63	2	N	Hart Crowser 2021
DMW-3IA	Y	BME932	231698.1	1268264.1	02/27/20	56.09	55.84	39.0	49.0	17.09	7.09	50.25	5.84	2	N	Hart Crowser 2021
DMW-4S	Y	BME929	231624.3	1268253.8	02/26/20	61.76	61.54	23.0	33.0	38.76	28.76	70.33	-8.57	2	N	Hart Crowser 2021
DMW-5IA	Y	BME930	231627.7	1268079.5	02/28/20	69.48	69.15	39.8	49.8	29.68	19.68	70.33	-0.85	2	N	Hart Crowser 2021
DMW-6	Y	BME934	231731.4	1268185.8	03/04/20	66.30	66.08	34.0	44.0	32.30	22.30	50.30	16.00	2	N	Hart Crowser 2021
DMW-7S	Y	BLY430	231679.4	1268275.5	10/26/20	58.34	58.01	28.0	38.0	30.3	20.3	38.00	20.34	2	N	Hart Crowser 2021
DMW-8S	Y	BLY431	231659.2	1268275.5	10/27/20	58.57	58.35	27.0	37.0	31.6	21.6	37.00	21.57	2	N	Hart Crowser 2021
DMW-9S	Y	BLY432	231623.8	1268275.2	10/27/20	58.85	58.55	23.0	33.0	35.9	25.9	33.00	25.85	2	N	Hart Crowser 2021
DMW-10S	Y	BNF363	231588.9	1268260.6	10/19/20	59.46	59.24	35.0	55.0	24.46	4.46	55.00	4.46	2	N	Hart Crowser 2021
DMW-11S	Y	BNF365	231596.2	1268238.6	10/20/20	61.15	61.19	30.0	50.0	31.15	11.15	50.00	11.15	2	N	Hart Crowser 2021
DMW-12S	Y	BNF364	231632.9	1268169.6	10/20/20	66.05	66.02	30.0	50.0	36.05	16.05	55.00	11.05	2	N	Hart Crowser 2021
DMW-13S	Y	BNF376	231631.3	1268126.1	10/23/20	66.28	66.3	30.0	50.0	36.28	16.28	50.00	16.28	2	N	Hart Crowser 2021
DMW-14S	Y	BLY433	231627.6	1268064.1	10/28/20	70.29	70.32	41.0	51.0	29.29	19.29	51.00	19.29	2	N	Hart Crowser 2021
HC-4	Y	BLR695	231573.2	1268251.5	04/12/19	60.23	-	40.0	50.0	20.23	10.23	50.00	10.23	2	N	Hart Crowser 2019
MW-117	Y	BHS885	231643.7	1268343.7	02/04/13	57.78	56.90	40.0	55.0	17.78	2.78	55.50	2.28	2	N	SoundEarth Strategies 2013
MW-305	Y	BMF579	231758.3	1268248.3	10/03/19	60.15	59.82	22.8	32.8	37.31	27.31	35.00	25.15	2	N	PES Environmental 2020
MW-306	Y	BMF577	231757.5	1268252.6	09/30/19	59.91	59.48	42.8	52.8	17.11	7.11	55.00	4.91	2	N	PES Environmental 2020
MW-307	Y	BMF580	231758.0	1268244.5	10/03/19	60.29	60.21	72.8	82.8	-12.51	-22.51	85.00	-24.71	2	N	PES Environmental 2020

Notes:
a. "Y" represents yes and "N" represents no.
– = Data not available or not applicable.
Depths of grab groundwater samples are approximate.
Elevations referenced to North American Vertical Datum of 1988 (NAVD88).
ft = feet.
in = inches.
TOC = Top of Casing.

TABLE 2-3a
IDENTIFICATION OF PROPOSED COCS IN SOIL
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

COPC	Screening Levels: Vadose Zone (less than or equal to 25 feet bgs)			Screening Levels: Saturated Zone (greater than 25 feet bgs)			COC?	Rationale
	Direct Contact	Protective of Groundwater Vadose Zone	Natural Background	Direct Contact	Protective of Groundwater Saturated Zone	Natural Background		
Total Petroleum Hydrocarbons								
Gasoline Range Organics	--	**X**	NA	--	--	NA	yes	Retained as COC
Inorganic Compounds								
Barium	--	--	NA	--	**X**	NA	no	1. Constituent does not pose an unacceptable direct contact risk. Its maximum concentration is below the direct contact screening level. 2. Constituent does not pose an unacceptable risk to drinking water. Although maximum detected concentration exceeds screening level in soil suggesting it could potentially cause an exceedance of drinking water levels in groundwater, empirical groundwater data indicates that dissolved barium is not a COC in groundwater. This indicates that the soil-to-drinking-water pathway is not complete and barium in soil does not pose an unacceptable risk to drinking water.

Notes:
Screening levels provided by Ecology (November 17, 2020).
Pink = COC.
X = Maximum detected conctration exceeded available screening level.
-- = Maximum detected concentration below available screening level.
bgs = Below ground surface.
COC = Constituent of Concern.
COPC = Constituent of Potential Concern.
NA = No screening level available.

TABLE 2-3b
IDENTIFICATION OF PROPOSED COCS IN GROUNDWATER
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

COPC	Screening Levels: Protective of Drinking Water	Screening Levels: Protective of Indoor Air	Screening Levels: Natual Background	COC?	Rationale
Volatile Organic Compounds					
1,2,4-Trimethylbenzene	**X**	--	NA	no	This constituent is a component of petroleum fuels and its presence at the Site is likely related to the known petroleum impacts in groundwater. MTCA cleanup levels for TPH include 1,2,4-trimethylbenzene as part of the mixture.
1,3,5-Trimethylbenzene	**X**	NA	NA	no	This constituent is a component of petroleum fuels and its presence at the Site is likely related to the known petroleum impacts in groundwater. MTCA cleanup levels for TPH include 1,3,5-trimethylbenzene as part of the mixture.
Benzene	--	**X**	NA	yes	Retained as COC
Semi-Volatile Organic Compounds					
Naphthalene	--	**X**	NA	no	This constituent is a component of petroleum fuels and its presence at the Site is likely related to the known petroleum impacts in groundwater. Naphthalene was detected in a grab sample from a discontinuous perched zone in 2017 and has not been detected in any other groundwater samples at the Site.
Total Petroleum Hydrocarbons					
Diesel Range Organics	**X**	NA	NA	yes	Retained as COC
Gasoline Range Organics	**X**	NA	NA	yes	Retained as COC
Inorganic Compounds					
Arsenic	**X**	NA	**X**	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential and constituent is associated with background conditions.
Barium	**X**	NA	NA	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential.
Cadmium	**X**	NA	NA	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential.
Chromium	**X**	NA	NA	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential.
Lead	**X**	NA	NA	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential.
Mercury	**X**	**X**	NA	no	High levels of total metals associated with excess turbidity and are not representative of actual transport/exposure potential.

Notes:
Screening levels provided by Ecology (November 17, 2020).
Pink = COC.
X = Maximum detected conctration exceeded available screening level.
-- = Maximum detected concentration below available screening level.
COC = Constituent of Concern.
COPC = Constituent of Potential Concern.
MTCA = Model Toxics Control Act.
NA = No screening level available.
TPH = Total petroleum hydrocarbons.

TABLE 3-1a
PROPOSED SOIL CLEANUP STANDARDS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

COC	Proposed CUL (mg/kg)	Basis of CUL	POC
GRO	30[a,b]	Protection of Groundwater	Sitewide

Notes:

a. MTCA Method A CUL was used since a MTCA Method B CUL is not available. Petroleum fractionation data were not obtained for calculating a Site-specific Method B CUL for GRO. The MTCA Method A CULs are presented in WAC 173-340-900, Table 740-1.

b. The CUL assumes benzene is present.

COC = Constituent of Concern.

CUL = Cleanup Level.

GRO = Gasoline-range Petroleum Hydrocarbons.

mg/kg = milligram per kilogram.

MTCA = Model Toxics Control Act.

POC = Point of Compliance.

WAC = Washington Administrative Code.

TABLE 3-1b
PROPOSED GROUNDWATER CLEANUP STANDARDS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

COC	Proposed CUL (µg/L)	Basis of CUL	POC
GRO	800[a,b]	Protection of Drinking Water	Sitewide
DRO	500[a]	Protection of Drinking Water	Sitewide
Benzene	2.4	Protection of Indoor Air	Sitewide

Notes:

a. MTCA Method A CUL was used since a MTCA Method B CUL is not available without petroleum fractionation analysis. The MTCA Method A CULs are presented in WAC 173-340-900, Table 720-1.

b. The CUL assumes benzene is present.

µg/L = Microgram per liter.

COC = Constituent of Concern.

CUL = Cleanup Level.

DRO = Diesel-range Petroleum Hydrocarbons.

GRO = Gasoline-range Petroleum Hydrocarbons.

MTCA = Model Toxics Control Act.

POC = Point of Compliance.

WAC = Washington Administrative Code.

TABLE 3-1c
PROPOSED INDOOR AIR CLEANUP STANDARDS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

COC	Proposed CUL ($\mu g/m^3$)	Basis of CUL	POC
TPH[a]	140	Inhalation	Sitewide
Benzene	0.32	Inhalation	Sitewide

Notes:

a. The indoor air CUL for petroleum is based on total TPH, which includes aliphatic hydrocarbons C5-8, aliphatic hydrocarbons C9-12, aromatic hydrocarbons C9-10, BTEX, and naphthalene, rather than constituent-specific CULs for the Site COCs (GRO and DRO).

$\mu g/m^3$ = Microgram per cubic meter.

BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes.

COC = Constituent of Concern.

CUL = Cleanup Level.

DRO = Diesel-range Petroleum Hydrocarbons.

GRO = Gasoline-range Petroleum Hydrocarbons.

POC = Point of Compliance.

TPH = Total Petroleum Hydrocarbons.

TABLE 3-2
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Contaminant-Specific ARARs				
State	Soil	MTCA [RCW 70A.305; Chapter 173-340 WAC]	Yes	The MTCA soil cleanup levels are applicable.
State	Groundwater	MTCA [RCW 70A.305; Chapter 173-340 WAC]	Yes	The MTCA groundwater cleanup levels are applicable.
State	Air	MTCA [RCW 70.305; Chapter 173-340 WAC]	Yes	The MTCA air cleanup levels are applicable.
Action-Specific ARARs				
Federal	Air	Clean Air Act [42 USC § 7401 et seq.; 40 CFR Part 50]	Yes	The federal Clean Air Act creates a national framework designed to protect ambient air quality by limiting air emissions.
State	Air	Clean Air Act and Implementing Regulations [RCW 70A.15; Chapter 173-400 WAC]	Yes	These regulations require the owner or operator of a source of fugitive dust to take reasonable precautions to prevent fugitive dust from becoming airborne and to maintain and operate the source to minimize emissions primarily during construction. These regulations are applicable to cleanup action alternatives involving construction.
Local	Air Emissions	Regional Emission Standards for Toxic Air Pollutants [PSCAA Regulations I and III]	No	A source of toxic air contaminants requires a notice of construction. This is not applicable to the cleanup action alternatives.
Federal	Solid Waste	RCRA [42 USC § 6901 et seq.], Subtitle D -- Managing Municipal and Solid Waste [40 CFR Parts 257 and 258]	Yes	Subtitle D of RCRA establishes a framework for management of non-hazardous solid waste. These regulations establish guidelines and criteria from which states develop solid waste regulations. These requirements are applicable to cleanup action alternatives that involve off-site disposal of impacted soil and/or groundwater designated as non-hazardous waste.
Federal/ State	Solid Waste	U.S. Transportation of Hazardous Materials [49 CFR Part 105 to 177] Washington Transportation of Hazardous Materials [Chapter 446-50 WAC]	No	Transportation of hazardous waste or materials must meet state and federal requirements. These requirements are likely not applicable because soil and groundwater will likely not be designated as hazardous waste.
Federal/ State	Solid Waste	U.S. Land Disposal Restrictions [40 CFR Part 268] Washington Land Disposal Restrictions [Chapter 173-303-140 WAC]	No	Best management practices for dangerous wastes are required to meet state and federal requirements. These requirements are likely not appliable because soil will likely not be designated as hazardous waste.
Federal/ State	Solid Waste	U.S. RCRA [42 USC § 6901 et seq.], Subtitle C -- Hazardous Waste Management [40 CFR Parts 260 to 262] Washington Dangerous Waste Regulations [Chaper 173-303 WAC]	No	Subtitle C of RCRA pertains to the management of hazardous waste. This requirement is likely not applicable because soil and/or groundwater will likely not be designated as hazardous waste.
State	Solid Waste	Solid Waste Handling Standards [RCW 70A.205; Chapter 173-350 WAC]	Yes	Washington Solid Waste Handling Standards apply to facilities and activities that manage solid waste. The regulations set minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. These requirements are applicable to cleanup action alternatives that involve off-site disposal of impacted soil.
Federal/ State	Remedy Construction	U.S. OSHA [29 CFR Parts 1904, 1910, and 1926] WISHA [RCW 49.17; Title 296 WAC]	Yes	Site worker and visitor health and safety requirements established by OSHA/WISHA are to be met during implementation of the cleanup action.
State	Remedy Construction	UIC Program [Chapter 173-218 WAC]	Yes	UIC regulations apply to cleanup action alternatives that include injection of biological or chemical oxidants into injection wells or trenches.
State/ Local	Remedy Construction	SEPA [RCW 43.21C; Chapter 197-11 WAC]	Yes	A SEPA review identifies and analyzes environmental impacts associated with the selected cleanup action alternative. A SEPA review is required for local permitting and pursuant to MTCA.
Local	Remedy Construction	King County Stormwater Runoff and Surface Water and Erosion Control [KCC Chapter 9.04] and King County Water Quality [KCC Chapter 9.12] Seattle Stormwater Code [SMC Title 22, Subtitle VIII]	Yes	Guidelines for erosion control and construction stormwater management. These regulations are applicable to cleanup action alternatives involving construction.
State/ Local	Remedy Construction	Washington Noise Control [RCW 70A.20; Chapter 173-60 WAC] Seattle Noise Control [SMC Chapter 25.08]	Yes	Potentially relevant, depending on construction activities and equipment selected. Construction activities will be limited to normal working hours, to the extent possible, to minimize noise impacts.
Local	Remedy Construction	Grading Code [SMC Chapter 22.170]	Yes	Guidelines for grading activities, applicable to cleanup action alternatives involving an excavation and filling volume greater than 500 cubic yards.
Federal	Surface Water	Federal Water Pollution Control Act--Water Quality Certification [CWA; 33 USC § 1341, Section 401] and Implementing Regulations	No	Section 401 of the CWA provides that applicants for a permit to conduct any activity involving potential discharges into waters or wetlands shall obtain certification from the state that discharges will comply with applicable water quality standards. These activities are not expected for the proposed cleanup action alternatives.
Federal/ State	Surface Water	U.S. Federal Water Pollution Control Act--NPDES [CWA; 33 USC § 1342, Section 402] and Implementing Regulations Washington Waste Discharge General Permit Program [RCW 90.48; Chapter 173-226 WAC]	Yes	The NPDES program establishes requirements for point source discharges, including stormwater runoff. These requirements would be applicable for any cleanup action alternatives involving point source discharge of stormwater during construction or following cleanup.

TABLE 3-2
POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Action-Specific ARARs				
State	Surface Water	Hydraulic Code [RCW 77.55; Chapter 220-660 WAC]	No	The Hydraulic Code requires that any construction activity that uses, diverts, obstructs, or changes the bed or flow of state waters must be done under the terms of a Hydraulic Project Approval permit issued by the Washington State Department of Fish and Wildlife. These activities are not expected as part of the cleanup action alternatives.
State	Groundwater	Minimum Standards for Construction and Maintenance of Wells [RCW 18.104; Chapter 173-160 WAC]	Yes	Washington state has developed minimum standards for constructing water and monitoring wells, and for the decommissioning of wells. These regulations are applicable to all cleanup action alternatives involving drilling or decommissioning wells.
Location-Specific ARARs				
Federal	Endangered Species; Critical Habitats	ESA [16 USC §§ 1531-1544] and Implementing Regulations	No	The ESA protects species of fish, wildlife, and plants that are listed as threatened or endangered with extinction. It also protects designated critical habitat for listed species. The ESA outlines procedures for federal agencies to follow, including consultation with resource agencies, when taking actions that may jeopardize listed species. No threatened or endangered species or habitat areas are expected to be impacted by the cleanup action alternatives.
Federal/ State	Historic Areas	U.S. Archaeological and Historic Preservation Act [16 USC § 469, 470 et seq.; 36 CFR Parts 65 and 800] Washington Archaeological Sites and Resources [RCW 27.44, 27.48, and 27.53; Chapter 25-48 WAC]	No	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeological properties and resources, and minimize harm to national landmarks. There are no known or suspected historic or archaeological sites on the Site. Although the building on the Property is 75 to 95 years old, the DAHP website indicates the building does not warrant inclusion in the NRHP due to a lack of historic or architectural significance.
Local	Historic Areas	Clarification of SEPA Historic Preservation Policy for Potential Archaeologically Significant Sites and Requirements for Archaeological Assessments (Director's Rule 2-98; SMC Chapter 25.05.675 H)	No	Provides guidance for the identification, protection, and treatment of archaeological sites on the City of Seattle's shorelines. The archaeological significance of a project site must be assessed for any proposed project involving excavation within 200 feet of the US Government Meander line which approximates the historical shoreline. The Site is not within 200 feet of the historical shoreline.
State	Aquatic Lands	Aquatic Land Management [RCW 79.105; Chapter 332-30 WAC]	No	The Aquatic Lands Management law develops criteria for managing state-owned aquatic lands. Aquatic lands are to be managed to promote uses and protect resources as specified in the regulations. The cleanup action alternatives do not occur on state-owned aquatic lands.
State	Shorelines and Surface Water	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	No	Actions are prohibited within 200 feet of shorelines of statewide significance unless permitted. Cleanup action alternatives do not occur within 200 feet of a shoreline.
State	Wetlands	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	No	The construction or management of property in wetlands is required to minimize potential harm, avoid adverse effects, and preserve and enhance wetlands. The cleanup action alternatives do not occur within a wetland.
State	Public Lands	Public Lands Management [RCW 79.02]	No	Activities on public lands are restricted, regulated, or proscribed. The cleanup action alternatives do not occur on state-owned public lands.
Local	Shoreline	Seattle Shoreline Master Program Regulations [SMC Chapter 23.60A]	No	Properties within 200 feet of the shoreline are regulated by the Seattle Shoreline Master Program, in addition to any zoning requirements. The Site is not within 200 feet of the shoreline.

Notes:
ARAR = Applicable or Relevant and Appropriate Requirement.
CFR = Code of Federal Regulations.
CWA = Clean Water Act.
DAHP = Washington Department of Archaeology and Historic Preservation.
DPD = Department of Planning and Development.
ESA = Endangered Species Act.
KCC = King County Code.
MTCA = Model Toxics Control Act.
NPDES = National Pollutant Discharge Elimination System.
NRHP = National Register of Historic Places.
OSHA = Occupational Safety and Health Act.
PSCAA = Puget Sound Clean Air Agency.
RCRA = Resource Conservation and Recovery Act.
RCW = Revised Code of Washington.
SEPA = State Environmental Policy Act.
SMC = Seattle Municipal Code.
SPU = Seattle Public Utilities.
UIC = Underground Injection Controls.
USC = United States Code.
WAC = Washington Administrative Code.
WISHA = Washington Industrial Safety and Health Act.

