Morris, Matthew (ECY)

From:	Morris, Matthew (ECY)
Sent:	Monday, August 06, 2018 3:30 PM
To:	Tom Colligan
Cc:	Kim Seely; Tina Huff; John Houlihan; 'Kristin Anderson'
Subject:	RE: Revised West Coast Door Site RI Data Gaps Work Plan

Hello Tom,

I have received the July 2018 Remedial Investigation Data Gaps Work Plan for the West Coast Door Cleanup Site (FSID 6308485) and have completed Ecology's review. Please consider the work plan approved contingent upon the following items,

- Page 4-2 states, "The summer season quarterly sampling event will be representative of groundwater conditions during the time frame when the City of Tacoma is likely to be pumping or have recently pumped well 12A." Ecology will require documentation of the pumping schedule to demonstrate groundwater flow contours during this quarter are representative of groundwater conditions when well 12A is active.
- Page 4-3 states, "If soil vapor concentrations exceed the MTCA Method B cancer sub-slab soil gas screening levels, collection of indoor air samples will be performed. The approach for indoor air sampling, if needed, will be determined in coordination with Ecology and summarized in a memorandum after receipt of the sub-slab data." Ecology will require submittal of the memorandum proposing the indoor air investigation scope of work within 30 calendar days of receiving sub-slab sampling data reports from the laboratory.
- Page B-21 states, "Four soil borings will be advanced radially around MW-7… Samples will be screened for field indications of contamination to define the extent of impacts, and two to three representative samples of impacted soil will be collected for analysis." Ecology will require implementation of the same soil sampling procedure at boreholes advanced in order to install the five proposed monitoring wells, in addition to the four soil borings proposed. If no field indications of impacts are identified, a soil sample should be collected from the upper-most silt layer (approximately 200 feet MSL), if encountered, at a minimum.

In accordance with *Section 7.0 Schedule*, field work to implement this scope of work will begin within 30 calendar days from today. Please notify me when you have established a more detailed schedule so I may arrange for a site visit.

Thank you,
Matt

Matthew Morris, P.E.
Cleanup Project Manager
Ecology's Toxics Cleanup Program
Southwest Regional Office
Phone: (360) 407-7529
Matthew.Morris@ecy.wa.gov

From: Kristin Anderson [mailto:Kristin.Anderson@floydsnider.com]
Sent: Friday, July 13, 2018 2:25 PM
To: Morris, Matthew (ECY) <MAMO461@ECY.WA.GOV>
Cc: Tom Colligan <Tom.Colligan@floydsnider.com>; Kim Seely <kseely@coastlinelaw.com>; Tina Huff <tinahuff@faralloconsulting.com>; John Houlihan <john@houlihan-law.com>
Subject: Revised West Coast Door Site RI Data Gaps Work Plan

Hi Matt,

Here is the final RI Data Gaps Work Plan for the West Coast Door Site incorporating your most recent round of comments sent 6/12. There is a link to download the pdf via Sharefile at the bottom of the email. The hard copy will arrive next week; please confirm that you require one copy.

Thanks,
Kristin

ShareFile Attachments Expires January 09, 2019

WCD RI Data Gaps Work Plan_2018-0713.pdf 13.3 MB

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West Coast Door Site

Remedial Investigation Data Gaps Work Plan

Prepared for

3102 TIC
4015 Ruston Way, Suite 920
Tacoma, Washington

July 2018

Certified B Corporation

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LIMITATIONS

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
AGI	Applied Geotechnology Inc.
AO	Agreed Order
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
EAI	Environmental Associates Inc.
ECI	ECI Environmental Services
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
ft/ft	Feet per foot
$\mu g/m^3$	Micrograms per cubic meter
MSL	Mean sea level
MTCA	Model Toxics Control Act
NAPL	Non-aqueous phase liquid
Pacific Crest	Pacific Crest Environmental
PLP	Potentially liable person
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
Site	West Coast Door Site
SVOC	Semivolatile organic compound
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

1.0 Introduction

This Remedial Investigation Data Gaps Work Plan presents the scope of a supplementary environmental investigation to be performed at the West Coast Door Site (Site) generally located at 3120 South Pine Street and 3102 South Pine Street (formerly adjoined as 3133 South Cedar Street) in Tacoma, Washington (refer to Figure 1.1). The Site is currently subject to an Agreed Order (AO) with the Washington State Department of Ecology (Ecology) that requires former owners of the Site (collectively referred to as 3102 Tenants in Common [TIC]) to prepare a Remedial Investigation and Feasibility Study (RI/FS). A draft RI/FS for the Site was previously submitted to Ecology through the Voluntary Cleanup Program (VCP) after several investigations identified the presence of soil and groundwater contamination resulting from historical creosote-treated wood pipe manufacturing operations. Ecology identified data gaps in the draft RI/FS to be fulfilled during this supplemental investigation, which are summarized in a comment letter provided at Appendix A.

The objective of the RI/FS for this Site is to complete a comprehensive site-wide evaluation that will allow for the development and recommendation of cleanup alternatives that meet Model Toxics Control Act (MTCA) criteria. In accordance with Ecology's August 2, 2017, comment letter and subsequent discussions, the potentially liable persons (PLPs) will collect additional data to complete a full characterization of the soil and groundwater at the Site, and will evaluate contaminant migration pathways. Applicable remedial technologies will be evaluated and coordinated to develop remedial alternatives, which will be evaluated against MTCA criteria in the FS phase of the project, and a preferred cleanup alternative will be identified in the RI/FS Report.

2.0 Site Description

Two tax parcels comprise the Site, covering approximately 10.5 acres of land in the City of Tacoma. The Site is bounded to the north by South Center Street, to the west by South Cedar Street, to the south by Sound Transit-owned railroad tracks, and to the east by South Pine Street. The property is zoned for industrial use and its western portion is occupied by adjoining north and south warehouse buildings of approximately 89,000 and 108,000 square feet, respectively. The warehouse building floors are elevated approximately 4 feet above the surrounding grade to accommodate loading docks at the north warehouse.

The two parcels that comprise the Site are currently owned by CenterPoint Properties Trust. The warehouse buildings on the western portion of the Site are leased to Goodwill Industries, which uses the north warehouse for shipping, receiving, and sorting operations. A section of the south warehouse is used as a retail outlet for marked down goods that is open to the public.

Approximately 95 percent of the surface area of the Site is capped with impermeable surfaces including pavement and structures. The remaining 5 percent of uncapped surfaces consist of landscaped areas.

2.1 SITE HISTORY

The Site was originally developed by Buffelen Pipe and Creosote Company and American Wood Pipe Company, which operated from the early 1900s to the mid-1930s. Manufacturing operations included log storage, drying kilns, and a creosoting plant that included two retorts located in the southwestern portion of the current south warehouse footprint. The creosote oil consisted of a distillate of coal-gas tar or coke-oven tar and was stored outside in creosote oil tanks that had a combined capacity of 50,000 gallons (Engineering World 1921).

Monarch Door and Manufacturing Company began door manufacturing at the Site in the mid-1930s. West Coast Door, Inc., purchased the subject property in 1954. West Coast Door manufacturing operations included cutting, sanding, and gluing of wood-veneered fiberboard core doors. These operations continued in both the north and south portions of the current warehouse after they were constructed in the mid-1980s. William B. Swensen purchased the Site in the 1970s, and operated it as West Coast Door until 2005, at which time door manufacturing operations ceased. Subsequently, Site facilities were converted to warehouse use and office space.

Ownership of the Site was passed to the heirs of William B. Swensen, operating as 3102 Tenants in Common (TIC), after Mr. Swensen's death in 2006. CenterPoint Properties Trust subsequently purchased the property in 2017 and is the current owner.

2.2 ADJACENT PROPERTIES

Property use in the surrounding area is primarily industrial. Several contaminated properties lie adjacent to or near the Site.

Immediately to the north of the Site is the former City of Tacoma Materials Handling Laboratory. This facility is a known source of trichloroethene (TCE) contamination in groundwater resulting from improper disposal of the industrial solvent between 1963 and 1992 (EAI 2006a). A portion of the TCE groundwater plume has been detected in well MW-02 located on the north edge of the Site. A 2005 indemnity agreement between the City of Tacoma and Swensen Enterprises acknowledges that the City of Tacoma is the source of the contamination and is responsible for its cleanup (City of Tacoma 2005). Environmental investigation on the West Coast Door property conducted for evaluation of the City of Tacoma Materials Handling Laboratory is discussed in further detail in Section 3.0. To the northwest of the property is TAM Engineering, which has also released chlorinated solvents to groundwater and is currently undergoing cleanup, as indicated by available records in Ecology's Facility/Site database.