TABLE 4-1a
REMEDIATION TECHNOLOGY SCREENING FOR SOIL
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Monitoring	Monitoring to assure compliance with CAOs, to assess performance of remedial technology during operation, and to measure continued effectiveness over time.	Technically implementable.	Effective for assessing soil conditions at the site.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Governmental and proprietary controls; enforcement and permit tools; information devices	Physical and administrative measures to control access or exposure to contaminated soil. Placement of an environmental covenant on the affected property.	Technically implementable.	Reliable conventional administrative measures.	Low capital and O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Monitored natural attenuation	Naturally occurring physical, chemical, and biological processes that reduce contaminant mobility or concentration.	Technically implementable. Cleanup time frame longer than for other remedial options for soil.	Ineffective for site contaminants in soil as the sole remedy.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Capping	Placement of a surface cap over impacted soil areas to minimize water infiltration and mobilization of contaminants, and to minimize direct-contact risk for human and ecological receptors.	Technically implementable. Future building footprint and adjacent alley provide cap functionality.	Effective for minimizing access, direct-contact risk, and mobility of contaminants. Less effective than source removal and does not provide treatment of contaminants.	Low to moderate capital and O&M cost.	Yes	Site already includes cap of paved ROW surface or building slab. Applicable in locations where contaminants remain in place.	Yes
Solidification, stabilization	Chemicals are introducted to physically bind or enclose contaminants, or to induce chemical reactions between the stabilizing agent and contaminants to reduce contaminants' mobility.	Technically implementable.	May be less effective or ineffective for treatment of site contaminants.	Moderate to high capital cost. Low O&M cost.	Yes	Inadequate effectiveness for treatment of site contaminants.	No
In situ enhanced bioremediation	Enhanced biodegradation through addition of nutrients and electron acceptors to stimulate microbial growth and breakdown of contaminants. Moisture may need to be added to provide a medium where microbes can metabolize contaminants.	Technically implementable. Permitting and/or infrastructure required (e.g., injection wells for liquid-phase bioremediation or piping and blower for bioventing). Soil heterogeneities may intefere with consistent distribution of amendments. May require more than one application to attain CAOs. Cleanup time frame longer than for other remedial options for soil.	Established technology. Effective for site contaminants.	Moderate to potentially high capital and O&M costs.	Yes	Implementable and effective for site contaminants.	Yes
Chemical treatment	Injection of chemicals to degrade or destroy contaminants in place.	Technically implementable. Requires handling large quantities of hazardous chemicals. Presence of organics in soil may increase required chemical application rates. May require multiple applications of chemical to attain CAOs. Regulatory concerns over injection of chemicals into subsurface, which may make permitting difficult.	Effective for site soil contaminants.	High capital and O&M costs.	Yes	Implementable and effective for site contaminants.	Yes

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Soil vapor extraction (SVE)	Removal of volatile contaminants through vacuum extraction in the vadose (unsaturated) zone of subsurface. Could be used in conjunction with other technologies including air sparging (AS), steam injection, or six-phase soil heating.	Technically implementable. Would require design and construction of subsurface infrastructure for SVE and AS system.	Moisture content, organic content, and air permeability of the soil will affect SVE effectiveness. SVE is not effective in the saturated zone. Naturally occurring organic content in soil may reduce effectiveness. Effectiveness may be improved if SVE is combined with steam injection or six-phase soil heating. Oxygen introduced through the induced air flow by SVE may promote biodegradation of organic compounds.	High capital cost for new system installation. Moderate to high O&M costs.	Yes	SVE not effective since residual impacted soil expected to remain outside of the excavation footprint is primarily in the saturated zone.	No
Phytoremediation	Use growing plants to remove, transfer, stabilize, and destroy contaminants in soil. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction, phyto-degradation, and phyto-stabilization.	Difficult to implement because of future site use and limited accessibility. Cleanup time frame is typically long.	Potentially effective as a polishing step for site contaminants in soil.	Low capital and O&M cost.	No	Long cleanup time frame. Not compatible with site use (alley) in locations where contaminants expected to remain in place outside of the excavation footprint.	No
Thermal treatment	Application of heat via subsurface steam injection, electrical resistive heating, or other method to remove strippable contaminants. Volatilized compounds captured and treated at surface.	Technically implementable. Requires off-gas capture and treatment.	Effective for site contaminants. Requires off-gas capture and treatment to be effective. Buried objects or debris may interfere with operation and effectiveness.	High capital and O&M costs.	Yes	Buried objects may interfere with treatment. High cost.	No
Soil flushing	A surfactant or solvent solution is applied to soil in place to remove leachable contaminants. The solution and leached contaminants are recovered from the underlying aquifer and treated.	Difficult to implement. Requires capture and treatment of injected solution and leached contaminants. Regulatory concerns over complete capture of leached contaminants, which may make permitting difficult.	Effective for recovery of organic contaminants. Soil flushing is a developing technology; evidence supporting effectiveness is limited.	High capital and O&M costs.	Yes	The technology can be used to treat site contaminants in locations where contaminants remain in place, but may be less cost-effective than alternative technologies. May be difficult to implement. High cost.	No
Soil removal	Removal of impacted soil using common excavation techniques. Excavated soil treated on site or sent off site for disposal.	Technically implementable.	Effective for all site soil contaminants.	Moderate capital cost. Negligible O&M cost.	Yes	Commonly used, established technology effective for all site soil contaminants. Redevelopment plans already call for soil removal to construct below-grade parking garage.	Yes
Land disposal	Disposal of impacted soil at an offsite, lined, permitted landfill.	Technically implementable. Impacted soil requires profiling and must meet land disposal requirements. Soil treatment may be required if disposal requirements are not met.	Effective for site soil contaminants.	Moderate capital cost, depending on type of contaminant. Negligible O&M cost.	Yes	Common and cost-effective disposal option for excavated soil.	Yes
Ex Situ bioremediation, thermal desorption, soil washing, chemical treatment, solidification/ stabilization, etc.	Treatment of excavated soil by enhancing biodegradation through modification of soil conditions and provision of substrate necessary for microbial growth, heating to volatilize contaminants, using water and surfactants to leach contaminants from soil, using chemicals to degrade contaminants, binding or enclosing contaminants, etc.	Difficult to implement. Limited space on site for treatment system. May require leachate or off-gas collection and treatment. Homogenization of heterogeneous soil and debris screening may be required. Presence of moisture or organics in soil may affect treatment.	Effective for site soil contaminants except solidification/stabilization may be less effective or ineffective for treatment of organic compounds.	Moderate to high capital and O&M costs.	Yes	Difficult to implement. Potential space limitations. Low cost effectiveness compared to land disposal.	No

Notes:
AS = Air sparging.
CAOs = Cleanup action objectives.
O&M = Operation and maintenance.
ROW = Right of way.
SVE = Soil vapor extraction.

TABLE 4-1b
REMEDIATION TECHNOLOGY SCREENING FOR GROUNDWATER
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Monitoring	Monitoring to assure compliance with CAOs, to assess performance of remedial technology during operation, and to measure continued effectiveness over time.	Technically implementable.	Effective for assessing groundwater conditions at the site.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Governmental and proprietary controls; enforcement and permit tools; information devices	Physical and administrative measures to control access or exposure to contaminated groundwater. Placement of an environmental covenant on the affected property.	Technically implementable.	Reliable conventional administrative measures.	Low capital and O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Monitored natural attenuation	Naturally occurring physical, chemical, and biological processes that reduce contaminant mobility or concentration.	Technically implementable. Cleanup time frame longer than for other remedial options for groundwater.	Effective for contaminants amenable to natural attenuation processes.	Negligible capital cost. Low O&M cost.	Yes	Not retained as the sole remedy in the absence of other technologies, but as complementary to other engineered remedies.	Yes
Capping	Placement of a surface cap over impacted groundwater areas to minimize water infiltration and mobilization of contaminants.	Technically implementable. Future building footprint and surrounding paved ROWs provide cap functionality.	Established technology effective for reducing mobility of contaminants. However, does not provide treatment of contaminants.	Low to moderate capital and O&M cost.	Yes	Site already includes cap of paved ROW surface or building slab. Applicable in locations where contaminants remain in place.	Yes
Vertical barriers	Placement of vertical, low-permeability barriers to minimize contaminant migration by retarding groundwater flow.	Technically implementable. Requires management of groundwater upgradient of barrier.	Established technology effective for reducing mobility of contaminants. However, does not provide treatment of contaminants.	Moderate to potentially high capital cost. High O&M cost.	Yes	Potentially high cost. Does not provide treatment. May not provide added incremental benefit.	No
Horizontal barriers	Placement of subsurface, low-permeability barriers to minimize water infiltration and contaminant migration.	Difficult to implement. Subsurface features may interfere with installation.	Effectiveness of this developing technology not established. Difficult to ensure barrier continuity. Does not provide treatment of contaminants.	Moderate to potentially high capital cost. High O&M cost.	Yes	Difficult to implement. High cost. Questionable reliability. Does not provide treatment. Subsurface features may interfere with installation.	No
Hydraulic containment/Pump and treat	Pumping of groundwater to control downgradient migration of contaminant plume. Groundwater can be pumped via extraction wells or trench installed to intercept the contaminant plume. Recirculation of treated groundwater can be utilized.	Potentially difficult to implement for site hydrogeologic conditions. Requires management of extracted groundwater. UIC program authorization required for reinjection of treated groundwater.	Established technology effective for controlling contaminant migration. Hoewver, may not be reliable for particular site hydrogeologic conditions.	Moderate to high capital cost. High O&M cost.	Yes	Potentially difficult to implement and may not be reliable in site-specific conditions.	No
In situ enhanced bioremediation	Enhanced biodegradation through addition of nutrients and electron acceptors to stimulate microbial growth and breakdown of contaminants. Amendments may be injected directly into groundwater contaminant plume or may be introduced using a groundwater recirculation system.	Technically implementable. Permitting and/or infrastructure required (e.g., injection wells for liquid-phase bioremediation). Underground utilities and building foundations may limit accessibility in some locations. Soil heterogeneities may intefere with consistent distribution of amendments. May require more than one application to attain CAOs. Cleanup time frame longer than for other remedial options for groundwater.	Established technology. Effective for site contaminants amenable to biological degradation.	Moderate to potentially high capital cost. Low to potentially high O&M costs. Cost variability dependent on delivery method and application frequency.	Yes	Implementable and effective for site contaminants.	Yes

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Chemical treatment	Injection of chemicals to degrade or destroy contaminants in place.	Technically implementable. Requires handling large quantities of hazardous chemicals. Presence of organics in soil may increase required chemical application rates. May require multiple applications of chemical to attain CAOs. Regulatory concerns over injection of chemicals into subsurface, which may make permitting difficult.	Effective for treatment of site contaminants.	Moderate capital cost. Low to moderate O&M cost.	Yes	Implementable and effective for site contaminants. May be cost effective for treatment of site contaminants.	Yes
Passive/reactive treatment walls	Vertical barrier installed across groundwater flow path to intercept contaminant plume. The barrier materials either degrade or immobilize contaminants as groundwater passes through the barrier.	Technically implementable. Nearby dynamic loading (e.g., pile driving, dewatering, excavation) can compromise the structure of the reactive barrier media. Accessibility may be limited.	Barriers have limited life and may require replacement if treatment time frame exceeds barrier life. Chemical precipitation and biological activity may decrease permeability of barrier. Potentially effective treatment for most site contaminants.	High capital cost. Low O&M cost. High barrier replacement cost.	Yes	High cost and potential for reactive media to be compromised based on nearby construction activities.	No
Air sparging (AS)	Air is injected into the aquifer to remove volatile contaminants. Enhances bioremediation through addition of oxygen. May be combined with soil vapor extraction (SVE) for capture of volatilized contaminants.	May be difficult to implement. UIC program authorization required for injection wells. Subsurface heterogeneity can inhibit uniform air distribution. Changes in water table depth can affect airflow paths and injection pressures.	Effective treatment for volatile site contaminants.	Moderate to potentially high capital cost. High O&M cost.	Yes	High cost. May be difficult to implement due to complexities with variable water table depth and subsurface heterogeneity.	No
Thermal treatment	Application of heat via subsurface steam injection, electrical resistive heating, or other method to remove strippable contaminants. Volatilized compounds rise to the unsaturated zone where they are removed by vacuum extraction and treated.	Technically implementable. Requires off-gas capture and treatment.	Effective for site contaminants. Requires off-gas capture and treatment to be effective. Buried objects or debris may interfere with operation and effectiveness.	High capital and O&M costs.	Yes	High cost. More cost effective processes are available for site contaminants. Buried objects may interfere with treatment.	No
Phytoremediation	Use of growing plants to remove, transfer, stabilize, and destroy contaminants in groundwater. The mechanisms of phytoremediation include enhanced rhizosphere biodegradation, phyto-extraction, phyto-degradation, and phyto-stabilization.	Difficult to implement because of future site use and space limitations. Long cleanup time frame.	Potentially effective for site contaminants.	Low capital and O&M cost.	No	Long cleanup time frame. Not compatible with future site use.	No
In-well air stripping	Air is injected into groundwater in a dual-screened well to volatilize aqueous contaminants and to provide oxygen for biodegradation. Volatilized contaminants are withdrawn from the well and treated. Aerated groundwater flow is induced along the outside of the well, via its two screens, to provide biotreatment of groundwater contaminants in its vicinity.	Technically implementable. Treatment time frame may be long.	Less effective for recovery of low-volatility organic compounds. May stimulate aerobic biodegradation of some organic contaminants. Range of influence may be limited to vicinity of well. Technology in development.	Moderate to high capital and O&M costs.	Yes	Long treatment time frame. Radius of influence potentially limited. Not an established treatment technology.	No
Dual-phase extraction	Technology that uses a high vacuum system to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal, or reinjected into the subsurface (where permissible under applicable state laws).	Potentially difficult to implement. Site hydrogeologic conditions may not be conducive to implementability of dual-phase extraction. Regulatory authorization required for injection.	Dual-phase vacuum extraction is more effective than SVE for heterogeneous clays and fine sands.	Moderate to high capital and O&M costs.	Yes	Potentially effective for site groundwater contaminants, although potentially difficult to implement in site-specific hydrogeologic conditions. Questionable cost effectiveness.	No

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Ex Situ bioremediation	Impacted groundwater is pumped from the subsurface via extraction wells and biologically treated in an aboveground system.	Difficult to implement because of potentially low groundwater recovery. Long treatment time frame. Regulatory authorization potentially required for discharge of treated water. May need to be combined with pre- and post-treatment steps. Treatment byproducts (e.g., sludge) require management.	Established technology effective for treatment of site contaminants.	Moderate to high capital cost. High O&M cost.	Yes	Difficult to implement. Long treatment time frame. Questionable cost effectiveness. Potential space limitations.	No
Adsorption	Removal of contaminants from impacted groundwater is achieved as groundwater is pumped through vessels containing adsorbent material.	Difficult to implement because of potentially low groundwater recovery. Long treatment time frame. Regulatory authorization potentially required for discharge of treated water. May need to be combined with pre- and post-treatment steps. Treatment byproducts (e.g., spent carbon) require management.	Established technology effective for treatment of most site contaminants.	Moderate to high capital and O&M costs.	Yes	Difficult to implement. Long treatment time frame. Questionable cost effectiveness. Potential space limitations.	No
Ion exchange	Removal of exchangable ions by passing extracted impacted groundwater through resin bed.	Difficult to implement because of potentially low groundwater recovery. Long treatment time frame. Regulatory authorization potentially required for discharge of treated water. May need to be combined with pre- and post-treatment steps. Treatment byproducts (e.g., spent resin) require management.	Not effective for removal of organic compounds.	Moderate to high capital and O&M costs.	Yes	Not effective for removal of organic compounds.	No
Membrane separation	Porous membranes used to remove dissolved or colloidal material from extracted groundwater.	Difficult to implement because of potentially low groundwater recovery. Long treatment time frame. Regulatory authorization potentially required for discharge of treated water. May need to be combined with pre- and post-treatment steps.	Effective for removal of some organics.	High capital and O&M costs.	Yes	Difficult to implement. Long treatment time frame. High cost. Potential space limitations.	No
Advanced oxidation	Oxidation of aqueous contaminants in extracted groundwater through chemical addition (ozone or hydrogen peroxide) and/or exposure to ultraviolet (UV) light.	Difficult to implement because of potentially low groundwater recovery. Long treatment time frame. Regulatory authorization potentially required for discharge of treated water. May need to be combined with pre- and post-treatment steps. High energy requirements.	Effective for treatment of organic compounds.	High capital and O&M costs.	Yes	Difficult to implement. Long treatment time frame. High cost. Potential space limitations.	No
Sprinkler irrigation	Removal of contaminants through the distribution of volatile organic compound (VOC)-laden water through a standard sprinkler irrigation system. Sprinkler irrigation transfers VOCs from the dissolved aqueous phase to the vapor phase, whereby the VOCs are released directly to the atmosphere.	Difficult to implement because of potentially low groundwater recovery and space limitations. Regulatory approval may be difficult to obtain because of the direct release of contaminants to the atmosphere.	Technology in development.	Low capital and O&M cost.	No	Difficult to implement. Long treatment time frame. Not an established treatment technology.	No

Notes:
AS = Air sparging.
CAOs = Cleanup action objectives.
O&M = Operation and maintenance.
ROW = Right of way.
SVE = Soil vapor extraction.
UIC = Underground injection control.
UV = Ultraviolet.
VOCs = Volatile organic compounds.

TABLE 4-1c
REMEDIATION TECHNOLOGY SCREENING FOR INDOOR AIR
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Monitoring	Monitoring to assure compliance with CAOs, to assess performance of remedial technology during operation, and to measure continued effectiveness over time.	Technically implementable.	Effective for assessing soil vapor and/or indoor air conditions at the site.	Negligible capital cost. Low O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Governmental and proprietary controls; enforcement and permit tools; information devices	Physical and administrative measures to maintain engineering controls. Placement of an environmental covenant on the property.	Technically implementable.	Reliable conventional administrative measures.	Low capital and O&M cost.	Yes	Applicable in combination with other technologies.	Yes
Passive barrier	Placement of a vapor barrier below a building to physically block the entry of vapors. Soil gas that would otherwise enter the building under diffusion or pressure gradients migrates laterally beyond the building footprint.	Technically implementable. Constructability can be challenging because requires careful installation to prevent even small tears or holes in the barrier.	Established technology effective for reducing vapor intrusion of contaminants. However, does not provide treatment of contaminants.	Low capital and O&M costs.	Yes	Technically implementable and effective for site contaminants. Cost effective.	Yes
Passive venting	Placement of a venting layer below the floor slab to allow soil gas to move laterally beyond the building footprint under natural diffusion or pressure gradients. Perforated collection pipes are typically routed at the periphery or through the venting media to collect soil gas and convey it to an exhaust point outside the building.	Technically implementable. Typically installed in conjunction with passive barrier. Regulatory authorization potentially required for exhaust of soil gas to the atmosphere.	Established technology effective for reducing vapor intrusion of contaminants. However, does not provide treatment of contaminants. Consistent depressurization of the venting layer should not be expected.	Low to moderate capital cost. Low O&M cost.	Yes	Technically implementable and effective for site contaminants. May not be cost effective since low concentrations at the Site indicate venting is not considered necessary if a passive vapor barrier is implemented.	No
Sub-slab depressurization (SSD)	Creating a pressure differential across the slab that favors movement of indoor air down into the subsurface. Soil gases from beneath the slab are pulled and vented to the atmosphere at a height well above the outdoor breathing zone and away from windows and air supply intakes.	Technically implementable. Typically installed in conjunction with venting layer and passive barrier, although generally not as robust as for passive venting systems. Low-permeability soils retard soil gas movement and may require more permeable backfill materials around footings. Regulatory authorization potentially required for exhaust of soil gas to the atmosphere.	Established technology effective for reducing vapor intrusion of contaminants. However, does not provide treatment of contaminants. Simple gauges show whether the system is working.	Moderate to high capital cost. Low to moderate O&M costs.	Yes	Technically implementable and effective for site contaminants. High cost relative to other containment treatment technologies. May not provide added incremental benefit.	No
Sub-slab pressurization (SSP)	Similar to SSD, except fans are used to push air into the soil or venting layer below the slab instead of pulling it out.	Technically implementable. Regulatory authorization potentially required for exhaust of soil gas to the atmosphere.	May not be effective in low-permeability soils. Cracks or slab openings may result in short-circuiting, leading to vapors inside structure. More energy-intensive than SSD. Does not provide treatment of contaminants.	Moderate to high capital cost. Moderate O&M costs.	Yes	Limited effectiveness in low-permeability soils. High cost relative to other containment treatment technologies. May not provide added incremental benefit.	No

Remediation Technology	Description	Implementability	Reliability	Relative Cost	Compatible with Redevelopment?	Screening Comments	Technology Retained?
Building pressurization/HVAC optimization	Modifying HVAC system to achieve positive pressure in the building interior (relative to the subslab), thereby preventing vapor intrusion.	Technically implementable. Less practicable when the building has many doors and openings. If airflow between floors is limited, typically only the lowest floor of building will require positive pressurization.	Effective for reducing vapor intrusion of contaminants. Regular maintenance and air balancing needed to maintain consistent, positive pressure. Does not provide treatment of contaminants. Vapor intrusion may occur when HVAC systems are shut off (e.g., nights, weekends). Increased energy cost due to higher replacement-air flow rates.	Low capital cost. Moderate to high O&M costs. Cost variability dependent on size and complexity of structure.	Yes	Technically implementable and effective for site contaminants. High cost relative to other containment treatment technologies. May not provide added incremental benefit.	No
Indoor air treatment	Air within the building is directed to air pollution control equipment (e.g., carbon adsorption systems) to remove air contaminants.	Technically implementable. Requires uninterrupted performance to protect receptors. Generally combined with other techniques to control vapor intrusion in specific rooms due to the large volumetric rate of air required for treatment of entire structure. Less cost effective to install in new buildings than existing buildings.	Effective for physically removing and disposing the air contaminants rather than redirecting vapors. Less effective than other control methods. Maintenance-intensive. Typically generates ancillary waste stream requiring disposal.	Low to high capital and O&M costs. Actual costs heavily dependent upon type of technology employed.	Yes	Technically implementable and effective for site contaminants. Generates waste, requires large amounts of energy, and is maintenance-intensive. More cost effective systems can generally be installed in new buildings. May not provide added incremental benefit.	No

Notes:
CAOs = Cleanup action objectives.
HVAC = Heating, ventilation, and air conditioning.
O&M = Operation and maintenance.
SSD = Sub-slab depressurization.
SSP = Sub-slab pressurization.