The former Parker Paint facility is located across the Sound Transit right-of-way directly south of the Site. Parker Paint had several documented releases of petroleum solvents to groundwater (Pacific Crest 2008). This property is currently owned by FibroCorp.

Southeast of the property, approximately 1,300 feet to the south-southeast, is the Well 12A/South Tacoma Channel Superfund Site. Groundwater in this area was contaminated by chlorinated solvents and petroleum compounds by a former solvent recycling facility, which was located approximately ½ mile to the east of the Site on property that was operated by the Time Oil Company. In the 1980s, it was discovered that a City of Tacoma municipal drinking well (Well 12A) was contaminated by a groundwater plume originating at Time Oil and migrating east and southwest. The City of Tacoma pumps Well 12A intermittently for drinking water during periods of low reservoir levels during the summer, along with other city wells in the vicinity. Water that is pumped by Well 12A undergoes air stripping prior to being combined with other well waters for municipal consumption (Giaudrone 2012). Capture zone analyses performed for Well 12A and pumping wells at Time Oil have concluded that the West Coast Door Site lies outside the capture zones for both locations (PGG 2001). The Well 12A/South Tacoma Channel Superfund Site has undergone significant cleanup since contaminant discovery with no more active remediation planned. The U.S. Environmental Protection Agency (USEPA) now plans on transferring oversight of the Well 12A/South Tacoma Channel Superfund Site in 2018 to the State of Washington, which will be responsible for long-term maintenance and monitoring.

2.3 PHYSICAL SETTING

The Site is situated in the South Tacoma Channel of the Nalley Valley in Tacoma. The South Tacoma Channel is filled by Vashon era fluvial deposits, which were deposited in a high-energy glaciofluvial environment and are composed primarily of sand and gravel. The Vashon era deposits were created as a result of the South Tacoma channel acting as a spillway for proglacial lakes that formed during the recession of the Vashon ice sheet in the late Pleistocene. The valley is one of the major channels that connected glacial Lake Puyallup through progressively lower spillways into Lake Russell, the main proglacial lake in front of the receding Vashon Ice sheet (Troost and Sofield 2001, Walters and Kimmel 1968). Local geology and hydrogeology within the South Tacoma Channel, as it relates to the Site, is described in the following sections.

2.3.1 Site Geology

The Site is relatively flat and underlain by poorly graded medium sand and gravel with interbeds of silt to depths of at least 70 feet below ground surface (bgs). These native deposits have been covered by a layer of fill consisting of gravel to silty sands ranging from 1 to 12 feet thick. A low permeability silt layer has been observed from approximately 44.5 to 47 feet bgs (equivalent to elevation 200 to 203 feet mean sea level [MSL]) in borings advanced in the southwest portion of the Site and is assumed to be a discontinuous low permeability layer within the Vashon outwash. A second low permeability silt layer was also observed from 68 to 70 feet bgs in this area.

2.3.2 Hydrogeology

Groundwater first occurs at depths of approximately 25 feet bgs in an unconfined "water table" type aquifer in the sandy fluvial deposits. A second regional aquifer lying within older, pre-Vashon deposits underlies the Site and is separated from the shallower glacial outwash aquifer by a semi-confining silt to clay layer observed during investigations at other sites in the vicinity (e.g., URS 2005, Kennedy Jenks 1993) at approximately 100 to 130 feet bgs.

A Site-wide potentiometric surface and groundwater flow direction has been estimated using water elevation measurements in monitoring wells. These measurements indicate an area of groundwater mounding in the southwestern portion of the Site and variable west-northwesterly groundwater flow direction from this mounding area, with horizontal gradients of 0.019 feet per foot (ft/ft) during the dry season and 0.009 ft/ft during the wet season. Locally, there are seasonal variations in the potentiometric surface with observed elevations varying by approximately 1 to 2 feet across the Site. These local effects, in combination with drawdown effects during times of municipal well pumping, may alter the overall Site groundwater flow direction on a seasonal and localized level. Area-wide hydrogeologic work performed by others, however, suggests a groundwater divide in the vicinity of the Site, with flow direction switching from eastward toward the Tacoma Tideflats to westward toward the Puget Sound (Savoca et al. 2010.).

Additionally, hydrologic studies surrounding City of Tacoma Well 12A have found strong downward vertical gradients from the outwash sands to underlying deeper and older glacial deposits, which may influence groundwater flow more strongly than horizontal gradients (Giaudrone 2012). Vertical gradients of 0.014 ft/ft to 0.022 ft/ft have been measured between adjacent shallow and deep wells on the southwestern portion of the Site. This vertical gradient is greater than the horizontal, supporting the theory that there is a strong downward component of flow that adds complexity to the interpretation of horizontal groundwater flow based solely on interpretation of the potentiometric surface.

Surrounding surface water bodies include Snake Lake, approximately 0.7 miles to the southwest, and the Thea Foss Waterway arm of Commencement Bay, approximately 2.1 miles to the east.

3.0 Summary of Prior Environmental Investigations

Numerous environmental investigations have been undertaken at the Site to assess the impacts from former operations. Impacts due to former creosoting operations were first observed during excavation and grading for the construction of the south warehouse in 1986, when creosote-like material was encountered in surface soil in the vicinity of the former retorts. Approximately 10,500 pounds of material containing greater than 1 percent polycyclic aromatic hydrocarbons (PAHs) were excavated during construction and disposed of off-site under a Resource Conservation and Recovery Act (RCRA) dangerous waste permit (EAI 2006a, Pacific Crest 2008).

Previous site investigation findings are summarized below. Previous investigation locations are shown on Figure 3.1.

Applied Geotechnology Inc. (AGI) Phase 2 Environmental Site Assessment (1992). AGI advanced five soil borings (B1 through B5) inside the warehouse building and adjacent to the building to the east, and installed three monitoring wells (MW-01 through MW-03) near the southeast, northeast, and northwest corners of the Site. These exploration locations were not well suited to assess contamination in the vicinity of the former creosoting retorts; however, AGI identified TCE impacts were in groundwater at MW-02 near the City of Tacoma Asphalt Plant and Materials Testing Laboratory. Elevated chromium was also detected in one shallow soil sample form the northern portion of the Site and low levels of chromium and lead were detected in groundwater Site-wide.

Environmental Associates Inc. (EAI) Phase 2 Soil and Groundwater Sampling (2006). EAI advanced four shallow soil borings (SP1 through SP4) to depths of 9 to 11 feet bgs in the vicinity of the former retorts, installed one shallow aquifer monitoring well (MW-04) screened to 35 feet bgs south of the warehouse buildings, and sampled Site-wide groundwater in 2006. EAI identified carcinogenic polycyclic aromatic hydrocarbon (cPAH) and naphthalene impacts in shallow soils in the Former Creosoting Retort Area.

EAI Supplemental Soil and Groundwater Exploration (2006). EAI returned to the Site in 2006 and completed five additional shallow soil borings (SP5 through SP9) to depths of 7 to 9 feet bgs to the south and west of the warehouse, installed two additional shallow aquifer monitoring wells (MW-05 and MW-06) screened to 35 feet bgs to the west and southwest of the warehouse, and sampled groundwater. EAI identified cPAH and naphthalene impacts in soil nearest to the Former Creosoting Retort Area to the south and west, and in groundwater at both new monitoring wells. EAI also collected surface soil samples (SS1 through SS6) approximately 1 foot deep to the east of the warehouse in an attempt to identify the source of chromium previously detected in groundwater by AGI, but did not find elevated chromium concentrations in surface soils.

Pacific Groundwater Group (PGG) City of Tacoma Materials Handling Laboratory Remedial Investigation (2007–2008). PGG installed three permanent monitoring wells (MHLMW-6 through MHLMW-8) screened to a depth of 36 feet bgs and collected groundwater reconnaissance samples at approximately 25 feet bgs from three soil borings (HSA-8 through HSA-10) on the Site property between 2007 and 2008. These wells and borings were installed as part of a larger remedial investigation to assess on-site and off-site impacts of prior TCE releases at the Materials Handling Laboratory. PGG found elevated TCE concentrations in groundwater extending 200 feet onto the northeast corner of the Site with the extent of the plume delineated by boring HSA-10.