TABLE 4-2a
CLEANUP ACTION ALTERNATIVE 1 COST ESTIMATE
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Location:	Seattle DOT Dexter Parcel Site Seattle, WA	**Description:** Alternative 1 consists of on-Property soil excavation and off-site disposal, in-situ enhanced bioremediation (ISEB) of off-Property residual impacted soil and groundwater, monitored natural attenuation (MNA) of residual impacted soil and groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.
Phase:	Feasibility Study (-30% to + 50%)	
Base Year:	2021	
Date:	October 2021	

Assumptions

1) Soil volume estimates include a conversion factor of 1.35 from bank cubic yards to truck cubic yards, and 1.4 from truck cubic yards to tonnage.
2) Existing groundwater monitoring wells will be sampled for MNA implementation.
3) Quarterly groundwater monitoring for two years, then biannual groundwater monitoring for three years, then groundwater monitoring every five years, for a total monitoring period of 20 years in the development of this cost estimate.
4) Cap inspection will be performed annually and maintenance will be performed as needed for 20 years.
5) Air monitoring will be performed biannually for the first year and then annually for 4 years. Each sampling event will consist of 4 samples.
6) Present value analysis uses two percent discount rate.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
On-Property Excavation					
Excavation and loading	770	TN	$ 8	$ 6,000	Volume based on assumed excavation area of 33 feet by 33 feet from 7.5 feet bgs to 17.5 feet bgs.
Transportation and disposal	770	TN	$ 108	$ 83,000	Non-hazardous disposal at Waste Management Subtitle D landfil.
Performance sampling and analysis	20	EA	$ 330	$ 7,000	
Subtotal				*$ 96,000*	
In-situ Enhanced Bioremediation					
Injections, Labor, Oversight					Assumes 3 injection points and 1 application with sonic drill rig.
Injection Product	1	LS	$ 26,000	$ 26,000	Regenesis quote.
Drilling	1	LS	$ 11,000	$ 11,000	Engineer's estimate.
Injection Labor	1	LS	$ 15,000	$ 15,000	Engineer's estimate.
Engineering Oversight	1	LS	$ 4,000	$ 4,000	Engineer's estimate based on estimated two-day injection event.
Subtotal				*$ 56,000*	
Monitored Natural Attenuation					
Pre-Remedial Design Investigation	1	LS	$ 21,000	$ 21,000	Groundwater monitoring of 5 existing wells for DRO, GRO, BTEX, nitrate, sulfate, methane, alkalinity, ferrous iron, and manganese and associated reporting.
Preparation of MNA Work Plan	1	EA	$ 19,400	$ 19,000	Engineer's estimate.
Subtotal				*$ 40,000*	
Vapor Barrier Installation					
Vertical vapor barrier	19,140	SF	$ 13	$ 249,000	
Horizontal vapor barrier	24,267	SF	$ 16	$ 388,000	
Support and Labor	9	DY	$ 1,300	$ 12,000	
Subtotal				*$ 649,000*	
Institutional Controls					
Preparation of environmental covenant	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Land use restrictions for surrounding ROWs	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Subtotal				*$ 16,000*	
Contingency	20%	--	--	*$ 171,000*	Scope and bid contingency. Percentage of capital costs.
Professional/Technical Services					
Project Management	6%	--	--	$ 62,000	EPA 540-R-00-002. Percentage of capital and contingency costs.
Remedial Design	12%	--	--	$ 123,000	
Construction Management	8%	--	--	$ 82,000	
Subtotal				*$ 267,000*	
TOTAL CAPITAL COST				**$ 1,295,000**	

Location: Seattle DOT Dexter Parcel Site Seattle, WA **Phase:** Feasibility Study (-30% to + 50%) **Base Year:** 2021 **Date:** October 2021	**Description:** Alternative 1 consists of on-Property soil excavation and off-site disposal, in-situ enhanced bioremediation (ISEB) of off-Property residual impacted soil and groundwater, monitored natural attenuation (MNA) of residual impacted soil and groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Compliance Groundwater Monitoring	4	EA	$ 4,100	*$ 16,000*	Quarterly groundwater monitoring of 4 wells for DRO, GRO, BTEX, nitrate, sulfate, methane, alkalinity, ferrous iron, and manganese.
Compliance Air Monitoring	2	EA	$ 3,300	*$ 7,000*	Biannual air monitoring
Cap Monitoring	1	EA	$ 1,500	*$ 2,000*	Annual monitoring.
Cap Maintenance	1	EA	$ 500	*$ 500*	
Contingency	25%	--	--	*$ 6,000*	Scope and bid contingency. Percentage of annual O&M cost.
Professional/Technical Services					
Project management	10%	--	--	$ 3,000	Percentage of annual + contingency costs. EPA 540-R-00-002.
Compliance Groundwater Monitoring Reporting	4	EA	$ 7,100	$ 28,000	Quarterly data management, groundwater reporting.
Compliance Air Monitoring Reporting	2	EA	$ 6,700	$ 13,000	Biannual data management, air quality reporting.
Cap Monitoring Reporting	1	YR	$ 2,700	$ 3,000	Annual cap performance monitoring.
Subtotal				*$ 47,000*	
TOTAL ANNUAL O&M COST FOR YEAR 1				**$ 79,000**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Professional/Technical Services					
Five-Year Reviews and Reporting	1	EA	$ 5,000	$ 5,000	Years 5, 10, 15, and 20.
Subtotal				*$ 5,000*	

TOTAL COST SUMMARY

Total years 20

COST TYPE	YEAR	TOTAL COST PER YEAR	TOTAL COST	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 1,295,000	$ 1,295,000	1.000	$ 1,295,000	
Annual O&M	1	$ 79,000	$ 79,000	0.980	$ 77,451	Quarterly groundwater, biannual air, annual cap.
Annual O&M	2	$ 68,000	$ 68,000	0.961	$ 65,359	Quarterly groundwater, annual air, annual cap.
Annual O&M	3 - 5	$ 42,000	$ 126,000	2.884	$ 121,123	Biannual groundwater, annual air, annual cap.
Annual O&M	6 - 20	$ 5,000	$ 75,000	12.849	$ 64,246	Annual cap.
Periodic	5	$ 5,000	$ 5,000	0.906	$ 4,529	Five-year review and reporting.
Periodic	10	$ 18,000	$ 18,000	0.820	$ 14,766	Groundwater monitoring and five-year review and reporting.
Periodic	15	$ 18,000	$ 18,000	0.743	$ 13,374	Groundwater monitoring and five-year review and reporting.
Periodic	20	$ 18,000	$ 18,000	0.673	$ 12,113	Groundwater monitoring and five-year review and reporting.
TOTAL NET PRESENT VALUE OF ALTERNATIVE 1					**$ 1,668,000**	

Notes:
bgs = Below ground surface.
BTEX = Benzene, toluene, ethylbenzene, and xylenes.
DRO = Diesel-range organics.
DY = Day.
EA = Each.
GRO = Gasoline-range organics.
LF = Linear Feet.
LS = Lump sum.
MNA = Monitored natural attenuation.
O&M = Operation and maintenance.
ROW = Right of way.
SF = Square Feet.
TN = Ton.
YR = Year.

TABLE 4-2b
CLEANUP ACTION ALTERNATIVE 2 COST ESTIMATE
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Location:	Seattle DOT Dexter Parcel Site Seattle, WA	**Description:** Alternative 2 consists of on and off-Property soil excavation and off-site disposal, monitored natural attenuation (MNA) of residual impacted groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.
Phase:	Feasibility Study (-30% to + 50%)	
Base Year:	2021	
Date:	October 2021	

Assumptions
1) Soil volume estimates include a conversion factor of 1.35 from bank cubic yards to truck cubic yards, and 1.4 from truck cubic yards to tonnage.
2) Existing groundwater monitoring wells will be sampled for MNA implementation.
3) Quarterly groundwater monitoring for two years, then biannual groundwater monitoring for three years, then groundwater monitoring every five years, for a total monitoring period of 10 years in the development of this cost estimate.
4) Cap inspection will be performed annually and maintenance will be performed as needed for 10 years.
5) Air monitoring will be performed biannually for the first year and then annually for 4 years. Each sampling event will consist of 4 samples.
6) Present value analysis uses two percent discount rate.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
On-Property Excavation					
Excavation and loading	770	TN	$ 8	$ 6,000	Volume based on assumed excavation area of 33 feet by 33 feet from 7.5 feet bgs to 17.5 feet bgs.
Transportation and disposal	770	TN	$ 108	$ 83,000	Non-hazardous disposal at Waste Management Subtitle D landfil.
Performance sampling and analysis	20	EA	$ 330	$ 7,000	
Subtotal				*$ 96,000*	
Off-Property Excavation					
Mobilization	1	LS	$ 2,880	$ 3,000	
Support of Excavation	3,240	SF	$ 102	$ 330,000	Sheetpile on four sides of assumed 37 feet by 17 feet excavation area to 30 feet bgs.
Dewatering	1	LS	$ 200	$ 200	2-inch pump. Excludes water treatment.
Excavating, stockpiling, and re-use as backfill	524	BCY	$ 19	$ 10,000	Clean overburden. Volume based on assumed excavation area of 37 feet by 17 feet from ground surface to 22.5 feet bgs.
Excavation and loading	220	TN	$ 14	$ 3,000	Impacted soil. Volume based on assumed excavation area of 37 feet by 17 feet from 22.5 feet bgs to 27.5 feet bgs.
Transportation and disposal	220	TN	$ 108	$ 24,000	Non-hazardous disposal at Waste Management Subtitle D landfil.
Performance sampling and analysis	15	EA	$ 330	$ 4,950	
Backfill and compaction	220	TN	$ 47	$ 10,000	Utility Sand or Gravel Borrow delivered and placed to replace impacted soil disposed of off-site.
Asphalt restoration	630	SF	$ 19	$ 12,000	Based on assumed excavation area of 37 feet by 17 feet.
Subtotal				*$ 397,000*	
Monitored Natural Attenuation					
Preparation of MNA Work Plan	1	EA	$ 19,400	$ 19,000	Engineer's estimate.
Decommission, install, and develop monitoring wells	1	LS	$ 14,000	$ 14,000	Decommission DMW-4S removed in off-property excavation. Install and develop replacement for DMW-4S.
Subtotal				*$ 33,000*	
Vapor Barrier Installation					
Vertical vapor barrier	19,140	SF	$ 13	$ 249,000	
Horizontal vapor barrier	24,267	SF	$ 16	$ 388,000	
Support and Labor	9	DY	$ 1,300	$ 12,000	
Subtotal				*$ 649,000*	
Institutional Controls					
Preparation of environmental covenant	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Land use restrictions for surrounding ROWs	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Subtotal				*$ 16,000*	
Contingency	20%	--	--	*$ 238,000*	Scope and bid contingency. Percentage of capital costs.
Professional/Technical Services					
Project Management	6%	--	--	$ 86,000	EPA 540-R-00-002. Percentage of capital and contingency costs.
Remedial Design	12%	--	--	$ 171,000	
Construction Management	8%	--	--	$ 114,000	
Subtotal				*$ 371,000*	
TOTAL CAPITAL COST				**$ 1,800,000**	

Location:	Seattle DOT Dexter Parcel Site Seattle, WA	**Description:** Alternative 2 consists of on and off-Property soil excavation and off-site disposal, monitored natural attenuation (MNA) of residual impacted groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.
Phase:	Feasibility Study (-30% to + 50%)	
Base Year:	2021	
Date:	October 2021	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Compliance Groundwater Monitoring	4	EA	$ 4,100	*$ 16,000*	Quarterly groundwater monitoring of 4 wells for DRO, GRO, BTEX, nitrate, sulfate, methane, alkalinity, ferrous iron, and manganese.
Compliance Air Monitoring	2	EA	$ 3,300	*$ 7,000*	Biannual air monitoring.
Cap Monitoring	1	EA	$ 1,500	*$ 2,000*	Annual monitoring.
Cap Maintenance	1	EA	$ 500	*$ 500*	
Contingency	25%	--	--	*$ 6,000*	Scope and bid contingency. Percentage of annual O&M cost.
Professional/Technical Services					
Project management	10%	--	--	$ 3,000	Percentage of annual + contingency costs. EPA 540-R-00-002.
Quarterly Groundwater Quality Reporting	4	EA	$ 7,100	$ 28,000	Quarterly data management, groundwater reporting.
Compliance Air Monitoring Reporting	2	EA	$ 6,700	$ 13,000	Biannual data management, air quality reporting.
Annual Cap Performance Monitoring Reporting	1	YR	$ 2,700	$ 3,000	Annual cap performance monitoring.
Subtotal				*$ 47,000*	
TOTAL ANNUAL O&M COST FOR YEAR 1				**$ 79,000**	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Professional/Technical Services					
Five-Year Reviews and Reporting	1	EA	$ 5,000	$ 5,000	Years 5 and 10.
Subtotal				*$ 5,000*	

TOTAL COST SUMMARY

Total years 10

COST TYPE	YEAR	TOTAL COST PER YEAR	TOTAL COST	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 1,800,000	$ 1,800,000	1.000	$ 1,800,000	
Annual O&M	1	$ 79,000	$ 79,000	0.980	$ 77,451	Quarterly groundwater, biannual air, annual cap.
Annual O&M	2	$ 68,000	$ 68,000	0.961	$ 65,359	Quarterly groundwater, annual air, annual cap.
Annual O&M	3 - 5	$ 42,000	$ 126,000	2.884	$ 121,123	Biannual groundwater, annual air, annual cap.
Annual O&M	6 - 10	$ 5,000	$ 25,000	4.713	$ 23,567	Annual cap.
Periodic	5	$ 5,000	$ 5,000	0.906	$ 4,529	Five-year review and reporting.
Periodic	10	$ 18,000	$ 18,000	0.820	$ 14,766	Groundwater monitoring and five-year review and reporting.
TOTAL NET PRESENT VALUE OF ALTERNATIVE 2					**$ 2,107,000**	

Notes:
BCY = Bank cubic yards.
bgs = Below ground surface.
BTEX = Benzene, toluene, ethylbenzene, and xylenes.
DRO = Diesel-range organics.
DY = Day.
EA = Each.
GRO = Gasoline-range organics.
LF = Linear Feet.
LS = Lump sum.
MNA = Monitored natural attenuation.
O&M = Operation and maintenance.
ROW = Right of way.
SF = Square Feet.
TN = Ton.
YR = Year.

TABLE 4-2c
CLEANUP ACTION ALTERNATIVE 3 COST ESTIMATE
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Location:	Seattle DOT Dexter Parcel Site Seattle, WA	**Description:** Alternative 3 consists of on-Property soil excavation and off-site disposal, in-situ chemical oxidation (ISCO) of residual impacted soil and groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.
Phase:	Feasibility Study (-30% to + 50%)	
Base Year:	2021	
Date:	October 2021	

Assumptions

1) Soil volume estimates include a conversion factor of 1.35 from bank cubic yards to truck cubic yards, and 1.4 from truck cubic yards to tonnage.
2) Existing groundwater monitoring wells will be sampled for compliance monitoring.
3) Quarterly groundwater monitoring for two years, then biannual groundwater monitoring for three years, for a total monitoring period of 5 years in the development of this cost estimate.
4) Cap inspection will be performed annually and maintenance will be performed as needed for 5 years.
5) Air monitoring will be performed biannually for the first year and then annually for 4 years. Each sampling event will consist of 4 samples.
6) Present value analysis uses two percent discount rate.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
On-Property Excavation					
Excavation and loading	770	TN	$ 8	$ 6,000	Volume based on assumed excavation area of 33 feet by 33 feet from 7.5 feet bgs to 17.5 feet bgs.
Transportation and disposal	770	TN	$ 108	$ 83,000	Non-hazardous disposal at Waste Management Subtitle D landfil.
Performance sampling and analysis	20	EA	$ 330	$ 7,000	
Subtotal				*$ 96,000*	
In-situ Chemical Oxidation					
Preparation of Chemical Oxidation Work Plan	1	EA	$ 29,100	$ 29,000	Engineer's estimate.
Pilot Study	1	LS	$ 57,000	$ 57,000	Engineer's estimate and Regenesis quote.
Injections, Labor, Oversight					Assumes 15 injection points for first application and 5 injection points for second application with sonic drill rig.
Injection Product	1	LS	$ 63,000	$ 63,000	Regenesis quote.
Drilling	1	LS	$ 50,000	$ 50,000	Engineer's estimate.
Injection Labor	1	LS	$ 45,000	$ 45,000	Engineer's estimate.
Engineering Oversight	1	LS	$ 14,000	$ 14,000	Engineer's estimate based on estimated one week for first injection event and two days for second injection event.
Subtotal				*$ 258,000*	
Vapor Barrier Installation					
Vertical vapor barrier	19,140	SF	$ 13	$ 249,000	
Horizontal vapor barrier	24,267	SF	$ 16	$ 388,000	
Support and Labor	9	DY	$ 1,300	$ 12,000	
Subtotal				*$ 649,000*	
Institutional Controls					
Preparation of environmental covenant	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Land use restrictions for surrounding ROWs	1	EA	$ 8,000	$ 8,000	Engineer's estimate.
Subtotal				*$ 16,000*	
Contingency	20%	--	--	*$ 204,000*	Scope and bid contingency. Percentage of capital costs.
Professional/Technical Services					
Project Management	6%	--	--	$ 73,000	EPA 540-R-00-002. Percentage of capital and contingency costs.
Remedial Design	12%	--	--	$ 147,000	
Construction Management	8%	--	--	$ 98,000	
Subtotal				*$ 318,000*	
TOTAL CAPITAL COST				**$ 1,541,000**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Compliance Groundwater Monitoring	4	EA	$ 4,100	*$ 16,000*	Quarterly groundwater monitoring of 4 wells for DRO, GRO, BTEX, nitrate, sulfate, methane, alkalinity, ferrous iron, and manganese.
Compliance Air Monitoring	2	EA	$ 3,300	*$ 7,000*	Biannual air monitoring.
Cap Monitoring	1	EA	$ 1,500	*$ 2,000*	Annual monitoring.
Cap Maintenance	1	EA	$ 500	*$ 500*	
Contingency	25%	--	--	*$ 6,000*	Scope and bid contingency. Percentage of annual O&M cost.
Professional/Technical Services					
Project management	10%	--	--	$ 3,000	Percentage of annual + contingency costs. EPA 540-R-00-002.
Quarterly Groundwater Quality Reporting	4	EA	$ 7,100	$ 28,000	Quarterly data management, groundwater reporting.
Compliance Air Monitoring Reporting	2	EA	$ 6,700	$ 13,000	Biannual data management, air quality reporting.
Annual Cap Performance Monitoring Reporting	1	YR	$ 2,700	$ 3,000	Annual cap performance monitoring.
Subtotal				*$ 47,000*	
TOTAL ANNUAL O&M COST				**$ 79,000**	

Location:	Seattle DOT Dexter Parcel Site Seattle, WA	**Description:** Alternative 3 consists of on-Property soil excavation and off-site disposal, in-situ chemical oxidation (ISCO) of residual impacted soil and groundwater, installation of a passive vapor barrier, institutional controls, and compliance monitoring and maintenance. Costs that are associated with the redevelopment (e.g., shoring, construction dewatering, building slab) are common elements across all three alternatives, and they have been excluded from this cost estimate.
Phase:	Feasibility Study (-30% to + 50%)	
Base Year:	2021	
Date:	October 2021	

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Professional/Technical Services					
Five-Year Review and Reporting	1	EA	$ 5,000	$ 5,000	Year 5.
Subtotal				*$ 5,000*	

TOTAL COST SUMMARY

Total years 5

COST TYPE	YEAR	TOTAL COST PER YEAR	TOTAL COST	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 1,541,000	$ 1,541,000	1.000	$ 1,541,000	
Annual O&M	1	$ 79,000	$ 79,000	0.980	$ 77,451	Quarterly groundwater, biannual air, annual cap.
Annual O&M	2	$ 68,000	$ 68,000	0.961	$ 65,359	Quarterly groundwater, annual air, annual cap.
Annual O&M	3 - 5	$ 42,000	$ 126,000	2.884	$ 121,123	Biannual groundwater, annual air, annual cap.
Periodic	5	$ 5,000	$ 5,000	0.906	$ 4,529	Five-year review and reporting.
TOTAL NET PRESENT VALUE OF ALTERNATIVE 3					**$ 1,809,000**	

Notes:
bgs = Below ground surface.
BTEX = Benzene, toluene, ethylbenzene, and xylenes.
DRO = Diesel-range organics.
DY = Day.
EA = Each.
GRO = Gasoline-range organics.
ISCO = In situ chemical oxidation.
LF = Linear Feet.
LS = Lump sum.
O&M = Operation and maintenance.
ROW = Right of way.
SF = Square Feet.
TN = Ton.
YR = Year.