Pacific Crest Environmental (Pacific Crest) Additional Soil and Groundwater Characterization (2008). Pacific Crest advanced five soil borings (SB-01 through SB-05) to 35 feet bgs to the north, south, southeast, and west of the Former Creosoting Retort Area and installed three monitoring wells (MW-07 through MW-09) in 2008. Well MW-07 was installed within the footprint of the Former Creosoting Retort Area, and MW-08 was installed inside the warehouse to the north. MW-09 was screened to 70 feet bgs to examine deeper groundwater quality west of the retorts where groundwater contamination had previously been identified in the shallow aquifer well MW-05. Pacific Crest identified minor cPAH impacts in shallow soils north of the former retorts and naphthalene and cPAH impacts in groundwater to the south and west of the Former Creosoting Retort Area. Groundwater from MW-09 had very low level detections of naphthalene and cPAHs indicating limited downward migration of creosote as a dense non-aqueous phase liquid (DNAPL).

Pacific Crest Additional Geoprobes (2009). Pacific Crest returned to the Site in 2009 to advance six additional soil borings (SB-06 through SB-11) farther south of the Site property in the adjacent railroad right-of-way to collect groundwater reconnaissance samples both at the water table and at deeper depths. Pacific Crest identified naphthalene impacts below 35 feet bgs immediately south of the warehouse, attenuating within the right-of-way, and did not identify cPAH impacts. Groundwater collected from the water table interval in the right-of-way south of the Site was also largely unimpacted.

Floyd|Snider Well Installation and Groundwater Sampling (2010). Floyd|Snider installed three additional shallower aquifer monitoring wells (MW-10 through MW-12) screened to 46 feet bgs in the area north and west of the former retorts and advanced one soil boring (SP2-B) to 46 feet bgs inside the warehouse building in 2010. Soil samples collected from SP2-B within the footprint of the former retorts found creosote odors, heavy sheens, and elevated cPAH and naphthalene concentrations, which attenuated at the silt layer encountered at 45 feet bgs. Pentachlorophenol, another wood treating product, was also analyzed in samples from this boring and was not detected. Floyd|Snider subsequently sampled groundwater from the expanded well network surrounding the Former Creosoting Retort Area and found elevated concentrations of naphthalene and benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds extending northwest to MW-10 and MW-12 with the greatest impacts directly to the west in MW-10. Groundwater contamination was considered to be delineated to the southwest, however, by MW-11. Floyd|Snider also collected one shallow soil sample (SS-2B) in the northern portion of the Site where AGI had previously found elevated chromium concentrations and found that the predominant chromium species in Site soils is chromium (III).

Floyd|Snider Geoprobe Groundwater and Indoor Air Sampling (2011). Floyd|Snider returned to the Site in 2011 to advance nine additional borings (SB-21 through SB-29) to 45 feet bgs to the west and northwest of MW-10 and MW-12, re-sample monitoring well groundwater, and evaluate indoor air quality in the south warehouse. Reconnaissance groundwater samples were collected from nine reconnaissance Geoprobe borings at the water table interval (i.e., 20 to 25 feet bgs) and deeper (i.e., above the silt layer from 35 to 40 feet bgs). Elevated naphthalene and BTEX concentrations were detected in the deeper samples west of MW-10 and MW-12. Groundwater contamination was found to attenuate rapidly to the north of MW-12. Monitoring well groundwater samples collected during this investigation were consistent with prior sampling in 2010, indicating a naphthalene and a BTEX plume migrating west from the Former Creosoting Retort Area and attenuating at the silt layer at 45 feet bgs. Indoor air samples collected in the south warehouse, which was being used for storage and not ventilated during this investigation, had slightly elevated naphthalene concentrations less than the applicable MTCA screening level. Ambient air quality outside the warehouse building was not evaluated.

Floyd|Snider Additional Geoprobe Groundwater Sampling (2012). Floyd|Snider advanced nine additional borings (SB-31 through SB-39) to 45 bgs to the west of MW-10 onto adjacent property to further delineate naphthalene and BTEX in groundwater in the presumed downgradient direction from the Former Creosoting Retort Area. Reconnaissance groundwater samples collected from the water table interval and approximately 35 to 40 feet bgs found elevated naphthalene and BTEX in the deeper interval, attenuating beneath the adjacent property to the west of the Site.

Floyd|Snider Quarterly Groundwater Monitoring (2012–2013). Floyd|Snider sampled groundwater from the well network surrounding the Former Creosoting Retort Area (including MW-01, MW-05, MW-06, MW-09, MW-10, MW-11, and MW-12) for four quarters between 2012 and 2013. Samples collected during the first quarter were analyzed for volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) including cPAHs, and subsequent samples were analyzed for VOCs. Similar to previous sample results, Floyd|Snider found that cPAHs were not present in groundwater due to their limited mobility. VOCs including naphthalene and BTEX compounds were detected at elevated concentrations in groundwater above the 45-foot bgs silt layer within and west of the Former Creosoting Retort Area at MW-06, MW-07, MW-10, and MW-12.

ECI Environmental Services (ECI) Focused Subsurface Investigation (2014). On behalf of the adjacent property owners to the west, Bob Shea and Butch Nyssen, ECI advanced nine borings (ECI-B1 through ECI-B9) to 40 feet bgs for collection of groundwater reconnaissance sampling beneath the Shea and Nyssen Buildings in 2014. These borings were situated in two rows; one row of five borings was just west of the Shea property line and one row of four borings was approximately 50 feet farther to the west. The borings advanced on the Shea property generally coincided with previous Floyd|Snider groundwater reconnaissance samples. ECI collected groundwater samples at the water table and deeper at 40 feet bgs and analyzed samples for naphthalene using a mobile laboratory. ECI detected elevated naphthalene in the deeper groundwater samples at ECI-B1 and ECI-B2 nearest the Shea property line. Elevated naphthalene was not detected on the Nyssen property or beneath the Shea warehouse, or in shallower water table interval samples. Overall, ECI's results were similar to the findings by Floyd|Snider in 2012.

ECI Vapor Intrusion Investigation (2016). ECI returned to the Shea property in 2016 to collect two sub-slab soil vapor samples beneath the building floor. Soil vapor samples were collected in the eastern and western half of the Shea building and analyzed for naphthalene and BTEX; ECI did not find elevated soil vapor concentrations of any contaminants beneath the warehouse building and concluded that impacts to indoor air inside this building due to underlying groundwater contamination were unlikely.

In addition to investigations related to the former creosoting operations, soil sampling has also been conducted at the Site in connection with the removal of fuel storage tanks. Three storage tanks containing gasoline have previously existed on the Site, including two underground storage tanks (USTs) of 3,000- and 2,500-gallon capacity, which were removed from the Site in 1989 by Langseth Environmental. Confirmation soil samples from this tank removal were submitted to the Tacoma-Pierce County Health Department, which certified the tank removal as complete (TPCHD 1989). An aboveground storage tank (AST), installed in 1990, was removed from the Site in 2005 and soil sampling conducted by EAI in the vicinity confirmed that gasoline was not released to soil (EAI 2006a).

4.0 Data Gaps and Sampling Plan Summary

In response to the findings presented in the Draft RI/FS, Ecology issued a comment letter dated August 2, 2017 (refer to Appendix A), identifying specific data gaps that needed to be filled in order to prepare a revised RI/FS. These data gaps, and proposed additional field investigation to fulfill these data gaps, are discussed in the following sections. Additional details regarding laboratory analysis methods and data quality objectives are provided in the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) presented in Appendix B.

4.1 GROUNDWATER DATA GAPS

Ecology identified data gaps regarding groundwater quality and the potential for contaminant migration including:

1. **Establishing with more certainty the vertical depth of groundwater contamination in the source area near MW-07 given the absence of evidence of a low permeability unit in prior borings at this location and the presence of creosote-impacted soils as deep as elevation 200 feet MSL.**

   To fill this data gap, an additional deep well (MW-14) will be installed in the vicinity of MW-07. This well will be installed using roto-sonic drilling methodology that samples soil continuously with depth, allowing more precise vertical delineation of soil contamination and identification of any confining layers. The roto-sonic boring for this new deep well will be advanced potentially as deep as to the lower silt layer that is expected to be encountered at approximately 70 to 80 feet bgs. The screened interval will be determined based upon soil observations from the soil borings described below and in coordination with Ecology. For ease of drilling and access for future sampling, this well will be installed just outside of the warehouse but still within the footprint of the Former Creosoting Plant Area. Refer to Figure 4.1 for the proposed MW-14 location. Details regarding field protocols for well installation and soil screening are discussed in Sections 5.1 and 5.2.

2. **Delineating the lateral extent of naphthalene impacts in groundwater to the north, south, and west of the Former Creosoting Retort Area.**

   Four additional groundwater monitoring wells (MW-15, MW-16, MW-17, and MW-18) will be installed to the west, northwest, and south of the Former Creosoting Retort Area to better delineate the lateral extent of the naphthalene-impacted groundwater. Refer to Figure 4.1 for the proposed locations of these wells. The wells will be screened immediately above the upper silt layer from approximately 35 to 45 feet bgs as this is the most impacted interval based on previous investigations. Prior to monitoring well installation, groundwater screening samples will be collected via direct-push drilling to verify that the proposed new well locations fully delineate the extent of groundwater contamination exceeding the screening levels. Refer to Section 5.1 for details on reconnaissance groundwater sample collection and monitoring well installation.

3. Establishing groundwater gradients and potential influence from seasonal pumping of City of Tacoma Well 12A.

Quarterly groundwater monitoring will begin following installation of the newly proposed wells, and will be conducted using low-flow sampling methodology. The network of wells to be sampled include source area and cross- or downgradient wells that are screened just above the silt layer or below the silt layer in the deeper aquifer: MW-01, MW-05, MW-06, MW-09, MW-10, MW-11, MW-12, MW-14, MW-15, MW-16, MW-17, and MW-18. Upgradient wells MW-2, MW-3, and MW-8 are eliminated from quarterly monitoring because previous investigations establish that these wells are too great a distance from the source area to provide useful data to further characterize the extent of the naphthalene plume. Additionally, MW-4 and MW-7, located southeast of and within the source area, are eliminated from the well network since their screened depths are above the impacted groundwater interval. The summer season quarterly sampling event will be representative of groundwater conditions during the time frame when the City of Tacoma is likely to be pumping or have recently pumped Well 12A. Groundwater elevations and contaminant concentrations measured during quarterly monitoring will be used to determine groundwater gradients and potential effects of seasonal pumping.

Depth to groundwater will be measured at each well prior to sample collection. Groundwater analyses for VOCs, including naphthalene and BTEX by USEPA Method 8260, will be completed for all wells. Samples from monitoring wells in proximity to the source area, including MW-05, MW-06, MW-09, and MW-14, as well as additional new wells MW-15 through MW-18, will also be analyzed for SVOCs by USEPA Method 8270 during the first quarter of monitoring to confirm that cPAHs are not present in groundwater outside the source area. Any wells with cPAH toxic equivalent concentrations exceeding the screening levels during the first quarterly monitoring event will continue to be sampled for cPAH analysis during subsequent quarters.

A summary of quarterly groundwater monitoring data will be provided in tabulated data and figures as part of the required quarterly reports to Ecology. Analytical data will also be submitted to Ecology's Environmental Information Management (EIM) system on a quarterly basis.

4.2 SOIL DATA GAPS

Ecology identified data gaps regarding Site geology, soil quality, and the potential for contaminant migration including:

1. Delineating the vertical extent of source material around the Former Creosoting Retort Area.

In order to assess the vertical and lateral extent of creosote in soil, four soil borings (SB-40 through SB-43) will be advanced radially in the warehouse around MW-07 using roto-sonic drilling methodology. These borings will be advanced to the depth of the deeper low permeability silt layer at approximately 70 to 80 feet bgs. Soil will be continuously collected and logged during drilling. Samples will be screened for field indications of contamination to define the extent of impacts, and two to three representative samples of impacted soil will be collected for analysis at each location. A soil sample will also be collected below the interval of observed impacts where soil is first observed to be free of creosote impacts. Soil samples will be analyzed for VOCs by USEPA Method 8260 and cPAHs by USEPA Method 8270. One representative heavily contaminated soil sample will be analyzed for the full suite of SVOCs by USEPA Method 8270 to determine whether any additional contaminants are present at high concentrations in the creosote mixture. Refer to Figure 4.2 for proposed additional soil borings. Refer to Section 5.2 for field screening protocols.

2. **Sampling for the potential presence of pentachlorophenol and metals in the Former Creosoting Retort Area, which are historically associated with wood treating.**

   A representative sample of the most heavily impacted soil will be collected from one of the four soil borings advanced in the Former Creosoting Retort Area. This sample will be analyzed for pentachlorophenol and the Clean Water Act list of 13 Priority Pollutant Metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc).

3. **Delineating the horizontal and vertical extents of low permeability silt layers.**

   Previous investigations had a limited number of deep investigative sampling locations that reached either the shallower (around 45 feet bgs) or deeper (around 70 to 80 feet bgs) low permeability layers. The aforementioned soil borings will be advanced to the deeper low permeability layer. Field screening for contamination will be performed to note contamination as it relates to Site geology.

4.3 INDOOR AIR DATA GAPS

Since the January 2014 Draft RI/FS Report was written, the screening level for naphthalene in indoor air has been updated to include a MTCA Method B cancer cleanup level of 0.0735 micrograms per cubic meter ($\mu g/m^3$), which is considerably less than the non-cancer cleanup level of 1.37 $\mu g/m^3$ that was previously used as a screening level. To evaluate the risk of vapor intrusion from naphthalene and other VOCs using the updated cancer cleanup level, additional samples will be collected and analyzed as follows.

To assess the potential for vapor intrusion, sub-slab soil vapor samples will be collected within the south warehouse adjacent to existing source area soil borings SP2 and MW-07, where field screening identified creosote contamination in shallow soil. Sub-slab soil vapor samples provide adequate preliminary screening information to determine the potential for naphthalene impacts to indoor air from underlying contaminated soil. If soil vapor sample concentrations exceed the MTCA Method B cancer sub-slab soil gas screening levels, collection of indoor air samples will be performed. The approach for indoor sampling, if needed, will be determined in coordination with Ecology and summarized in a memorandum after receipt of the sub-slab data. The results from these additional samples and previous investigations at the Site, and at Shea and Nyssen properties, will be incorporated into the revised RI/FS Report to fully document potential impacts to indoor air quality of the Site. Site-specific field protocols for sub-slab vapor sampling are presented in Section 5.3.

4.4 TERRESTRIAL ECOLOGICAL EVALUATION

In accordance with Washington Administrative Code 173-340-7490, a Terrestrial Ecological Evaluation will be completed for the Site and will be included in the revised RI/FS Report.

5.0 Field Protocols

Site-specific field protocols for the scope of this Remedial Investigation Data Gaps Work Plan are summarized in the following sections and described in further detail in the SAP/QAPP (Appendix B). Floyd|Snider's Standard Guidelines for standard field activities such as soil logging and sampling, well development, and low-flow groundwater sampling are also provided in Appendix B.

5.1 MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING

All monitoring wells will be installed using roto-sonic drilling at the proposed locations shown on Figure 4.1. Prior to conducting the subsurface exploration program, each location will be checked for the presence of underground utilities by a utility location company. Exploration locations may be moved to a limited degree based on field conditions and if underground or aboveground utility locations, and/or site operational constraints are present. Specific procedures for well installation are described in the SAP/QAPP (Appendix B).

During drilling, soil samples will be collected continuously, and logged and photographed by the field geologist. At the deep well location (MW-14), the boring will be advanced until the deeper low permeability layer is encountered, which is anticipated to be about 70 to 80 feet bgs. The screened interval for this deep well will be decided in consultation with Ecology.