TABLE 4-3
GROUNDWATER RESULTS FOR BENZENE, TOTAL PETROLEUM HYDROCARBONS, FIELD PARAMETERS, AND GEOCHEMICAL PARAMETERS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Boring/ Well ID	Sample Type	Surface Elevation (ft)	Sample Depth (ft)	Sample Elevation (ft)	Grab or Monitoring Well?	Sample Date	Benzene	Total Petroleum Hydrocarbons							
								Gasoline Range Organics	Total Petroleum Hydrocarbons - Mineral Spirits	Diesel Range Organics	Diesel Range Organics, Silica-Gel Cleanup	Kerosene	Total Petroleum Hydrocarbons - Heavy Oils	Total Petroleum Hydrocarbons - Heavy Oils, Silica-Gel Cleanup	Diesel Range + Oil Range Organics
							ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
						Analytical Method	SW8021B SW8260B SW8260C SW8260D	NWTPH-GX	NWTPH-GX	NWTPH-DX	NWTPH-DX	NWTPH-DX	NWTPH-DX	NWTPH-DX	NWTPH-DX
21417-GP1	N	69.53	20 to 25	44.53 to 49.53	G	4/21/2017	1 U	50 U	-	50 U	-	-	100 U	-	100 U
21417-GP3	N	55.86	10 to 20	35.86 to 45.86	G	4/21/2017	1 U	50 U	-	49.8 U	-	-	99.6 U	-	99.6 U
21417-GP4	N	55.82	10 to 15	40.82 to 45.82	G	4/21/2017	1 U	**4830**	-	-	-	-	-	-	-
BB-10	N	57.40	29 to 39	18.40 to 28.40	MW	11/13/1997	1 U	100 U	-	630 U	-	-	630 U	-	630 U
DGW-1	N	55.98	20 to 30	25.98 to 35.98	G	3/6/2019	1 U	**340**	100 U	200 U	-	200 U	500 U	-	500 U
DGW-2	N	66.25	20 to 30	36.25 to 46.25	G	3/7/2019	1 U	100 U	100 U	200 U	-	200 U	500 U	-	500 U
DGW-3	N	56.08	35 to 45	11.08 to 21.08	G	3/6/2019	1 U	100 U	100 U	200 U	-	200 U	500 U	-	500 U
DGW-4	N	69.87	30 to 40	29.87 to 39.87	G	3/4/2019	1 U	100 U	100 U	200 U	-	200 U	500 U	-	500 U
DMW-1S	N	55.94	17 to 27	28.94 to 38.94	MW	3/25/2019	**1.5**	**350**	100 U	200 U	-	200 U	500 U	-	500 U
	FD					3/25/2019	**1.8**	**300**	100 U	200 U	-	200 U	500 U	-	500 U
	N					3/18/2020	**2.9**	**1800**	-	**580**	-	-	250 U	-	**580**
DMW-2S	N	56.03	25 to 35	21.03 to 31.03	MW	3/18/2020	0.2 U	100 U	-	50 U	-	-	250 U	-	250 U
	FD					3/18/2020	0.2 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-3IA	N	56.09	39 to 49	7.09 to 17.09	MW	3/18/2020	0.2 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-4S	N	61.76	23 to 33	28.76 to 38.6	MW	3/19/2020	0.2 U	**670**	-	**790**	-	-	250 U	-	**790**
DMW-5IA	N	69.48	39.8 to 49.8	19.68 to 29.68	MW	3/19/2020	0.2 U	100 U	-	760 U	-	-	250 U	-	760 U
	N					10/15/2020	-	-	-	100 U	60 U	-	250 U	250 U	100 U
DMW-6	N	66.30	34 to 44	22.30 to 32.30	MW	3/18/2020	0.2 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-7S	N	58.34	28 to 38	20.34 to 30.34	MW	11/2/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-8S	N	58.57	27 to 37	21.57 to 31.57	MW	11/2/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-9S	N	58.85	23 to 33	25.85 to 35.85	MW	11/2/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-10S	N	59.46	35 to 55	4.46 to 24.46	MW	11/2/2020	**1.5**	**630**	-	**190**	-	-	250 U	-	**190**
DMW-11S	N	61.15	30 to 50	11.15 to 31.15	MW	11/2/2020	**1.2**	**270**	-	**210**	-	-	250 U	-	**210**
DMW-12S	N	66.05	30 to 50	16.05 to 36.05	MW	11/2/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-13S	N	66.28	30 to 50	16.28 to 36.28	MW	11/3/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DMW-14S	N	70.29	41 to 51	19.29 to 29.29	MW	11/3/2020	1 U	100 U	-	50 U	-	-	250 U	-	250 U
DPP-3	N	55.98	20 to 30	25.98 to 35.98	G	3/6/2019	1 U	100 U	100 U	200 U	-	200 U	500 U	-	500 U
HC-1	N	62.33	21.5 to 31.5	30.83 to 40.83	G	4/11/2019	1 U	**6900**	100 U	200 U	-	200 U	500 U	-	500 U
HC-4	N	60.23	40 to 50	10.23 to 20.23	MW	4/12/2019	1 U	100 U	100 U	200 U	-	200 U	500 U	-	500 U
MW-117	N	57.78	40 to 55	2.78 to 17.78	MW	12/18/2013	0.35 U	100 U	-	50 U	-	-	250 U	-	250 U
MW-305	N	60.15	22.8 to 32.8	27.35 to 37.35	MW	10/15/2019	0.5 U	100 U	-	-	-	-	-	-	-
	N					1/15/2020	0.5 U	100 U	-	-	-	-	-	-	-
	N					4/28/2020	0.5 U	**54.4 J**	-	-	-	-	-	-	-
MW-306	N	59.91	42.8 to 52.8	7.11 to 17.11	MW	10/15/2019	0.5 U	100 U	-	-	-	-	-	-	-
	N					1/16/2020	0.5 U	100 U	-	-	-	-	-	-	-
	N					4/28/2020	0.5 U	**42.7 J**	-	-	-	-	-	-	-
MW-307	N	60.29	72.8 to 82.8	-22.51 to -12.51	MW	10/11/2019	0.5 U	100 U	-	-	-	-	-	-	-
	N					1/15/2020	0.5 U	100 U	-	-	-	-	-	-	-
	N					4/28/2020	**0.172 J**	**146 Z, J+**	-	-	-	-	-	-	-

TABLE 4-3
GROUNDWATER RESULTS FOR BENZENE, TOTAL PETROLEUM HYDROCARBONS, FIELD PARAMETERS, AND GEOCHEMICAL PARAMETERS
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Boring/ Well ID	Sample Type	Surface Elevation (ft)	Sample Depth (ft)	Sample Elevation (ft)	Grab or Monitoring Well?	Sample Date	Field Parameters						Geochemical Parameters					
							Conductivity, Field	Dissolved Oxygen, Field	ORP, Field	pH, Field	Temperature, Field	Turbidity, Field	Nitrate	Sulfate	Methane	Alkalinity	Ferrous Iron	Manganese, Total
							mS/cm	mg/L	mV	pH units	Degrees Celsius	NTU	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
						Analytical Method	Field	Field	Field	Field	Field	Field	SW 9056A	SW 9056A	RSK 175	SM 2320B	-	SW 6020B
21417-GP1	N	69.53	20 to 25	44.53 to 49.53	G	4/21/2017	-	-	-	-	-	-	-	-	-	-	-	-
21417-GP3	N	55.86	10 to 20	35.86 to 45.86	G	4/21/2017	-	-	-	-	-	-	-	-	-	-	-	-
21417-GP4	N	55.82	10 to 15	40.82 to 45.82	G	4/21/2017	-	-	-	-	-	-	-	-	-	-	-	-
BB-10	N	57.40	29 to 39	18.40 to 28.40	MW	11/13/1997	-	-	-	-	-	-	-	-	-	-	-	-
DGW-1	N	55.98	20 to 30	25.98 to 35.98	G	3/6/2019	-	-	-	-	-	-	-	-	-	-	-	-
DGW-2	N	66.25	20 to 30	36.25 to 46.25	G	3/7/2019	-	-	-	-	-	-	-	-	-	-	-	-
DGW-3	N	56.08	35 to 45	11.08 to 21.08	G	3/6/2019	-	-	-	-	-	-	-	-	-	-	-	-
DGW-4	N	69.87	30 to 40	29.87 to 39.87	G	3/4/2019	-	-	-	-	-	-	-	-	-	-	-	-
DMW-1S	N	55.94	17 to 27	28.94 to 38.94	MW	3/25/2019	**0.43**	**4.83**	**110.0**	**7.22**	-	**500**	-	-	-	-	-	-
	FD					3/25/2019	**0.43**	**4.83**	**110.0**	**7.22**	-	**500**	-	-	-	-	-	-
	N					3/18/2020	**0.41**	**1.61**	**102.7**	**7.31**	-	**8.2**	-	-	-	-	-	-
DMW-2S	N	56.03	25 to 35	21.03 to 31.03	MW	3/18/2020	**0.29**	**4.89**	**266.3**	**7.09**	-	**4.2**	-	-	-	-	-	-
	FD					3/18/2020	**0.29**	**4.89**	**266.3**	**7.09**	-	**4.2**	-	-	-	-	-	-
DMW-3IA	N	56.09	39 to 49	7.09 to 17.09	MW	3/18/2020	**0.61**	**0.14**	**-73.2**	**7.21**	-	**2.4**	-	-	-	-	-	-
DMW-4S	N	61.76	23 to 33	28.76 to 38.6	MW	3/19/2020	**0.41**	**4.97**	**244.6**	**7.69**	-	**19.5**	-	-	-	-	-	-
DMW-5IA	N	69.48	39.8 to 49.8	19.68 to 29.68	MW	3/19/2020	-	-	-	-	-	-	-	-	-	-	-	-
	N					10/15/2020	-	-	-	-	-	-	-	-	-	-	-	-
DMW-6	N	66.30	34 to 44	22.30 to 32.30	MW	3/18/2020	**0.44**	**0.74**	**118.9**	**6.09**	-	**2.8**	-	-	-	-	-	-
DMW-7S	N	58.34	28 to 38	20.34 to 30.34	MW	11/2/2020	**0.47**	**1.18**	**-29.9**	**7.08**	-	**24.2**	-	-	-	-	-	-
DMW-8S	N	58.57	27 to 37	21.57 to 31.57	MW	11/2/2020	**0.30**	**2.95**	**-15.1**	**6.98**	-	**1.2**	-	-	-	-	-	-
DMW-9S	N	58.85	23 to 33	25.85 to 35.85	MW	11/2/2020	**0.52**	**2.75**	**47.3**	**6.83**	-	**3.8**	-	-	-	-	-	-
DMW-10S	N	59.46	35 to 55	4.46 to 24.46	MW	11/2/2020	**0.48**	**1.06**	**-140.4**	**7.80**	-	**24.3**	-	-	-	-	-	-
DMW-11S	N	61.15	30 to 50	11.15 to 31.15	MW	11/2/2020	**0.45**	**4.19**	**-51.9**	**7.70**	-	**7.9**	-	-	-	-	-	-
DMW-12S	N	66.05	30 to 50	16.05 to 36.05	MW	11/2/2020	**0.46**	**0.45**	**-75.1**	**6.93**	-	**24.1**	-	-	-	-	-	-
DMW-13S	N	66.28	30 to 50	16.28 to 36.28	MW	11/3/2020	**0.31**	**4.79**	**91.6**	**6.73**	-	**18.2**	-	-	-	-	-	-
DMW-14S	N	70.29	41 to 51	19.29 to 29.29	MW	11/3/2020	**0.36**	**1.31**	**-81.0**	**6.68**	-	**14.9**	-	-	-	-	-	-
DPP-3	N	55.98	20 to 30	25.98 to 35.98	G	3/6/2019	-	-	-	-	-	-	-	-	-	-	-	-
HC-1	N	62.33	21.5 to 31.5	30.83 to 40.83	G	4/11/2019	-	-	-	-	-	-	-	-	-	-	-	-
HC-4	N	60.23	40 to 50	10.23 to 20.23	MW	4/12/2019	-	-	-	-	-	-	-	-	-	-	-	-
MW-117	N	57.78	40 to 55	2.78 to 17.78	MW	12/18/2013	-	-	-	-	-	-	25 U	**56300**	5 U	**200000**	**2030**	**344**
MW-305	N	60.15	22.8 to 32.8	27.35 to 37.35	MW	10/15/2019	**0.30**	**1.97**	**-10.9**	**6.34**	**16.8**	**99.9**	**1630**	**28,000**	0.678 U	**114,000**	0	**197**
	N					1/15/2020	**0.56**	**3.64**	**59.6**	**6.83**	**6.8**	-	**1020**	**28,600**	0.678 U	**107,000**	0	**98**
	N					4/28/2020	**0.48**	**4.75**	**88.6**	**6.50**	**16.0**	**93**	**2100**	**23,000**	0.678 U	**105,000**	0	**221**
MW-306	N	59.91	42.8 to 52.8	7.11 to 17.11	MW	10/15/2019	**0.47**	**0.31**	**119.4**	**6.64**	**16.9**	**26.7**	100 U	**80,900**	0.678 U	**187,000**	**2500**	**608**
	N					1/16/2020	**0.81**	**0.42**	**3.7**	**7.12**	**13.4**	-	100 U	**77,500**	0.678 U	**185,000**	**2600**	**550**
	N					4/28/2020	**0.59**	**0.44**	**-87.8**	**6.67**	**15.9**	**0.3**	100 U	**75,800**	0.678 U	**192,000**	**300**	**483**
MW-307	N	60.29	72.8 to 82.8	-22.51 to -12.51	MW	10/11/2019	**0.59**	**0.28**	**-540.2**	**8.19**	**16.5**	**101**	100 U	**69,100**	**26.6 J**	**276,000**	0	**149**
	N					1/15/2020	**0.99**	**0.43**	**-125.6**	**8.34**	**10.8**	-	100 U	**64,700**	**12.6**	**266,000**	0	**198**
	N					4/28/2020	**0.75**	**0.80**	**-174.2**	**7.85**	**15.8**	**29**	100 U	**72,000**	**25**	**274,000**	**250**	**172**

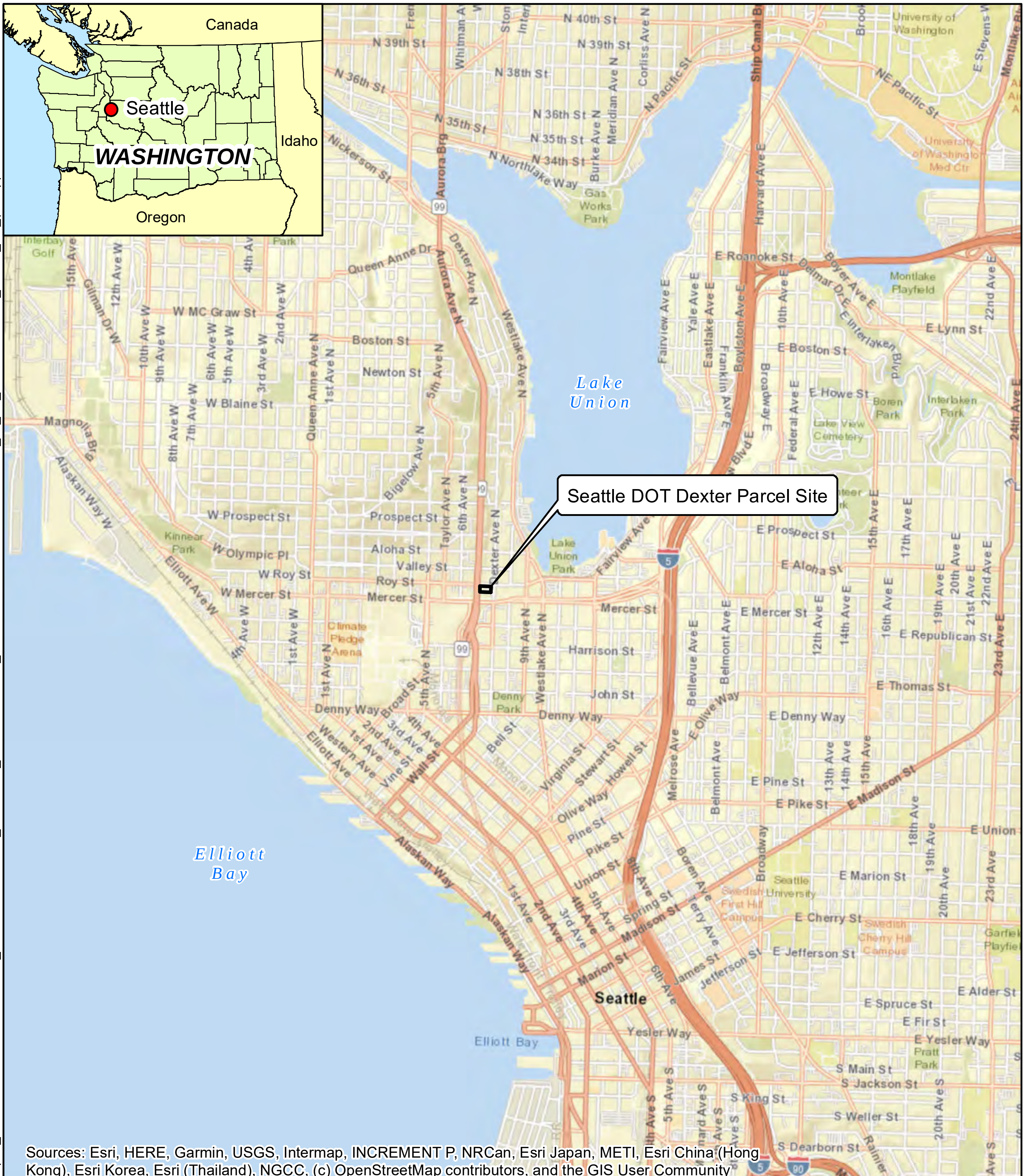
Notes:
Bold indicates a detected concentration at or above the reporting limit.
Elevations relative to North American Vertical Datum of 1988 (NAVD88).
\- = Data not available or applicable.
FD = Field duplicate.
ft = feet.
G = Grab groundwater sample.
J = Value is estimated.
J+ = Value is estimated with a potential high bias. Flag is from PES Environmental's data validation of their data.
mg/L = milligram per liter.
mS/cm = milliSiemen per centimeter.
mV = millivolt.
MW = Monitoring well sample.
N = Primary environmental sample.
NTU = nephelometric turbidity units.
ORP = Oxidation reduction potential.
U = Not detected, value is the laboratory reporting limit.
ug/L = microgram per liter.
Z = No/low level gasoline/petroleum detection; result is likely due to high detections of chlorinated volatile organic compounds. Flag is from PES Environmental's data validation of their data.