At the shallower well locations, a screening sample will first be collected by driving a retractable screen via direct-push drilling to the 35 to 40 feet bgs depth interval above the upper silt layer where contaminated groundwater was encountered during previous investigations. Step-out samples will be collected to ensure that the final monitoring well network fully delineates groundwater contamination exceeding the screening levels. Therefore, if strong creosote or naphthalene odors are observed in these screening samples, additional step-out samples will be collected. During installation of shallow monitoring wells, borings will be advanced to the anticipated depth of the upper silt layer between 35 and 45 feet bgs. If the silt layer is not encountered above 55 feet bgs, the screen will be placed from 35 to 45 feet or at the depth with the greatest field indications (if encountered).

All new wells will be developed prior to sampling, and existing Site wells will be additionally assessed for integrity, including the condition of surface seals and presence of sedimentation, and may be redeveloped or repaired prior to sampling if warranted. Wells will be allowed to equilibrate a minimum of 7 days after development before collecting groundwater samples. All new and existing wells will be surveyed by a professional surveyor.

5.2 SOIL SAMPLING AND FIELD SCREENING

Four soil borings will be advanced radially around MW-07 near the Former Creosoting Retort Area at the locations shown in Figure 4.2. The proposed borings will be advanced using standard roto-sonic drilling techniques until the second deeper low permeability layer is encountered. Soil samples will be collected continuously during drilling. Soils will be inspected for visual evidence of brown oily contamination; tactile evidence of sticky or oily soil; olfactory evidence of creosote, naphthalene, or other hydrocarbon odors; and the presence of volatiles measured using a photoionization detector. Soils will additionally be screened for the presence of non-aqueous phase liquid (NAPL) with sheen tests, ultraviolet light to detect fluorescence, and water shake tests with an oil soluble dye to make qualitative assessments of the presence and volume of NAPL and its relative mobility.

5.3 AIR SAMPLING

Soil vapor samples will be collected from permanent stainless steel vapor monitoring points installed directly below the floor slab adjacent to existing boring SP2 in the Former Creosoting Retort Area of the warehouse and adjacent to existing well MW-07, where shallow creosote-impacted soil was encountered during previous investigations. Samples will be collected in evacuated SUMMA® canisters using flow rate regulators to allow sample collection at a controlled purge rate. Details of vapor monitoring point installations and sampling and analysis are described in Appendix B.

If indoor air samples are determined to be necessary based on the results of soil vapor sampling showing concentrations of contaminants exceeding Ecology's published vapor intrusion values for sub-slab soil gas screening levels (Ecology 2018), indoor air samples will be collected. The approach for indoor air sampling, if needed, will be developed in coordination with Ecology and summarized in a memorandum after receipt of the sub-slab data.

5.4 HEALTH AND SAFETY, DECONTAMINATION, AND WASTE MANAGEMENT

Health and safety protocols for all sampling activities will be implemented in accordance with the Site-specific Health and Safety Plan provided in Appendix C.

All non-disposable sample equipment that comes into contact with samples, including equipment used for sample homogenization and temporary well screens, will be decontaminated by rinsing or brushing to remove soil particles, scrubbing with a soap solution, and rinsing with distilled water. If NAPL is encountered, the decontamination process will be repeated using a spray cleaner such as Clean Green until wiping with a paper towel leaves no visual film. Following this, the sampling equipment will be rinsed in deionized water. Alternatively, disposable sampling equipment may be used.

During sonic drilling, soil samples will be collected in disposable plastic sleeves. The industry standard of care for drilling is to power wash the drill rods between sampling locations; however, if NAPL is encountered and is not effectively removed by power washing, the drill rods will be steam cleaned to avoid cross-contamination between sampling locations.

All waste soil, purge water, and decontamination water will be collected in Washington State Department of Transportation-approved drums for proper off-site disposal by a local waste disposal contractor following receipt of the analytical data.

6.0 Remedial Investigation/Feasibility Study Report

The January 7, 2014, Draft RI/FS Report for the Site will be updated to include the results of the activities described in this Remedial Investigation Data Gaps Work Plan. Data presentation and analysis will be provided in accordance with Ecology's August 2, 2017, comment letter reproduced in Appendix A.

7.0 Schedule

The schedule for the RI/FS will proceed according to the existing schedule set forth in the AO. Below are expected periods of performance for completion of RI/FS tasks to be performed under this Work Plan. Actual field dates are not able to be set due to variable factors such as time required to obtain final Ecology work plan approval and obtain all access agreements.

Task	Expected Duration	Date
Submit Draft Remedial Investigation Data Gaps Work Plan to Ecology	--	Completed on October 31, 2017 (due within 90 days of issuance date of AO)
Submit Final Remedial Investigation Data Gaps Work Plan to Ecology	--	July 13, 2018
Implement RI Work Plan Field Work: Soil Sampling, Monitoring Well Installation, Groundwater Sampling, and Indoor Air Sampling	3 to 5 days	30 days after receipt of written Ecology approval of Work Plan
Implement RI Work Plan Field Work: Groundwater Sampling	Quarterly Groundwater Monitoring	Four quarterly events
Receive Data Reports from Laboratories, Complete Data Validation, Load Data to EIM[1]	--	Within 180 days of receipt
Submit Agency Review Draft RI/FS Report to Ecology	--	Within 90 days of receipt of final analytical data from field events specified in the Remedial Investigation Data Gaps Work Plan (Fall 2018)

Note:

1 Final laboratory data must be submitted to EIM within 180 days of receipt; this completion date may change based on the field data collection completion and data validation completion dates. All prior data collected by Floyd|Snider have been submitted to EIM; any additional data collected at the Site after 2005 will be loaded to EIM concurrently with data collected during fulfillment of this Work Plan. Finalization of any report is contingent upon EIM data submittal and verification by the Ecology Project Manager.

8.0 References

Applied Geotechnology Inc. (AGI). 1990. *Phase 1 Environmental Audit, West Coast Door Inc., Tacoma, Washington*. 16 October.

_____. 1992. *Phase II Environmental Site Assessment, West Coast Door Inc. Facility, 3133 South Cedar Street, Tacoma, Washington*. Prepared for Puget Sound National Bank. 25 June.

City of Tacoma. 2005. Environmental Remediation and Indemnity Agreement with William B. Swensen Enterprises. 7 October.

ECI Environmental Services (ECI). 2014. *Focused Subsurface Investigation (FSI)*. Letter report from K. Craig Klein and Stephen M. Spencer, ECI, to Nyssen Maule Associates.

_____. 2016. *Vapor Intrusion Investigation*. Letter report from Brian A. Dixon, ECI, to John Spencer, Spencer Law Firm, PLC. 8 January. 19 September.

Engineering World. 1921. "Creosote Treatment Plant for Wood Pipe Staves." *Engineering World* Vol. 19: 249.

Environmental Associates Inc. (EAI). 2006a. *Phase 1 Environmental Assessment, West Coast Door Property, 3133 South Cedar Street, Tacoma, Washington 98409*. Prepared for Tacoma Goodwill Industries. 30 June.

_____. 2006b. *Phase 2 Soil & Groundwater Sampling and Testing, West Coast Door Property, 3133 South Cedar Street, Tacoma, Washington*. Prepared for Tacoma Goodwill Industries. 9 August.

Giaudrone, Dominic. 2012. Personal Communication Regarding Tacoma Channel Hydrogeology. URS Project Manager, Well 12A/South Tacoma Channel Superfund Site. 27 March.

Kennedy Jenks Consultants (Kennedy Jenks). 1993. *South Tacoma Field Superfund Site Remedial Investigation and Feasibility Study*. Prepared for South Tacoma Field Site Group. 1 February.

Pacific Crest Environmental (Pacific Crest). 2008. *Additional Soil and Groundwater Characterization, West Coast Door Property, Former Buffelen Wood Pipe and Creosote Facility, 3133 South Cedar Street, Tacoma, Washington*. 11 June.

_____. 2009. Additional Geoprobe Soil Boring Logs and Analytical Data Tables.

Pacific Groundwater Group (PGG). 2001. Groundwater Capture Zone Investigation Report, City of Tacoma Materials Handling Lab. 28 June.

Savoca, M.E., Welch, W.B., Johnson, K.H., Lane, R.C., Clothier, B.G., and Fasser, E.T. 2010. *Hydrogeologic Framework, Groundwater Movement, and Water Budget in the Chambers-Clover Creek Watershed and Vicinity, Pierce County, Washington: U.S. Geological Survey Scientific Investigations Report 2010–5055*. Prepared for the U.S. Department of the Interior, U.S. Geological Survey, in cooperation with the Pierce Conservation District and the Washington State Department of Ecology.