TABLE 5-1
ALTERNATIVES EVALUATION AND BENEFITS SCORING
SEATTLE DOT DEXTER PARCEL SITE
SEATTLE, WASHINGTON

Criteria and Weighting[b]	Alternative 1	Alternative 2	Alternative 3
Protectiveness (30%)	Score[a] = 7 This alternative is less protective than Alternative 3 because ISEB and MNA will not reduce risk and attain cleanup standards as quickly as ISCO. Alternative 1 is also less protective than Alternative 2 because residual contamianted soil off-Property will not be excavated and removed, lengthening the time frame for ISEB and MNA to attain cleanup standards.	Score = 9 This alternative achieves the highest level of protectiveness due to the excavation and removal of all COC-contaminated soil on the Site, which will meet cleanup standards for soil in the shortest amount of time.	Score = 8 This alternative is more protective than Alternative 1 because ISCO will attain cleanup standards more quickly than ISEB and MNA.
Permanence (20%)	Score = 7 Contaminated soil removal on-Property reduces mobility of hazardous substances. Natural attenuation will effectively reduce residual soil and groundwater contaminant mass.	Score = 9 Benefits of Alternative 1 plus additional benefit of permanent soil removal off-Property which will further reduce contaminant mobility.	Score = 7 Contaminated soil removal on-Property reduces mobility of hazardous substances. ISCO will effectively reduce residual soil and groundwater contaminant mass.
Effectiveness over the Long Term (20%)	Score = 7 This alternative is less effective over the long term than Alternative 3 because there is less certainty that ISEB and MNA will be successful in attaining cleanup standards than ISCO.	Score = 9 This alternative is the most effective over the long term because there is a higher degree of certainty that it will be successful in attaining cleanup standards than the other alternatives due to the excavation and removal of all COC-contaminated soil on the Site.	Score = 8 This alternative is more effective over the long term than Alternative 1 because there is a higher degree of certainty that ISCO will be successful in attaining cleanup standards than ISEB and MNA.
Management of Short-Term Risks (10%)	Score = 9 Moderate but manageable short-term risks associated with soil excavation on the Property (worker safety, dust and erosion control, etc.). There are low short-term risks associated with ISEB and MNA.	Score = 8 Marginally greater short-term risks compared to Alternative 1 due to excavation of additional soil off-Property and associated structural requirements.	Score = 6 Moderate but manageable short-term risks associated with soil excavation on the Property (worker safety, dust and erosion control, etc). ISCO has more short-term risks than MNA due to amendment handling and injection, particularly when multiple injections are required and when on-Property injections would be conducted at the bottom of the excavation during construction.
Technical and Administrative Implementability (10%)	Score = 9 This alternative is more implementable than Alternative 3 because MNA has less regulatory requirements, less access and scheduling issues, and is less complex than ISCO. This alternative is also more implementable than Alternative 2 because it requires less excavation.	Score = 7 This alternative is more implementable than Alternative 3 because MNA has less regulatory requirements, less access and scheduling issues, and is less complex than ISCO. This alternative is less implementable than Alternative 1 because the excavation of additional soil off-Property would add complexity and access and scheduling concerns.	Score = 4 This alternative is less implementable than other alternatives because ISCO has more regulatory requirements (e.g., underground injection control regulation), more access and scheduling issues to inject amendments in multiple applications in ROWs, and is more complex than MNA.
Consideration of Public Concerns[c] (10%)	Score = 7 This alternative is anticipated to meet public concerns to a slightly lesser degree than Alternatives 2 and 3 because ISEB and MNA is expected to attain cleanup standards more slowly than excavation and MNA or ISCO.	Score = 8 This alternative is anticipated to meet public concerns the most (tied with Alternative 3) because it is expected to attain soil cleanup standards the fastest. Alternatives 2 and 3 are tied because they are anticipated to have about the same public disruption in the alley from excavation and off-site disposal (Alternative 2) and ISCO injections (Alternative 3).	Score = 8 This alternative is anticipated to meet public concerns the most (tied with Alternative 2) because it is expected to attain groundwater cleanup standards the fastest. Alternatives 2 and 3 are tied because they are anticipated to have about the same public disruption in the alley from excavation and off-site disposal (Alternative 2) and ISCO injections (Alternative 3).
Total Weighted Benefit Score[d]	7.4	8.6	7.2
Estimated Cost[e]	1,668,000	2,107,000	1,809,000
Benefit/Cost Ratio[f]	4.44	4.08	3.98

Notes:
a. Ranking score based on relative ability to achieve criteria on 1 (lowest) to 10 (highest) scale.
b. Weighting factors based on professional judgement. See justification described in Section 5.4.1.
c. Ecology considers and responds to all public comments received on the DCAP and PPCD as part of the cleanup process under MTCA. Because public comments have not yet been received, consideration of public concerns regarding the cleanup action alternatives is preliminary included in this document.
d. Total weighted benefit score is obtained by multiplying the rating for each criterion by its weighting factor, and summing the results for the six criteria.
e. Net present value costs are estimated in 2021 dollars, and were calculated using a two percent discount rate. Itemized estimates are provided in Tables 4-2a through 4-2c.
f. The benefit/cost ratio is obtained by dividing the alternative's total weighted benefit score by its estimated cost (in $million).
DCAP = Draft Cleanup Action Plan.
Ecology = Washington State Department of Ecology.
FS = Feasibility Study.
ISCO = In Situ Chemical Oxidation.
ISEB = In Situ Enhanced Bioremediation.
MNA = Monitored Natural Attenuation.
MTCA = Model Toxics Control Act.
PPCD = Prospective Purchaser Consent Decree.
RI = Remedial Investigation.
ROW = Right of way.

Document Path: \\haleyaldrich.com\share\pdx_data\Geomatics\GEOSPATIAL_LIBRARY\MASTER_PROJECT_FILES\MERCER_MEGABLOCK\1940904\MGIS\2021_10_FS_DX\1940904-FS_Dexter_AA_(VMap).mxd Date: 10/11/2021 User Name:



0 0.25 0.5 1
Miles

N

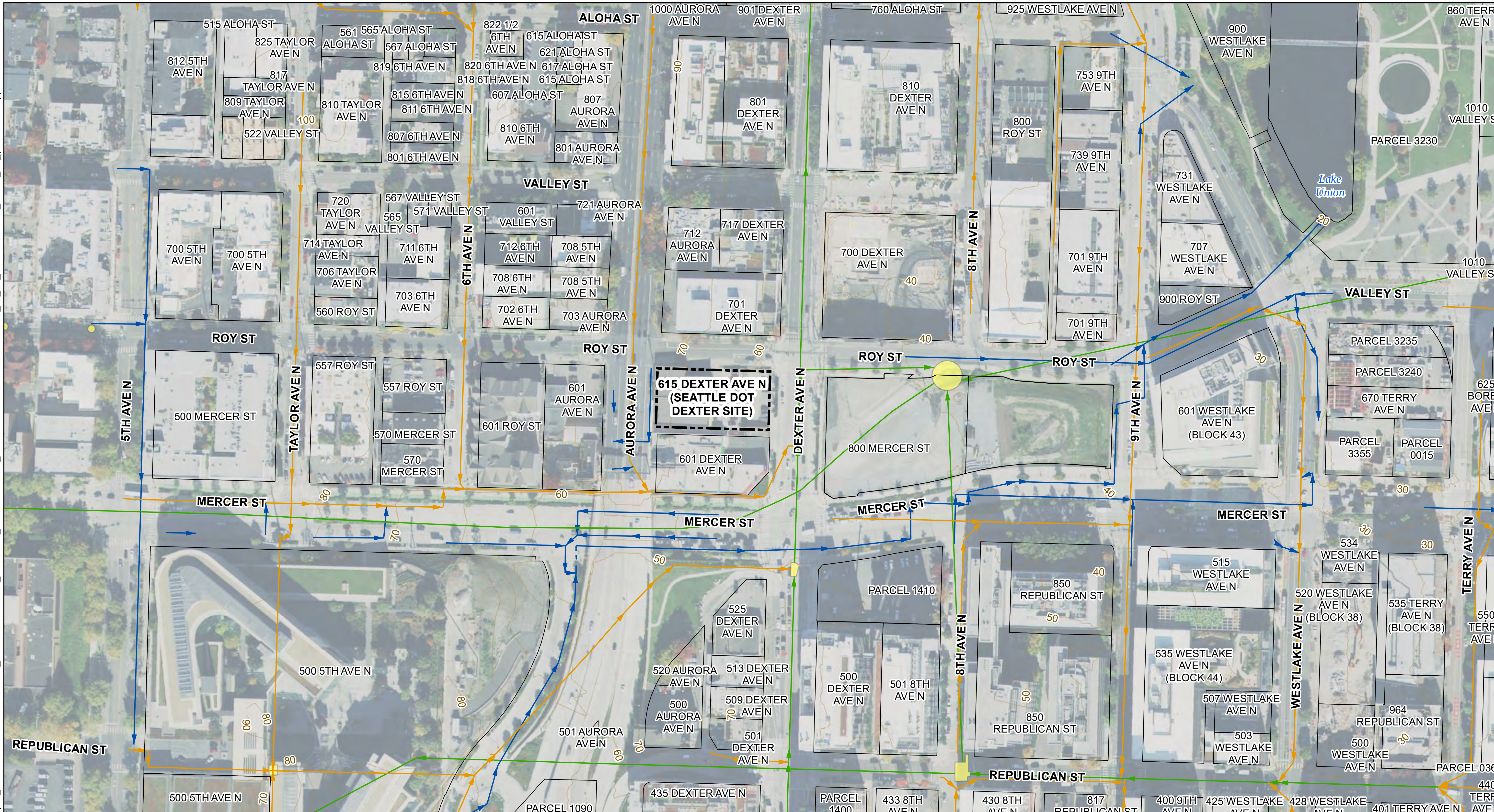
Seattle DOT Dexter Parcel Site
Seattle, Washington

Vicinity Map

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure
1-1



Legend

- Other Parcel Boundary
- Property Boundary

Underground Sewer Lines

- King County Main
- SPU Drainage Main
- SPU Combined Main

- King County Main Facility Structures
- Elevation Contour, 10 ft. (King County LiDAR, 2016)

0 90 180 360 Feet

N

Sources: Aerial photograph provided by Hexagon Imagery Program Data. Address information obtained from King County GIS Open Data portal's Parcel Address Area shapefile, published April 4, 2019. Stormwater line data obtained from City of Seattle ArcGIS Online data, published August 6, 2019.

Seattle DOT Dexter Parcel Site
Seattle, Washington

Site Conditions Map

19409-04 10/21

HARTCROWSER
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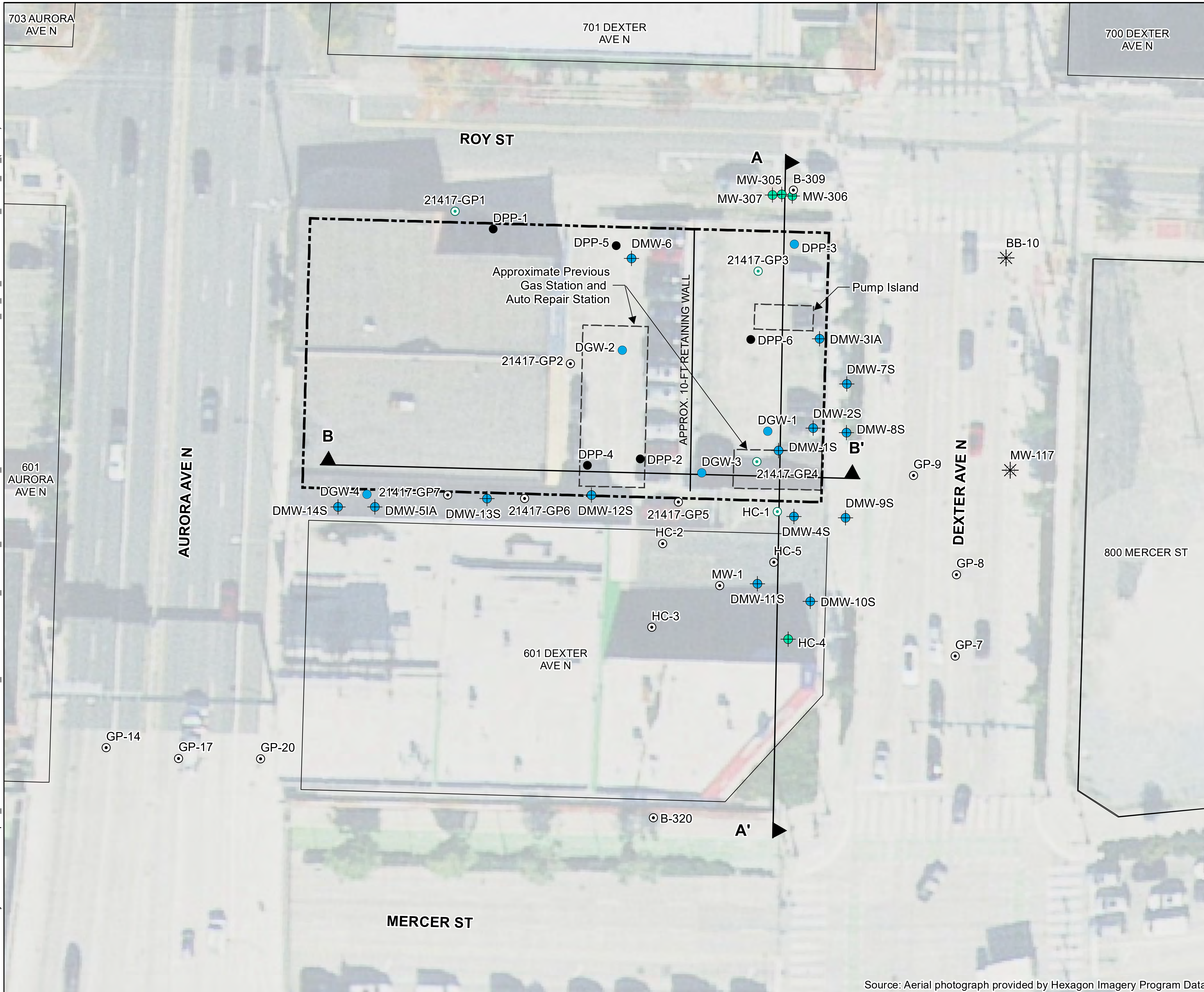
Figure
2-1



Legend

RI Investigations

- Soil Boring
- Soil Boring with Grab Groundwater Sample
- Monitoring Well

Other Investigations

- Soil Boring
- Soil Boring with Grab Groundwater Sample
- Monitoring Well
- Abandoned or Decommissioned Monitoring Well
- Cross Section
- Historical Contaminant Source
- Other Parcel Boundary
- Property Boundary

0 20 40 80 Feet

N

Seattle DOT Dexter Parcel Site
Seattle, Washington

Investigation Locations

19409-04 10/21

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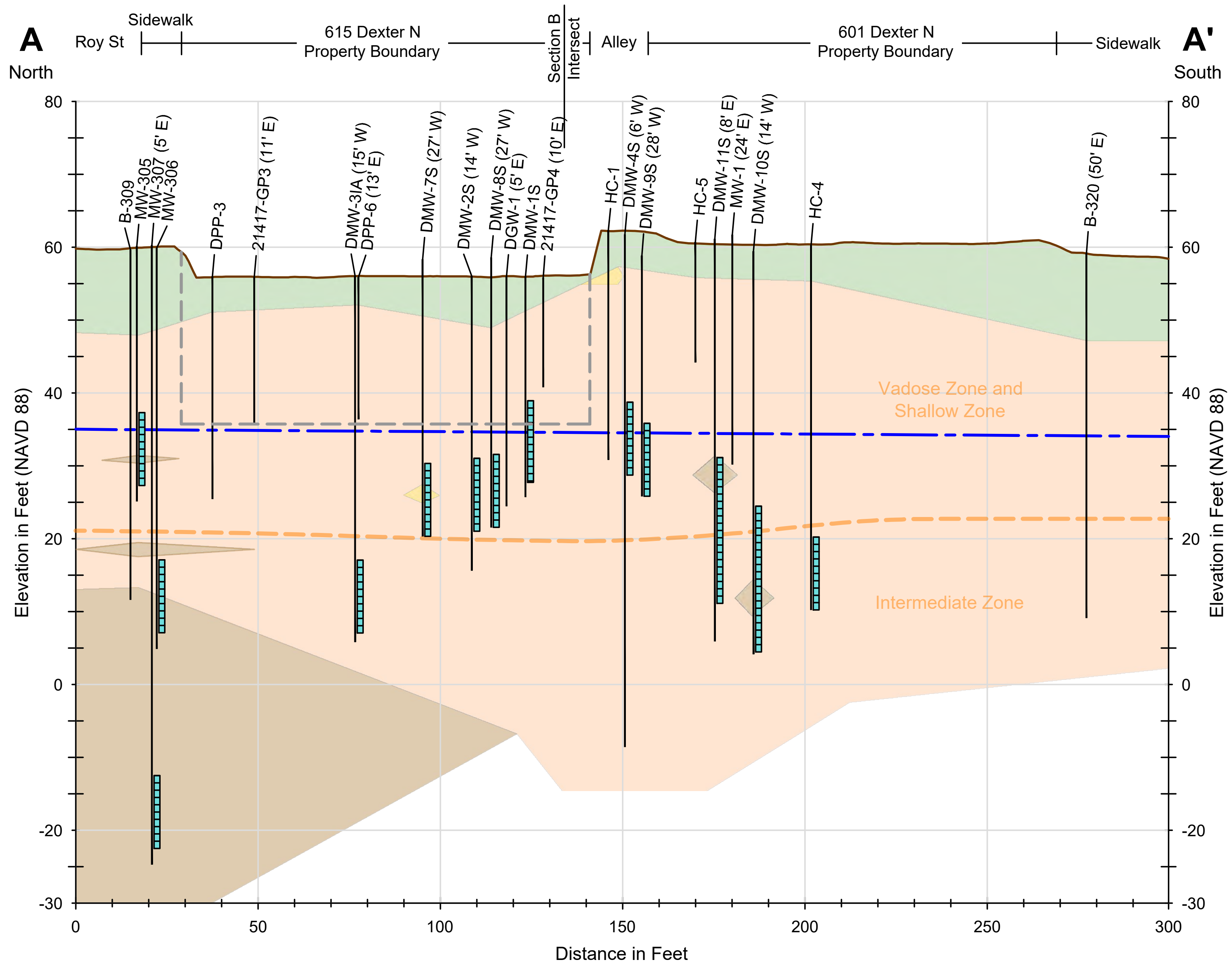
Figure **2-2**

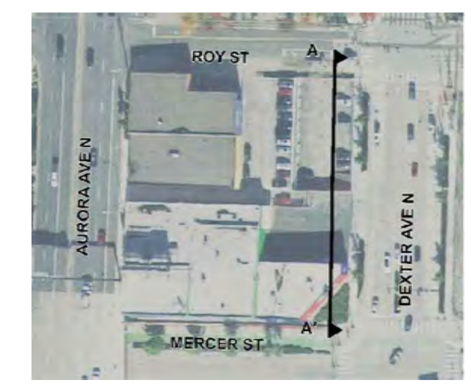


Legend

- Boring Name with Offset (e.g. MW-1 (15' W))
- Boring Location
- Approximate Average Water Table (25ft bgs)
- Inferred Groundwater Zone Boundary
- Screen Interval
- Approximate Limits of Proposed Excavation and Vapor Barrier Area at Seattle DOT Dexter Parcel Site ("Seattle DOT Dexter Parcel," Collins Woerman, 06/25/2020)

Geologic Units (Predominant Component)

- Fill
- Clean Sand and/or Gravel
- Silty Sand and Silty Gravel
- Silt and/or Clay with or without Sand



INSET MAP

Horizontal Scale in Feet
0 40 80

0 20 40
Vertical Scale in Feet
Vertical Exaggeration x 2

Explorations DMW-2S, DMW-8S, DMW-9S, DMW-11S, DGW-1, HC-1, MW-306, and MW-307 have been shifted horizontally for visual clarity.