Tacoma-Pierce County Health Department (TPCHD). 1989. Correspondence Re: Underground Storage Tank Removal. 19 June.

Troost, Kathy, and Darrel Sofield. 2011. "Jökulhlaups From Glacial Lake Puyallup, Pierce County, Washington." *Northwest Geological Society Field Trip Guidebook Series, No. 39*.

URS. 2005. *Draft Final Field Investigation and Capture Zone Analysis Report, Commencement Bay, South Tacoma Channel/Well 12A Superfund Site, Tacoma, Washington*. September.

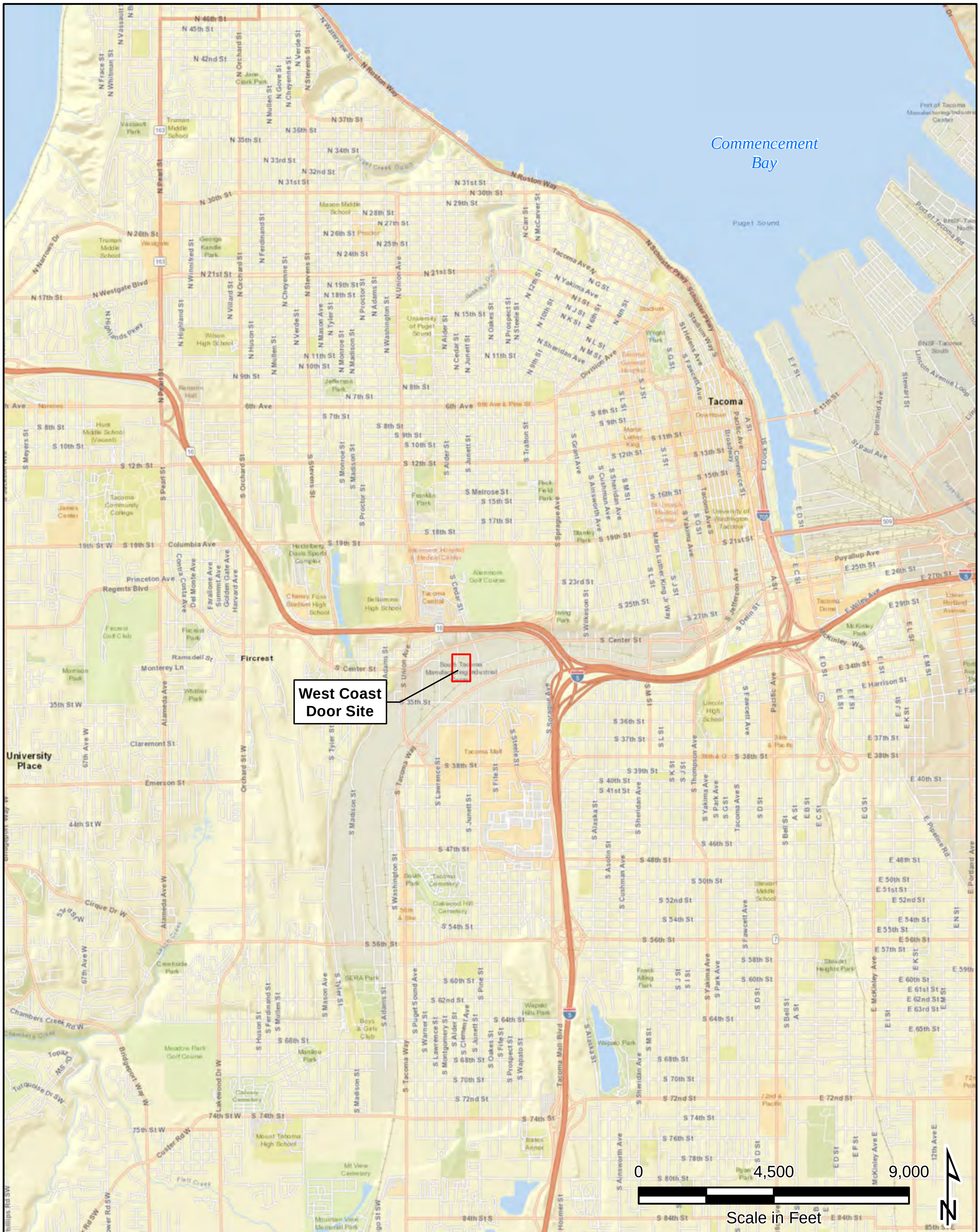
Walters, Kenneth L., and Grant E. Kimmel. 1968. "Ground-Water Occurrence and Stratigraphy of Unconsolidated Deposits, Central Pierce County, Washington." *Water Supply Bulletin No. 22.* Published by the Washington Department of Water Resources, Olympia, Washington.

Washington State Department of Ecology (Ecology). 2018. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action.* Publication No. 09-09-047. Toxics Cleanup Program. Olympia, Washington. April.

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Figures



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Tacoma, Washington

Figure 1.1
Vicinity Map

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3/20/2018

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Tacoma, Washington

Figure 2.1
Property Map

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7/10/2018

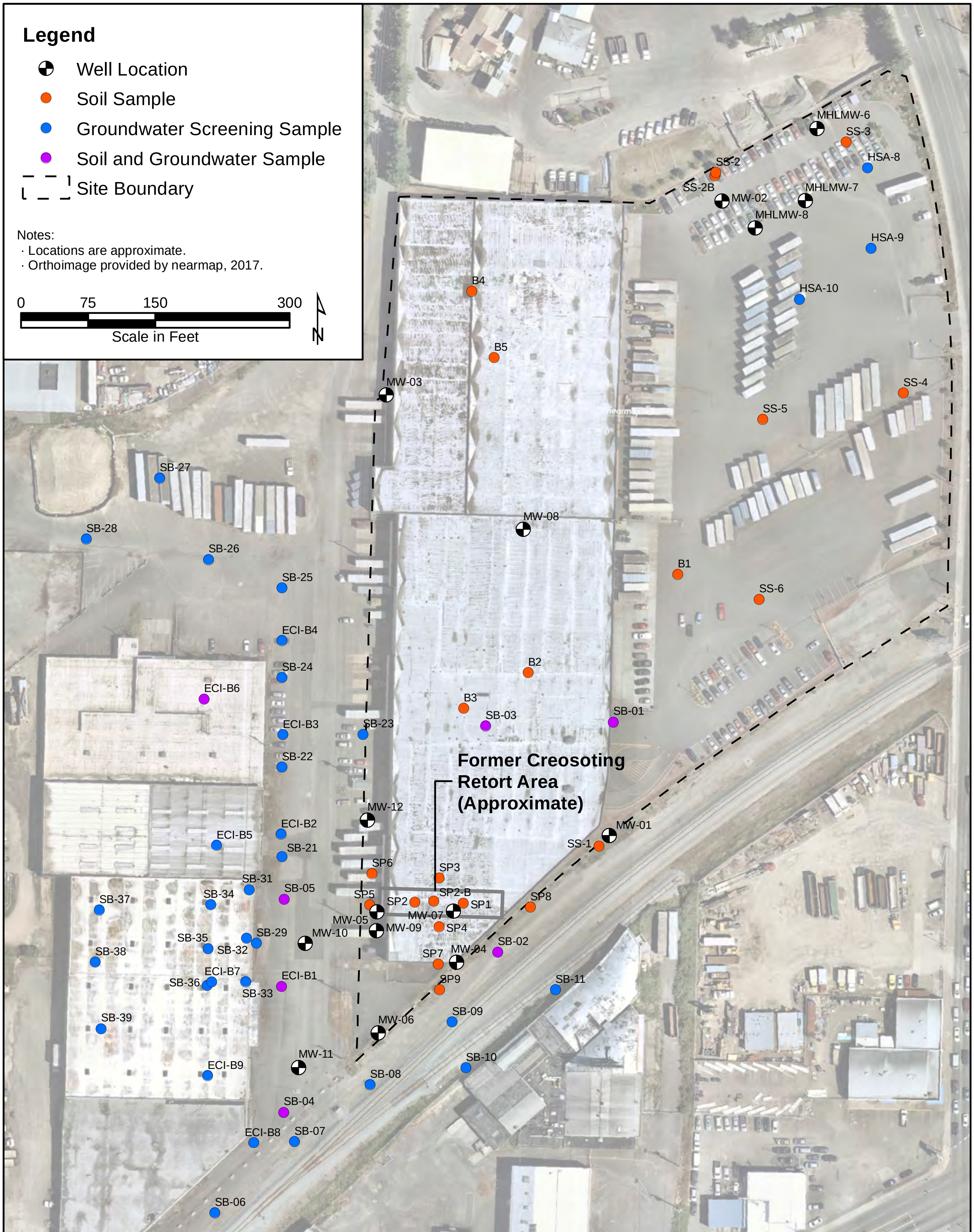

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Figure 3.1
Previous Investigations