Seattle DOT Dexter Parcel Site
Seattle, Washington

Geological Cross Section A-A'

19409-04 10/21

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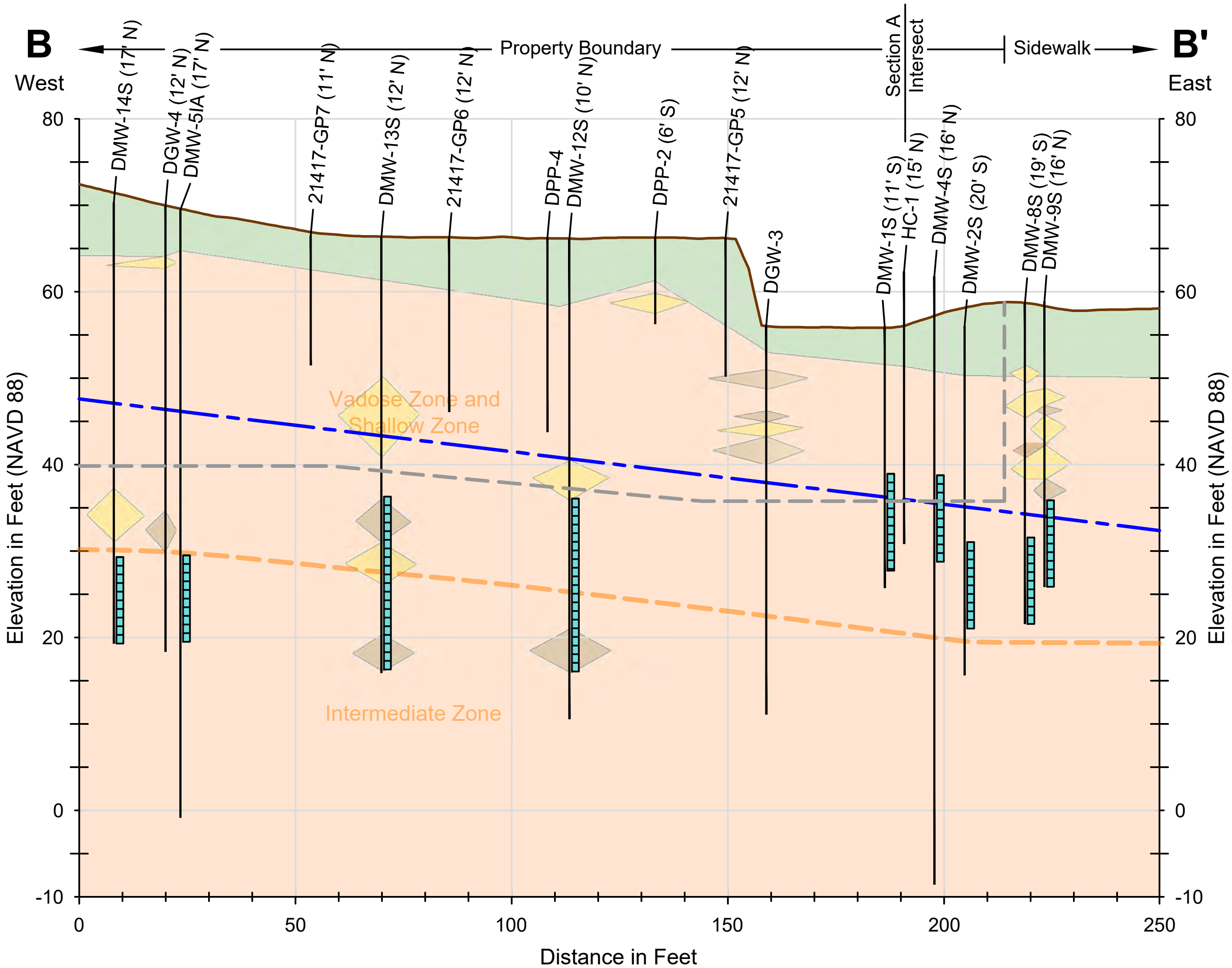
Figure
2-3a



Legend

Boring Name with Offset — MW-1(15' W)

Boring Location

Approximate Average Water Table (25ft bgs)

Inferred Groundwater Zone Boundary

Screen Interval

Geologic Units (Predominant Component)

- Fill
- Clean Sand and/or Gravel
- Silty Sand and Silty Gravel
- Silt and/or Clay with or without Sand

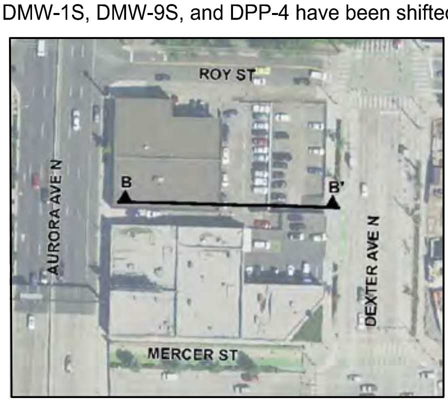
Approximate Limits of Proposed Excavation and Vapor Barrier Area at Seattle DOT Dexter Parcel Site ("Seattle DOT Dexter Parcel," Collins Woerman, 06/25/2020)

Horizontal Scale in Feet: 0, 40, 80

Vertical Scale in Feet: 0, 20, 40

Vertical Exaggeration x 2

Explorations DMW-1S, DMW-9S, and DPP-4 have been shifted horizontally for visual clarity.



INSET MAP

Seattle DOT Dexter Parcel Site
Seattle, Washington

Geological Cross Section B-B'

19409-04 | 10/21

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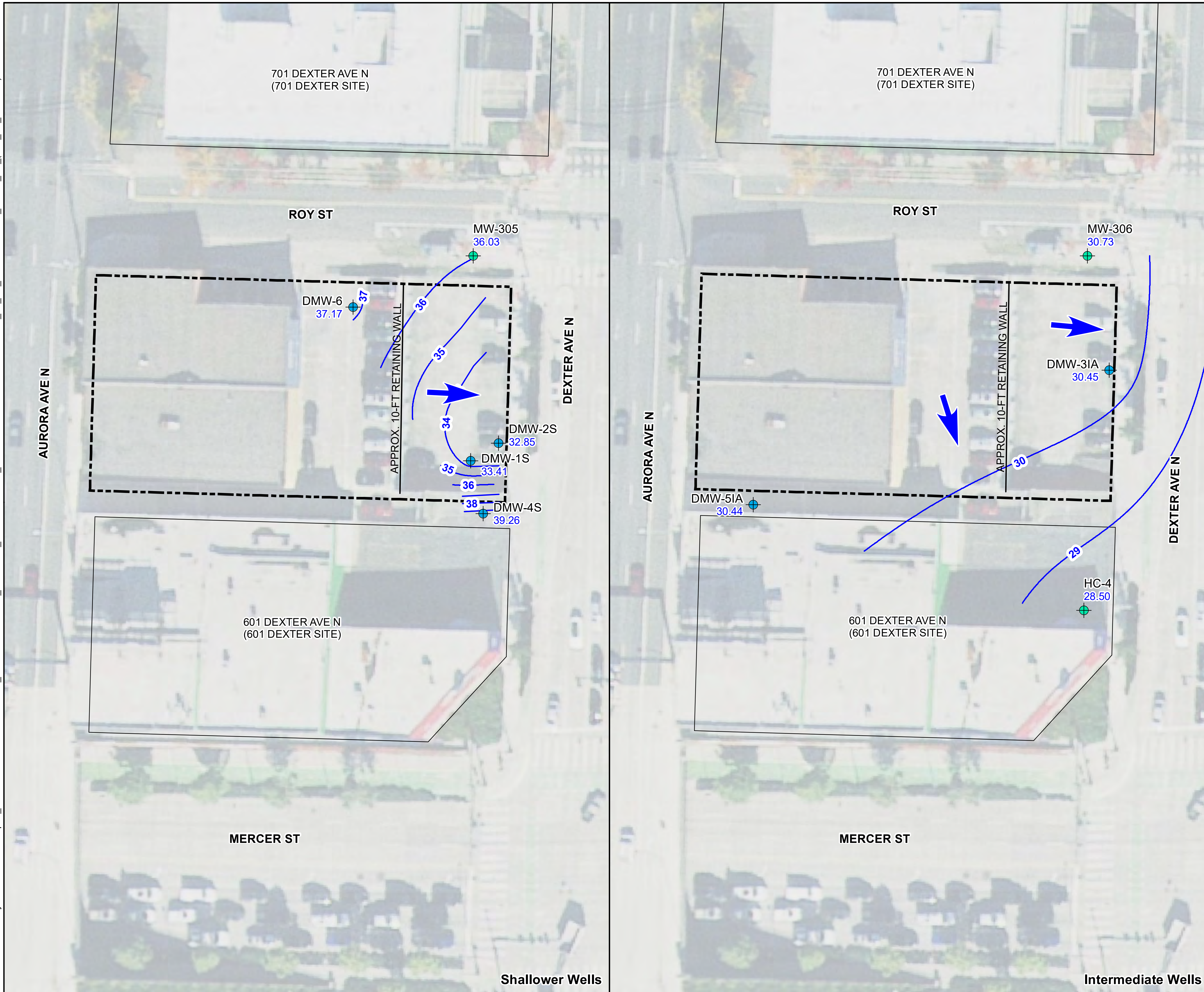
Figure **2-3b**

File: \\haleyaldrich.com\share\sea_projects\Notebooks\1940904_Mercer_Mega_Block_Remedial_Investigations\CAD\1940904-013 FS (XSec-Dexter).dwg Layout:FS-SEC_DexB Date: 10-11-2021 Author: mschweitzer



Legend

RI Investigations

Monitoring Well

Other Investigations

Monitoring Well

32.85 Groundwater Elevation (March 19, 2020)

Groundwater Elevation Contour

Groundwater Flow Direction

Other Property Boundary

Property Boundary

Note:
Elevations are in NAVD 88, feet.

0 25 50 100
Feet

N

Source: Aerial photograph provided by Hexagon Imagery Program Data.

Seattle DOT Dexter Parcel Site
Seattle, Washington

Water Level Elevations
March 2020

19409-04 10/21

HARTCROWSER
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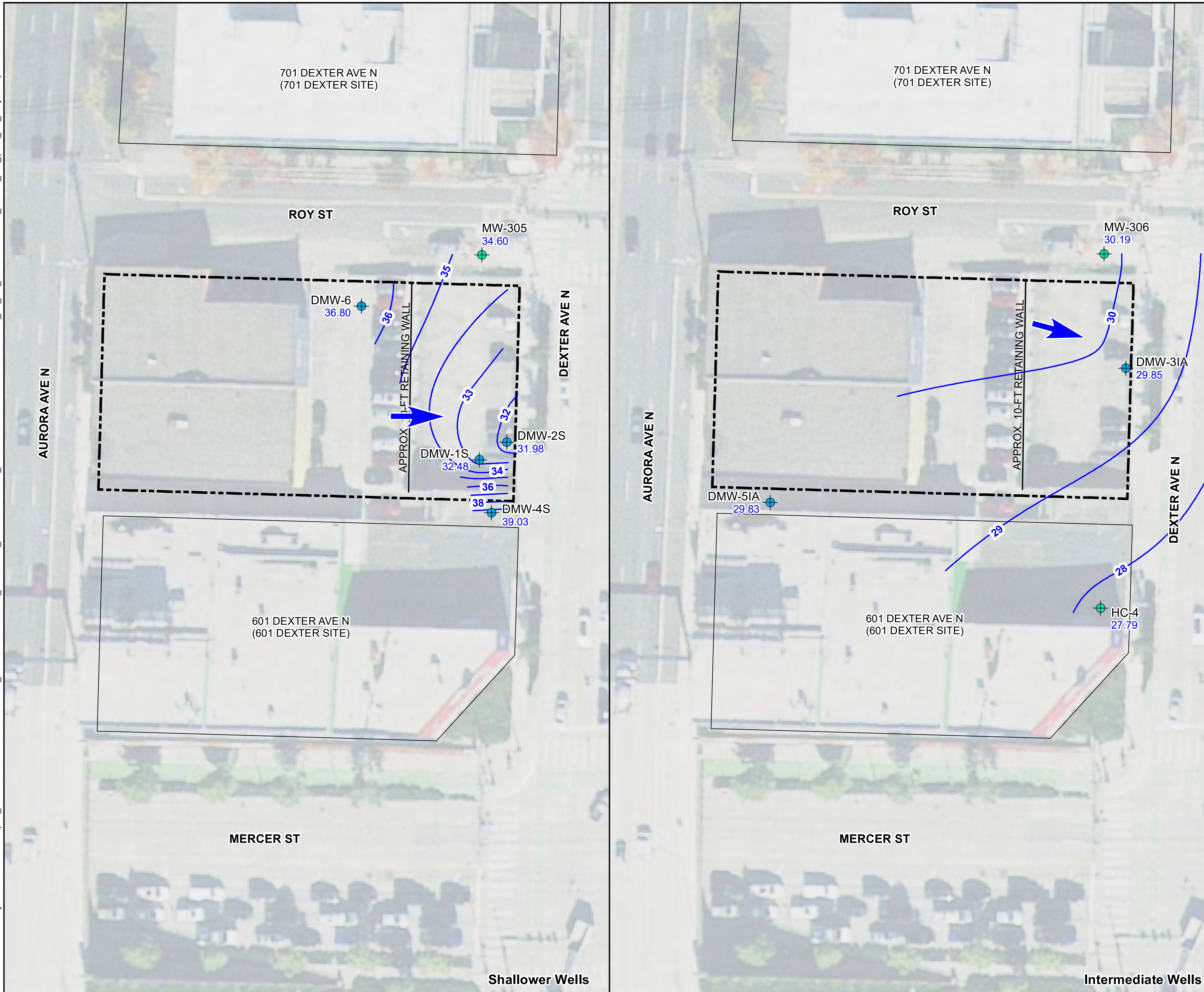
Figure
2-4a



Legend

RI Investigations

- Monitoring Well

Other Investigations

- Monitoring Well
- 32.85 Groundwater Elevation (May 11, 2020)
- Groundwater Elevation Contour
- Groundwater Flow Direction
- Other Property Boundary
- Property Boundary

Note:
Elevations are in NAVD 88, feet.

N

0 25 50 100 Feet

Source: Aerial photograph provided by Hexagon Imagery Program Data.

Seattle DOT Dexter Parcel Site
Seattle, Washington

Water Level Elevations
May 2020

19409-04 10/21

HARTCROWSER
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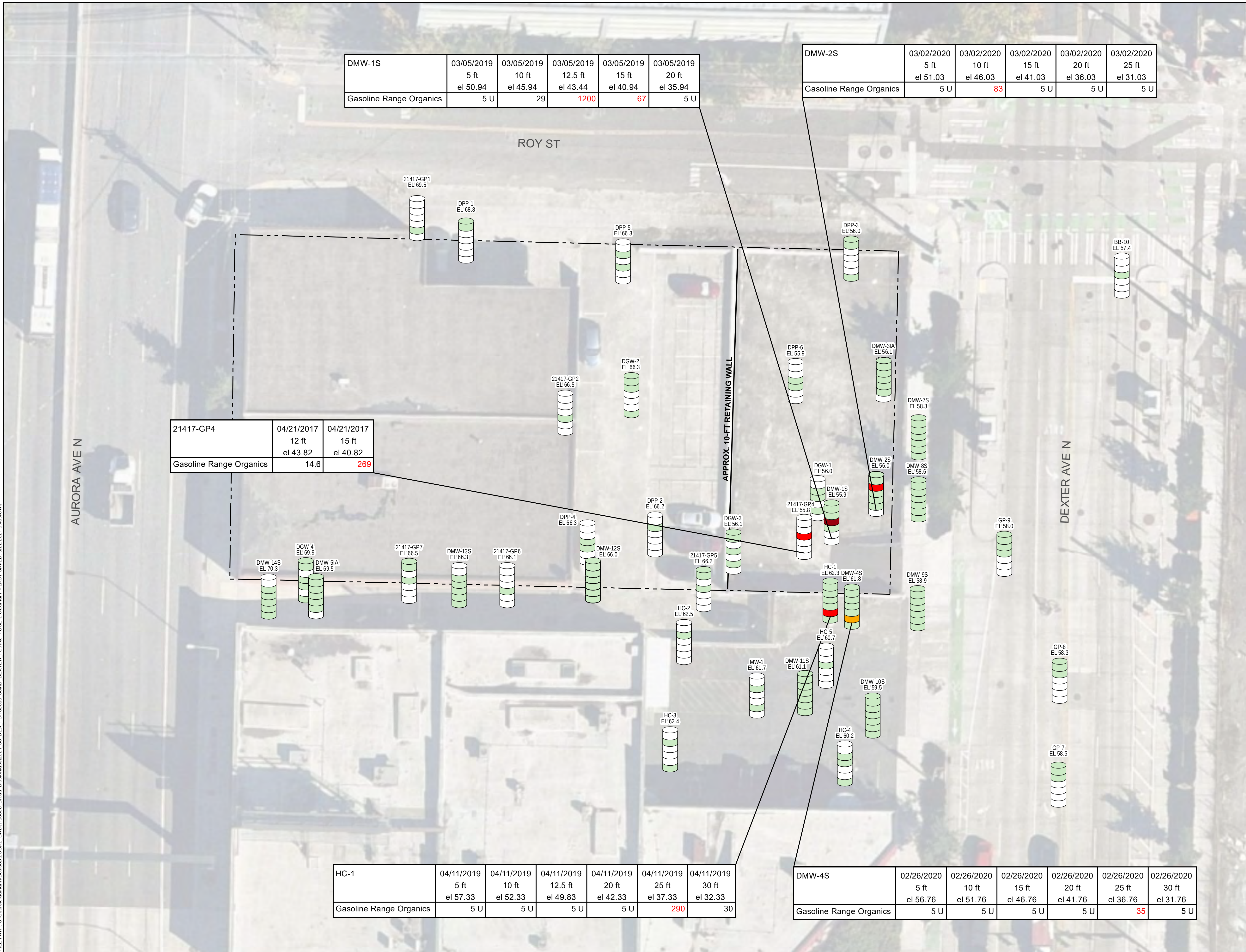
Figure
2-4b



DMW-1S	03/05/2019 5 ft el 50.94	03/05/2019 10 ft el 45.94	03/05/2019 12.5 ft el 43.44	03/05/2019 15 ft el 40.94	03/05/2019 20 ft el 35.94
Gasoline Range Organics	5 U	29	1200	67	5 U

DMW-2S	03/02/2020 5 ft el 51.03	03/02/2020 10 ft el 46.03	03/02/2020 15 ft el 41.03	03/02/2020 20 ft el 36.03	03/02/2020 25 ft el 31.03
Gasoline Range Organics	5 U	83	5 U	5 U	5 U

21417-GP4	04/21/2017 12 ft el 43.82	04/21/2017 15 ft el 40.82
Gasoline Range Organics	14.6	269

HC-1	04/11/2019 5 ft el 57.33	04/11/2019 10 ft el 52.33	04/11/2019 12.5 ft el 49.83	04/11/2019 20 ft el 42.33	04/11/2019 25 ft el 37.33	04/11/2019 30 ft el 32.33
Gasoline Range Organics	5 U	5 U	5 U	5 U	290	30

DMW-4S	02/26/2020 5 ft el 56.76	02/26/2020 10 ft el 51.76	02/26/2020 15 ft el 46.76	02/26/2020 20 ft el 41.76	02/26/2020 25 ft el 36.76	02/26/2020 30 ft el 31.76
Gasoline Range Organics	5 U	5 U	5 U	5 U	35	5 U

LEGEND

GRO IN SOIL (mg/kg)

- ≥ 300
- ≥ 60 TO 300
- ≥ 30 TO 60
- ND/0 TO < 30 (PROTECTIVE OF GROUNDWATER SCREENING LEVEL)
- NO DATA

SAMPLE DEPTH INTERVALS

- ≤ 5 FT BELOW GROUND SURFACE (BGS)
- 5 TO 10
- 10 TO 15
- 15 TO 20
- 20 TO 25
- > 25
- PROPERTY BOUNDARY

SCREENING LEVELS FOR GASOLINE RANGE ORGANICS (GRO) IN SOIL (mg/kg)	
ZONE	PROTECTIVE OF GW
Vadose (0 to 25 ft bgs) and Saturated (>25 ft bgs)	30

RED TEXT INDICATES EXCEEDANCE OF PROTECTIVE OF GROUNDWATER SCREENING LEVEL

SCREENING LEVEL SELECTION PROCESS IS DISCUSSED IN THE RI REPORT

DEPTH IN FEET BELOW GROUND SURFACE (BGS)