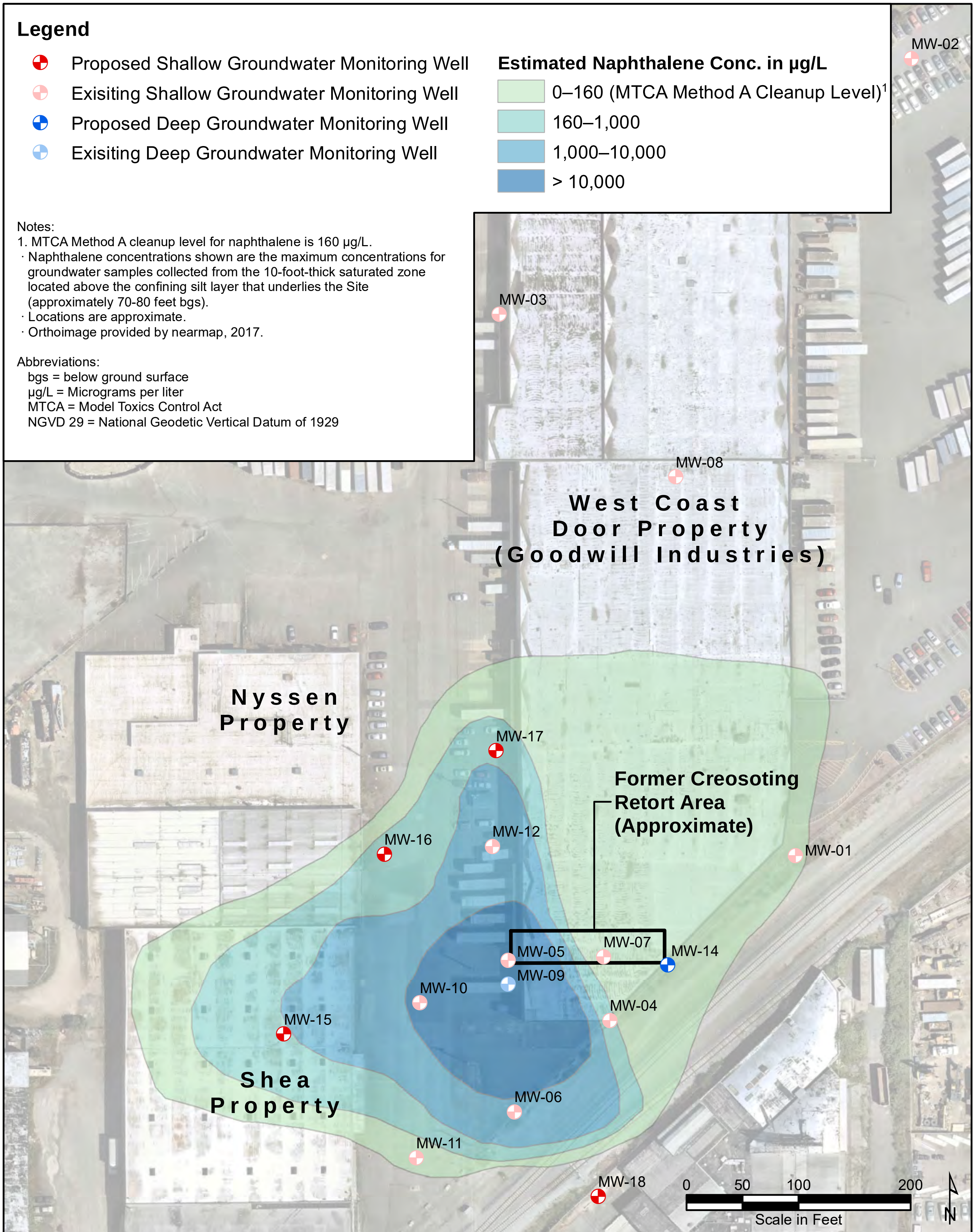

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Figure 4.1
Proposed Wells

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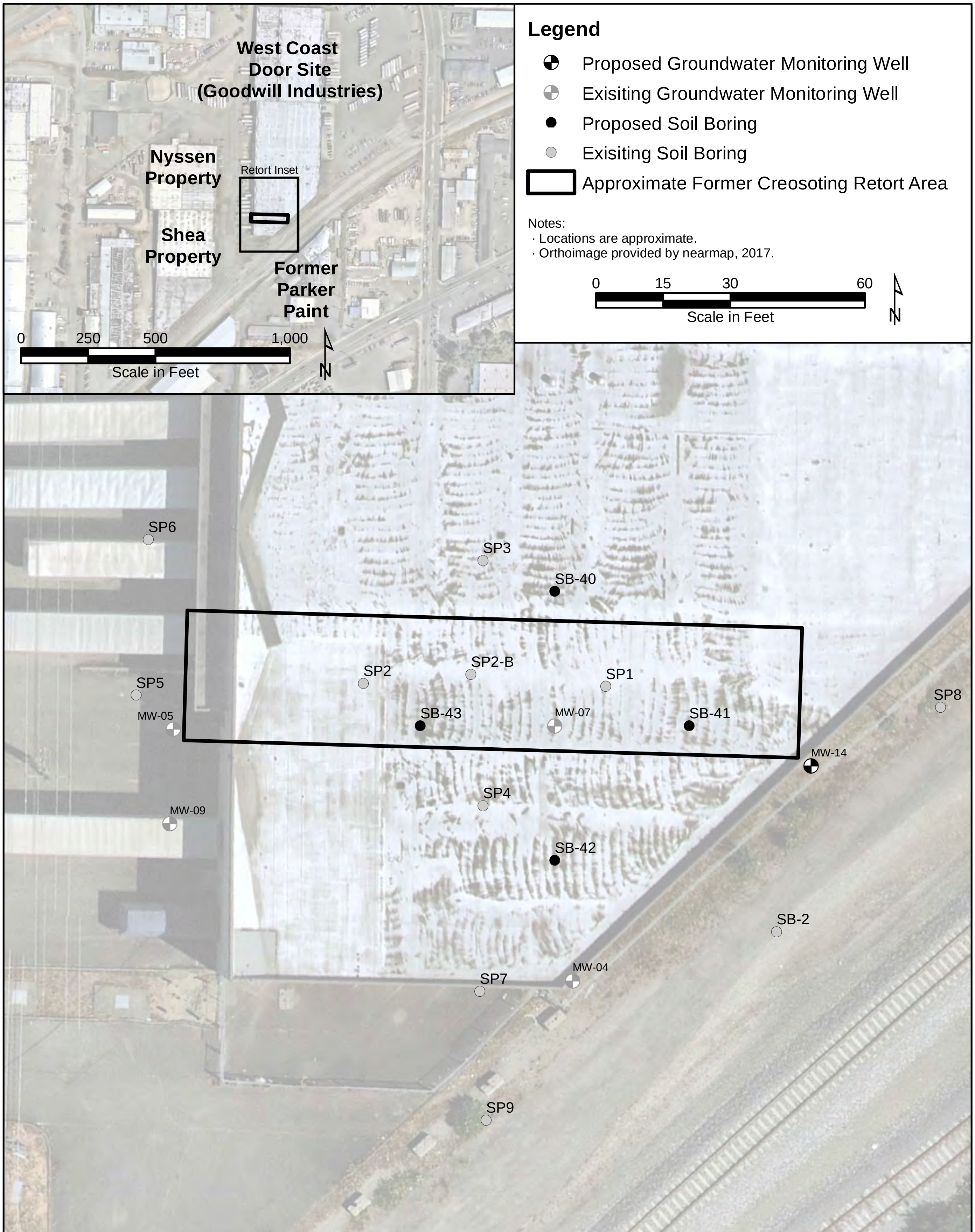