ELEVATION IN FEET (NAVD 88)

U = NON-DETECT AT DETECTION LIMIT AS INDICATED

AERIAL IMAGERY SOURCE: NEARMAP, AUGUST 28, 2020

0 15 30 60 Feet

N

Seattle DOT Dexter Parcel Site
Seattle, Washington

GRO Distribution in Soil

19409-04 06/21

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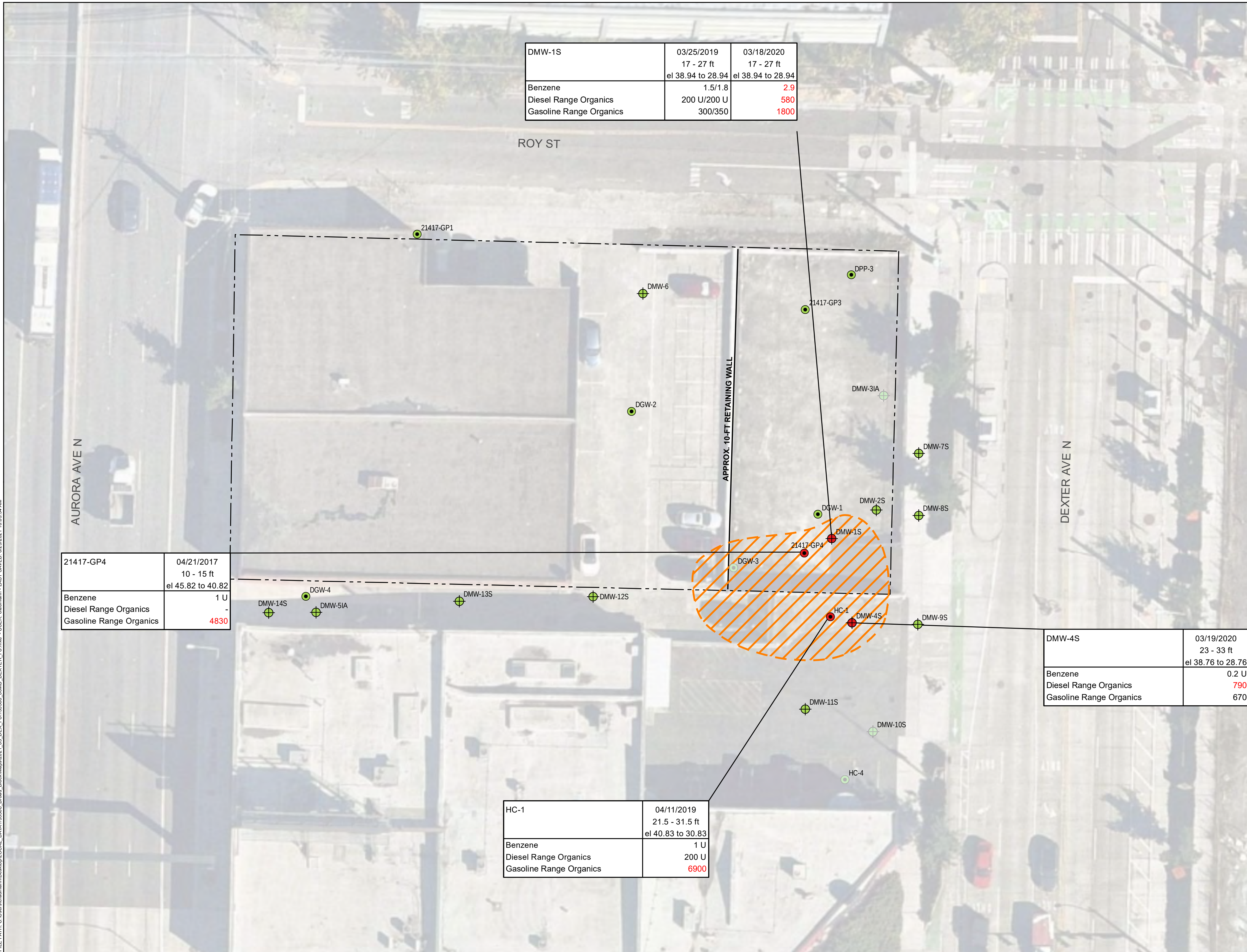
Figure **2-5**



DMW-1S	03/25/2019 17 - 27 ft el 38.94 to 28.94	03/18/2020 17 - 27 ft el 38.94 to 28.94
Benzene	1.5/1.8	2.9
Diesel Range Organics	200 U/200 U	580
Gasoline Range Organics	300/350	1800

21417-GP4	04/21/2017 10 - 15 ft el 45.82 to 40.82
Benzene	1 U
Diesel Range Organics	-
Gasoline Range Organics	4830

DMW-4S	03/19/2020 23 - 33 ft el 38.76 to 28.76
Benzene	0.2 U
Diesel Range Organics	790
Gasoline Range Organics	670

HC-1	04/11/2019 21.5 - 31.5 ft el 40.83 to 30.83
Benzene	1 U
Diesel Range Organics	200 U
Gasoline Range Organics	6900

LEGEND

- SOIL BORING, ANALYZED BUT WITHOUT EXCEEDANCE
- SOIL BORING, WITH EXCEEDANCE
- MONITORING WELL, ANALYZED BUT WITHOUT EXCEEDANCE
- MONITORING WELL, WITH EXCEEDANCE
- SHADED-BACK LOCATIONS ARE AT A DIFFERENT ELEVATION THAN THE EXCEEDANCES AND WERE NOT USED TO DEFINE THE EXTENT OF CONTAMINATION
- APPROXIMATE DISTRIBUTION OF GRO, DRO, AND BENZENE EXCEEDANCES IN GROUNDWATER
- PROPERTY BOUNDARY

SCREENING LEVELS FOR GRO, DRO, AND BENZENE GROUNDWATER (μg/L)

CONSTITUENT	PROTECTIVE OF DRINKING WATER	PROTECTIVE OF INDOOR AIR
Gasoline Range Organics (GRO)	800	-
Diesel Range Organics (DRO)	500	-
Benzene	5	2.4

DATA SHOWN IS FROM 2017-2020

RED TEXT INDICATES EXCEEDANCE OF PROTECTIVE OF DRINKING WATER OR INDOOR AIR SCREENING LEVELS

CONCENTRATIONS SHOWN IN MICROGRAMS PER LITER (μg/L)

SCREENING LEVEL SELECTION PROCESS IS DISCUSSED IN THE RI REPORT

DEPTH IN FEET BELOW GROUND SURFACE (BGS)

ELEVATION IN FEET (NAVD 88)

U = NON-DETECT AT DETECTION LIMIT AS INDICATED
J = ESTIMATED VALUE
- = ANALYTE WAS NOT ANALYZED
/ = MULTIPLE RESULTS INDICATE THAT A FIELD DUPLICATE WAS TAKEN

AERIAL IMAGERY SOURCE: NEARMAP, AUGUST 28, 2020

0 15 30 60 Feet

N

Seattle DOT Dexter Parcel Site
Seattle, Washington

GRO, DRO, and Benzene Distribution in Groundwater

19409-04 06/21

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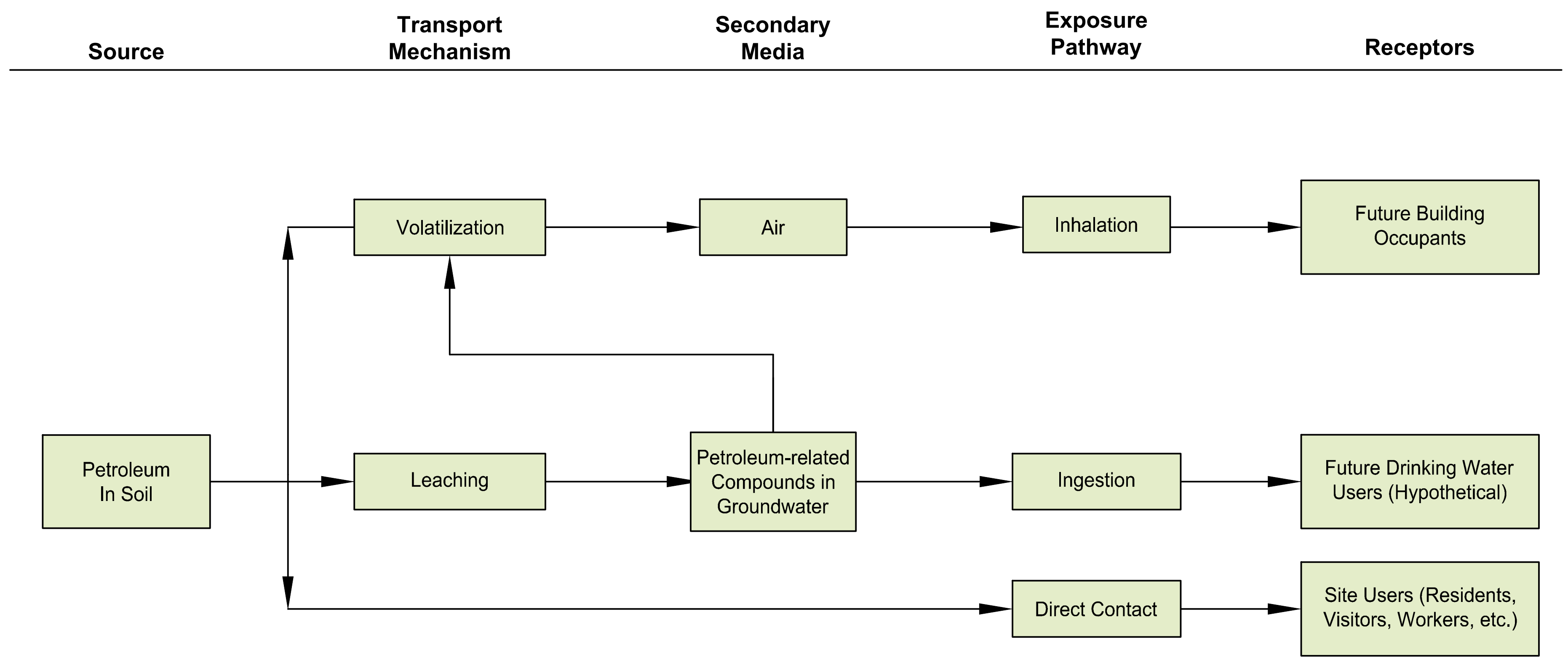
Figure **2-6**



Seattle DOT Dexter Parcel Site
Seattle, Washington

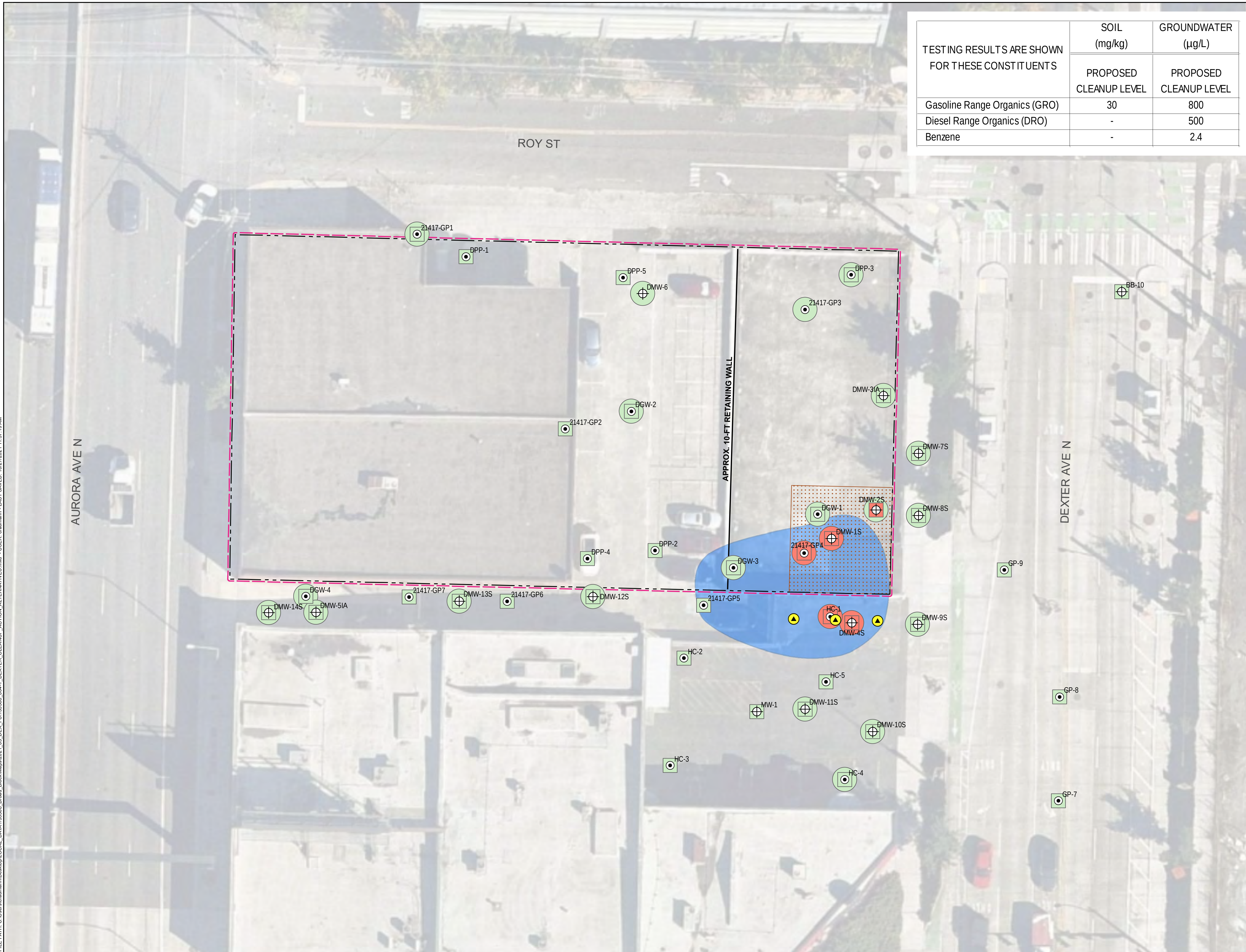
Sources, Pathways, and Receptors

19409-04 10/21

HARTCROWSER A division of Haley & Aldrich

Figure **2-7**

TESTING RESULTS ARE SHOWN FOR THESE CONSTITUENTS	SOIL (mg/kg)	GROUNDWATER (µg/L)
	PROPOSED CLEANUP LEVEL	PROPOSED CLEANUP LEVEL
Gasoline Range Organics (GRO)	30	800
Diesel Range Organics (DRO)	-	500
Benzene	-	2.4



LEGEND

- SOIL BORING
- MONITORING WELL

TESTING RESULTS

- SOIL TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- SOIL TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- APPROXIMATE LOCATION OF OXYGEN RELEASE COMPOUND (ORC) INJECTION POINT
- APPROXIMATE AREA OF MONITORED NATURAL ATTENUATION (MNA)
- APPROXIMATE AREA OF EXCAVATION AND OFF-SITE DISPOSAL OF ON-PROPERTY SOIL WITH CONCENTRATIONS OF COCs ABOVE PROPOSED CLEANUP LEVELS
- PROPOSED REDEVELOPMENT EXCAVATION, BUILDING FOOTPRINT, AND VAPOR BARRIER AREA
- PROPERTY BOUNDARY

ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

GROUNDWATER IN 21417-GP4 IS AT A HIGHER ELEVATION AND WILL BE REMVOED DURING PROPERTY EXCAVATION

DGW-3 IS AT A DIFFERENT ELEVATION THAN THE EXCEEDANCES AND WAS NOT USED TO DEFINE THE EXTENT OF CONTAMINATION

COC = CONSTITUENT OF CONCERN

AERIAL IMAGERY SOURCE: NEARMAP, AUGUST 28, 2020

0 15 30 60 Feet

N

Seattle DOT Dexter Parcel Site
Seattle, Washington

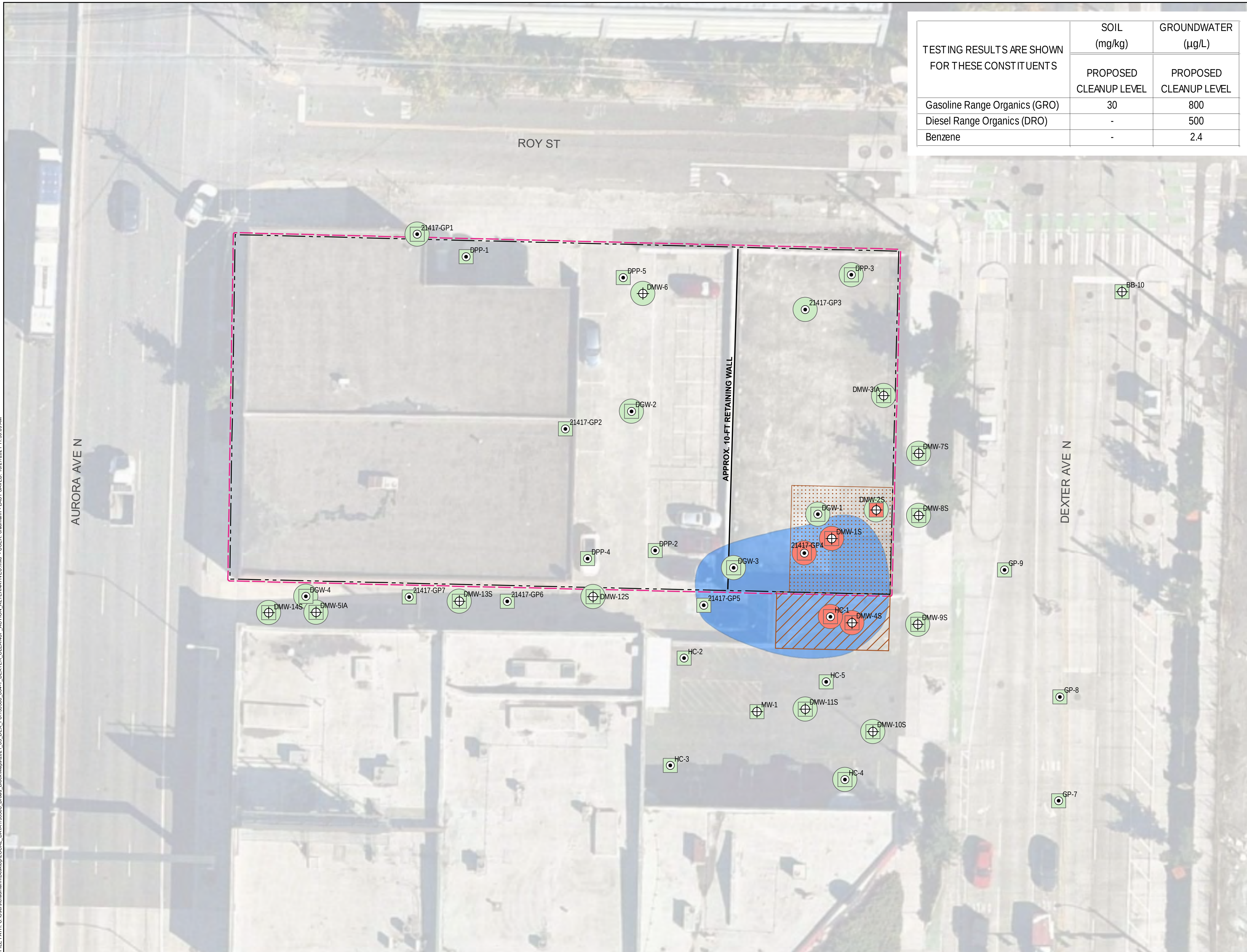
Cleanup Action Alternative 1

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure
4-1

GIS FILE PATH: C:\Users\craumann\Desktop\LOCAL_DATA\135568_Broad_Block\Maps\2021_05_DEX_FS\135568_004-1_DEXTER_CLEANUP_ACTION_ALTERNATIVES.mxd - USER: craumann - LAST SAVED: 10/27/2021 11:57:19 AM



TESTING RESULTS ARE SHOWN FOR THESE CONSTITUENTS	SOIL (mg/kg) PROPOSED CLEANUP LEVEL	GROUNDWATER (µg/L) PROPOSED CLEANUP LEVEL
Gasoline Range Organics (GRO)	30	800
Diesel Range Organics (DRO)	-	500
Benzene	-	2.4

LEGEND

- SOIL BORING
- MONITORING WELL

TESTING RESULTS

- SOIL TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- SOIL TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- APPROXIMATE AREA OF EXCAVATION AND OFF-SITE DISPOSAL OF OFF-PROPERTY SOIL WITH CONCENTRATIONS OF COCs ABOVE PROPOSED CLEANUP LEVELS
- APPROXIMATE AREA OF MONITORED NATURAL ATTENUATION (MNA)
- APPROXIMATE AREA OF EXCAVATION AND OFF-SITE DISPOSAL OF ON-PROPERTY SOIL WITH CONCENTRATIONS OF COCs ABOVE PROPOSED CLEANUP LEVELS
- PROPOSED REDEVELOPMENT EXCAVATION, BUILDING FOOTPRINT, AND VAPOR BARRIER AREA
- PROPERTY BOUNDARY

ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

GROUNDWATER IN 21417-GP4 IS AT A HIGHER ELEVATION AND WILL BE REMVOED DURING PROPERTY EXCAVATION

DGW-3 IS AT A DIFFERENT ELEVATION THAN THE EXCEEDANCES AND WAS NOT USED TO DEFINE THE EXTENT OF CONTAMINATION

COC = CONSTITUENT OF CONCERN

AERIAL IMAGERY SOURCE: NEARMAP, AUGUST 28, 2020

0 15 30 60 Feet

N

Seattle DOT Dexter Parcel Site
Seattle, Washington

Cleanup Action Alternative 2

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure
4-2

TESTING RESULTS ARE SHOWN FOR THESE CONSTITUENTS	SOIL (mg/kg) PROPOSED CLEANUP LEVEL	GROUNDWATER (µg/L) PROPOSED CLEANUP LEVEL
Gasoline Range Organics (GRO)	30	800
Diesel Range Organics (DRO)	-	500
Benzene	-	2.4

LEGEND

- SOIL BORING
- MONITORING WELL

TESTING RESULTS

- SOIL TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- SOIL TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITHOUT EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- GROUNDWATER TESTED, WITH EXCEEDANCE OF PROPOSED CLEANUP LEVEL
- APPROXIMATE LOCATION OF IN SITU CHEMICAL OXIDATION INJECTION POINT
- APPROXIMATE AREA OF EXCAVATION AND OFF-SITE DISPOSAL OF ON-PROPERTY SOIL WITH CONCENTRATIONS OF COCs ABOVE PROPOSED CLEANUP LEVELS
- PROPOSED REDEVELOPMENT EXCAVATION, BUILDING FOOTPRINT, AND VAPOR BARRIER AREA
- PROPERTY BOUNDARY

ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE

GROUNDWATER IN 21417-GP4 IS AT A HIGHER ELEVATION AND WILL BE REMVOED DURING PROPERTY EXCAVATION

DGW-3 IS AT A DIFFERENT ELEVATION THAN THE EXCEEDANCES AND WAS NOT USED TO DEFINE THE EXTENT OF CONTAMINATION

COC = CONSTITUENT OF CONCERN

AERIAL IMAGERY SOURCE: NEARMAP, AUGUST 28, 2020

N

0 15 30 60 Feet

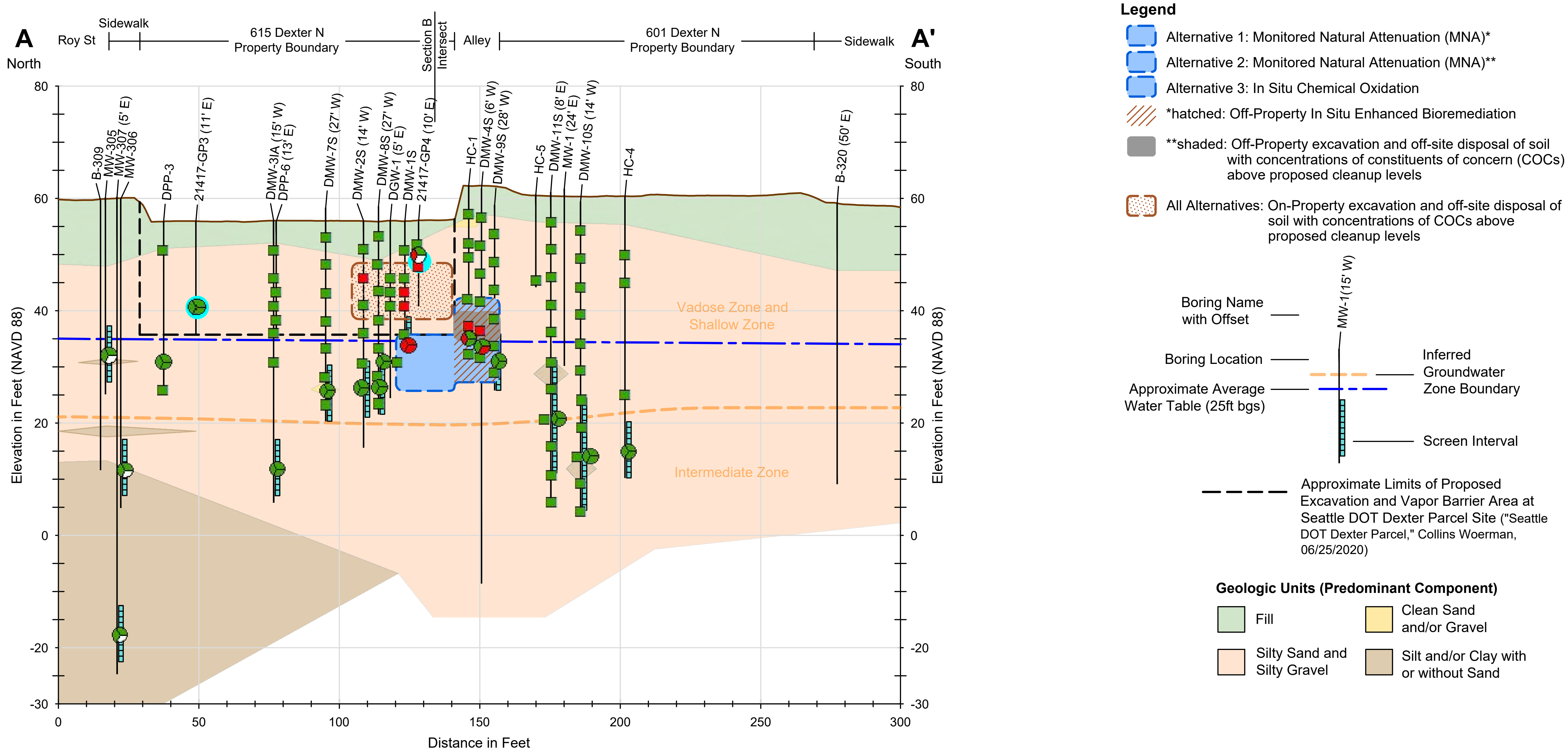
Seattle DOT Dexter Parcel Site
Seattle, Washington

Cleanup Action Alternative 3

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure
4-3



Soil	Proposed Cleanup Level (mg/kg)
Gasoline Range Organics (GRO)[1]	30

GW	Proposed Cleanup Level (µg/L)
Gasoline Range Organics (GRO)[2]	800
Diesel Range Organics (DRO)[2]	500
Benzene[3]	2.4

[1] Protective of Groundwater
[2] Protective of Drinking Water
[3] Protective of Indoor Air

GROUNDWATER SAMPLE

GRO — Benzene — DRO

SOIL SAMPLE

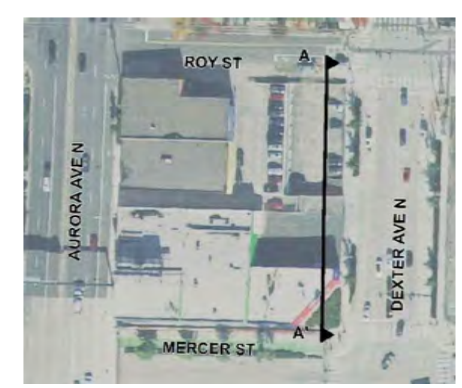
GRO

green = Constituent(s) below proposed cleanup level

red = Constituent(s) above proposed cleanup level

white = Constituent(s) not tested

= Perched groundwater



INSET MAP

Explorations DMW-2S, DMW-8S, DMW-9S, DMW-11S, DGW-1, HC-1, MW-306, and MW-307 have been shifted horizontally for visual clarity.

Horizontal Scale in Feet
0 40 80
0 20 40
Vertical Scale in Feet
Vertical Exaggeration x 2

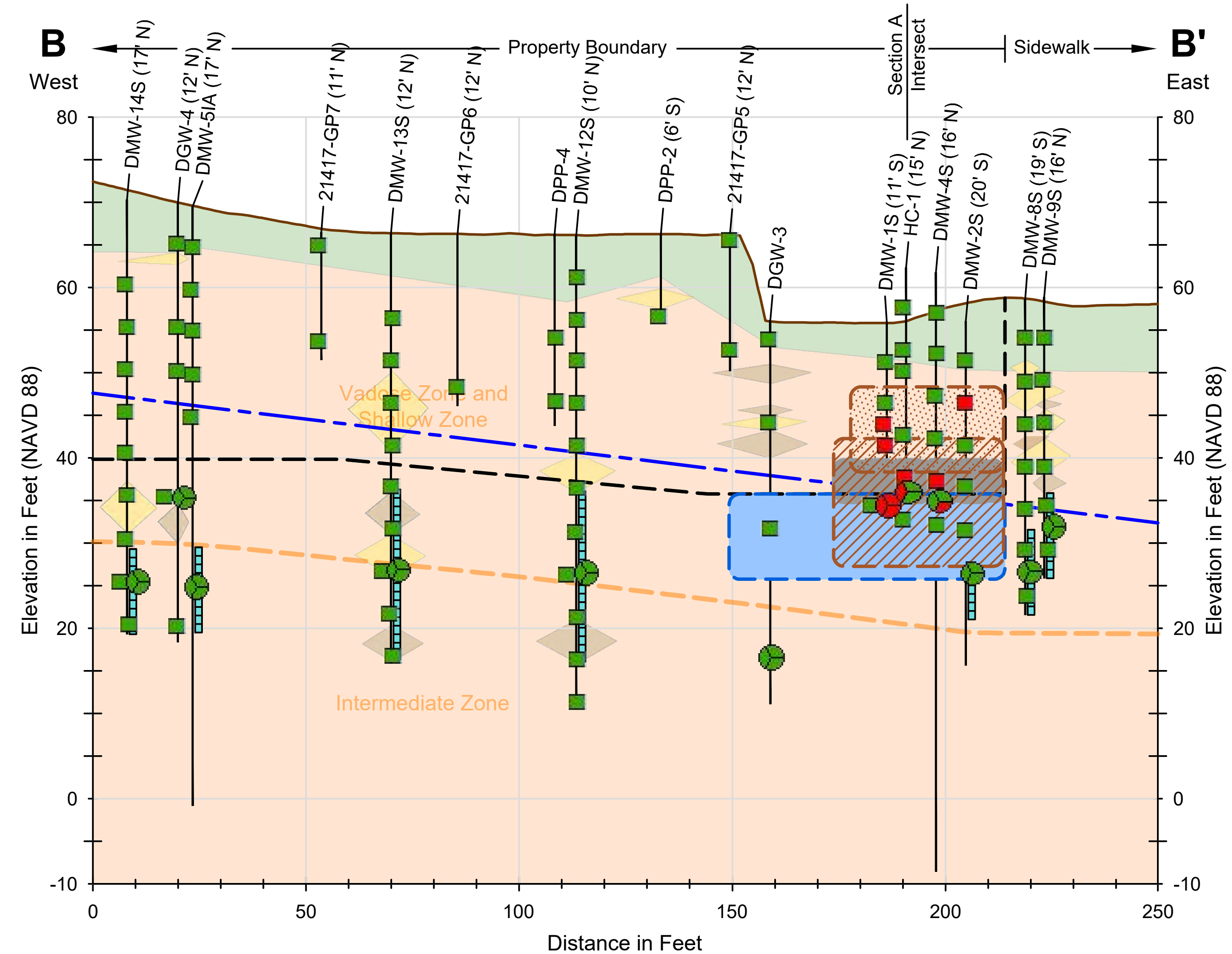
Seattle DOT Dexter Parcel Site
Seattle, Washington

Cleanup Action Alternatives
Cross Section A-A'

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

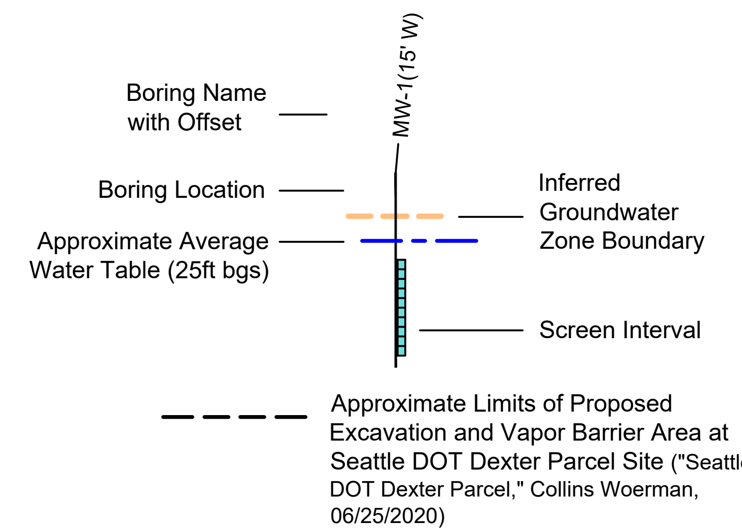
Figure
4-4a



Legend

- Alternative 1: Monitored Natural Attenuation (MNA)*
- Alternative 2: Monitored Natural Attenuation (MNA)**
- Alternative 3: In Situ Chemical Oxidation
- *hatched: Off-Property In Situ Enhanced Bioremediation
- **shaded: Off-Property excavation and off-site disposal of soil with concentrations of constituents of concern (COCs) above proposed cleanup levels
- All Alternatives: On-Property excavation and off-site disposal of soil with concentrations of COCs above proposed cleanup levels

This cross section was cut on-property. Any off-property features have been projected onto this section.



Approximate Limits of Proposed Excavation and Vapor Barrier Area at Seattle DOT Dexter Parcel Site ("Seattle DOT Dexter Parcel," Collins Woerman, 06/25/2020)

Geologic Units (Predominant Component)

- Fill
- Clean Sand and/or Gravel
- Silty Sand and Silty Gravel
- Silt and/or Clay with or without Sand

Soil	Proposed Cleanup Level (mg/kg)
Gasoline Range Organics (GRO)[1]	30

GW	Proposed Cleanup Level (µg/L)
Gasoline Range Organics (GRO)[2]	800
Diesel Range Organics (DRO)[2]	500
Benzene[3]	2.4

[1] Protective of Groundwater
[2] Protective of Drinking Water
[3] Protective of Indoor Air

GROUNDWATER SAMPLE

GRO — Benzene — DRO

SOIL SAMPLE

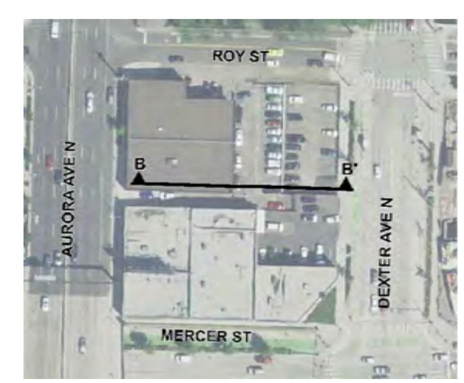
GRO

green = Constituent(s) below proposed cleanup level

red = Constituent(s) above proposed cleanup level

white = Constituent(s) not tested

= Perched groundwater



INSET MAP

Horizontal Scale in Feet: 0, 40, 80

Vertical Scale in Feet: 0, 20, 40

Vertical Exaggeration x 2

Explorations DMW-1S, DMW-9S, and DPP-4 have been shifted horizontally for visual clarity.

Seattle DOT Dexter Parcel Site
Seattle, Washington

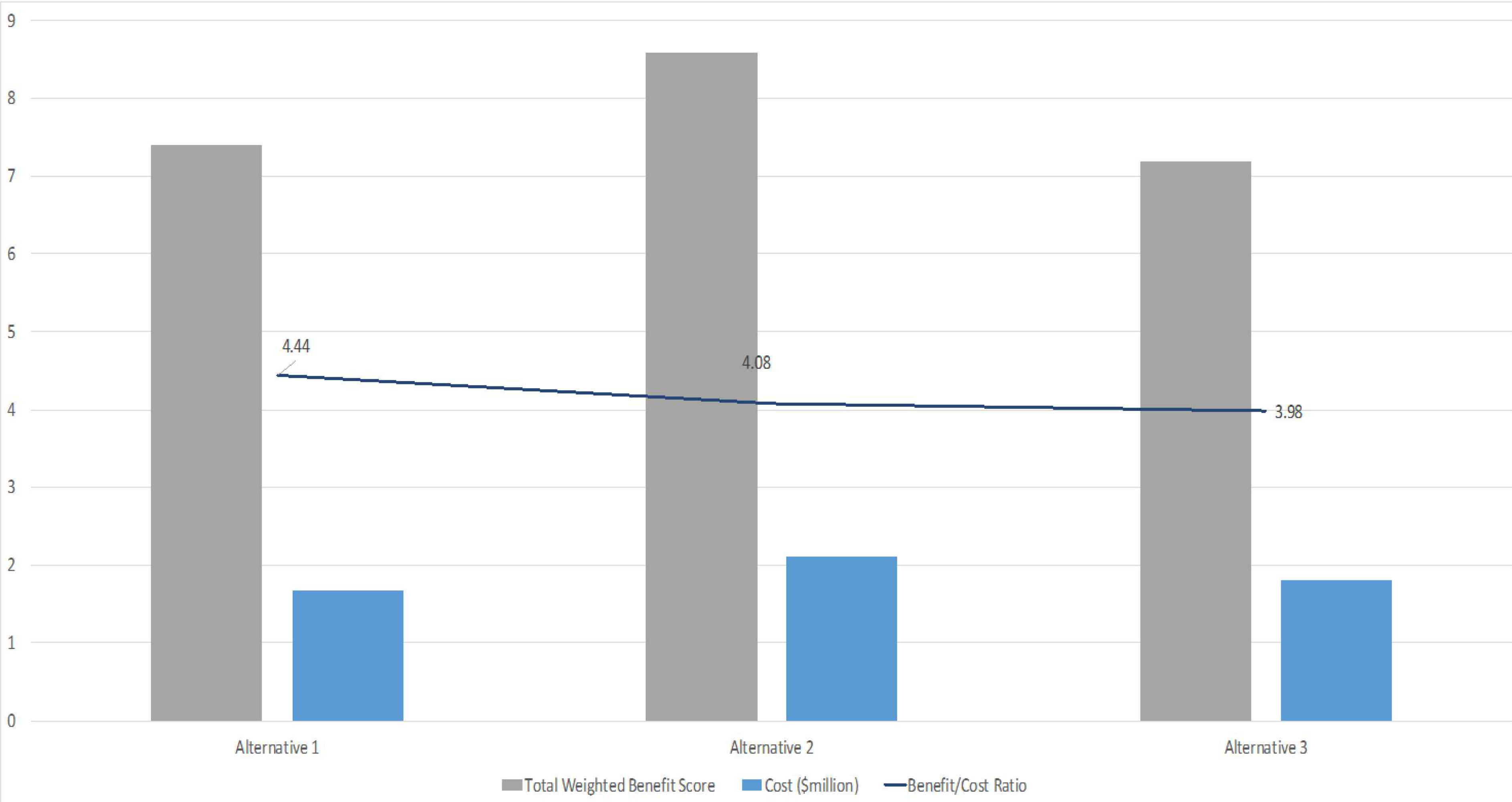
Cleanup Action Alternatives
Cross Section B-B'

19409-04 | 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure **4-4b**

File: \\haleyaldrich.com\share\sea_projects\Notebooks\1940904_Mercer_Mega_Block_Remedial_Investigations\CAD\1940904-013 FS (XSec-Dexter).dwg Layout:FS-SEC_DexB-ChemPlot Date: 10-27-2021 Author: mschweitzer



Seattle DOT Dexter Parcel Site
Seattle, Washington

Cost-to-Benefit Analysis

19409-04 10/21

HARTCROWSER
A division of Haley & Aldrich

Figure
5-1