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Tacoma, Washington

Figure 4.2
Proposed Soil Borings

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7/10/2018

West Coast Door Site

Remedial Investigation
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Appendix A
Ecology Comment Letter Re: Draft RI/FS

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47775 • Olympia, Washington 98504-7775 • (360) 407-6300
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

August 2, 2017

Electronic Copy

Kimberly Seely
Coastline Law Group PLLC
4015 Ruston Way, Suite 200
Tacoma, WA 98402

Re: Draft Remedial Investigation and Feasibility Study Report for the following site:

- **Site Name:** West Coast Door
- **Site Address:** 3133 S Cedar St Tacoma, 98409 Pierce
- **Facility/Site No.:** 6308485
- **Cleanup Site No.:** 2599
- **VCP Site No.:** SW0865

Dear Ms. Seely:

In accordance with Agreed Order No. DE 14016, the Washington State Department of Ecology (Ecology) is providing the following letter to comment on the sufficiency of the January 7, 2014 Draft Remedial Investigation and Feasibility Study (RIFS) Report for the West Coast Door Cleanup Site (Site) in meeting the requirements of WAC 173-340-350. The January 7, 2014, RIFS Report was developed while cleanup was being pursued at the Site through the Voluntary Cleanup Program (VCP). The Site was terminated from the VCP on October 15, 2015 due to inactivity and is now under an agreed order to complete a remedial investigation, feasibility study, and preliminary Draft Cleanup Action Plan (DCAP).

The comments below summarize the data gaps Ecology has identified in the January 7, 2014 Draft RIFS Report.

1. Conceptual Site Model and Source Area Delineation

a) Please propose additional investigation which evaluates the presence of source material at a greater depth near monitoring well MW-7 and radially around this location. Page 3-1 states, "*The presence of a low permeability silt layer under the retort area at 45 feet bgs (below ground surface), however, appears to have limited further downward migration of the creosote product*". Ecology disagrees that this statement has been adequately determined.

More specifically, monitoring well MW-7 appears to have been advanced past the elevation of this silt layer and the silt layer was not identified. A heavy rainbow sheen and strong petroleum odor were noted at the bottom of this investigation location (as deep as 51.5 feet bgs) which indicates the bottom of the source area has not been delineated. In addition, investigation locations advanced radially around monitoring well MW-7 were not advanced to sufficient depth to delineate the potential source material. Proposed investigation locations should be advanced until the source material impacts are vertically delineated. If the vertical extent of the source area is identified prior to reaching the silt layer, the investigation should still be advanced to the approximate elevation of the deepest identified silt layer (approximately 175 feet above mean sea level).

b) Please include a more in-depth evaluation of the contaminants of concern (COCs) in the next iteration of the Draft RIFS Report. The COCs currently proposed include carcinogenic polycyclic aromatic hydrocarbons, naphthalene, and select volatile organic compounds (benzene, toluene, ethylbenzene, and xylenes). Please describe why other hazardous substances associated with wood treating (pentachlorophenol, metals, and dioxins/furans) were not included as COCs. As discussed on June 29, 2017, additional soil sample collection for metals analysis should be collected from the source area.

2. Groundwater Characterization

a) Please provide a more in-depth evaluation on the impacts of changes in groundwater flow direction and the extent of the dissolved-phase impacts. As noted in the January 7, 2014 Draft RIFS Report, inconsistencies in the groundwater flow direction occur due to strong downward gradients as well as localized mounding observed at monitoring well MW-4. In addition, Ecology anticipates inconsistencies may occur from nearby groundwater extraction wells (see comment below). A more in-depth evaluation may include preparing groundwater contours for four consecutive quarters and comparing these to isoconcentration contours of the same time period.

b) Please provide a more in-depth evaluation of the impacts of groundwater extraction wells on the extent of the contaminated groundwater. Page 2-8 states, "*West Coast Door Site lies within the theoretical capture zone of 12A its distance from well 12A and the limited pumping schedule of this well will result in no detectable movement of contaminants from West Coast Door to the South*." Additional evaluation of this statement needs to be included in the next iteration of the Draft RIFS Report. Ecology recommends comparing the pump schedules of nearby extraction wells to the groundwater and isoconcentration contours mentioned above.

c) Please install permanent monitoring wells in the locations where the contaminated groundwater has primarily been characterized by grab groundwater samples and any other locations needed to vertically and horizontally delineate the groundwater plume.

Several grab groundwater samples indicate the western extent of the contaminated groundwater plume is approximately located beneath the Shea Property warehouse and the southern extent is located in the Sound Transit right-of-way. While this data is helpful for refining our understanding of the contamination, monitoring wells are necessary to observe how the contaminated groundwater responds to changes in groundwater flow conditions. In addition, some of the existing monitoring wells are not screened at an optimal depth interval based on our current understanding of the source area. Additional permanent monitoring wells appear to be needed in the following locations:

I. West of monitoring well MW-10 on the Shea Property or immediately west of the Shea Property
II. North of monitoring well MW-12
III. Southeast of monitoring wells MW-6 and MW-7 on the Sound Transit and/or Parker Paint properties
IV. Near monitoring well MW-7 (screened at an interval of most significant impacts based on field screening)
V. North of monitoring well MW-7

3. Soil Characterization

a) Please elaborate in the next iteration of the Draft RIFS Report how the soil contamination fits into the conceptual site model and provide greater detail on the delineation of soil contamination. In addition, please include call out boxes (or another depiction) for all contaminants exceeding preliminary cleanup levels. The estimated extent of soil contamination should be described in the report and supported by field observation and analytical data.

b) Please include all completed soil boring and monitoring well logs in the RIFS Report for all investigation locations used to characterize the Site. Soil borings SB-7, 8, 10, and 11 appear to be missing from the report.

c) In accordance with WAC 173-340-7490, a Terrestrial Ecological Evaluation (TEE) needs to be completed for the Site. The evaluation must be included in the next iteration of the Draft RIFS Report even if the Site qualifies for an exclusion (WAC 173-340-7491) or simplified TEE (WAC 173-340-7492).

4. Indoor Air Characterization

a) Page 2-11 states, "*Naphthalene concentrations measured in indoor air range from 0.82 to 1.1 ug/m^3 and do not exceed MTCA Method B screening levels of 1.4 ug/m^3.*" The screening level mentioned is the Method B non-cancer cleanup level for naphthalene in indoor air.

Effective April 6, 2015, the indoor air screening levels and cleanup levels have been updated. A Method B cancer cleanup level for naphthalene in indoor air has been developed (0.0735 ug/m3) and is considerably less than the non-cancer cleanup level (1.37 ug/m3). Ecology recommends resampling for naphthalene in indoor air using a laboratory method that can achieve reporting limits equal to or less than the Method B cancer cleanup level in indoor air.

b) On September 1, 2016, Ecology was provided with a January 8, 2016 report entitled *Vapor Intrusion Investigation* by ECI Environmental Services. This document suggests the groundwater plume extending beneath the Shea and Nyssen properties is not producing concentrations of volatile contaminants of concern significant enough to cause indoor air quality concerns. The RIFS Report should be a stand-alone document which fully documents characterization of the Site. The evaluation of indoor air quality for the Shea and Nyssen property buildings needs to be incorporated into the RIFS Report.

5. Miscellaneous and Administrative

a) All investigation data needs to be electronically submitted to Ecology (via EIM). Please ensure all previous site investigation data used for characterization purposes in the RIFS Report is submitted via EIM. Groundwater elevation measurements should be included in these electronic submittals.

6. Feasibility Study

a) Page 4-8 states, "*… all alternatives retained for evaluation meet the threshold criteria outlined in MTCA*." This statement is presumably referring to WAC 173-340-360(2)(a) "threshold requirements" for the selection of a cleanup action. In addition to threshold requirements, WAC 173-340-360(2)(b) includes "other requirements" that shall: 1) use permanent solutions to the maximum extent practicable, 2) provide for a reasonable restoration time frame, and 3) consider public concerns. In other words, monitored natural attenuation cannot be used exclusively as a cleanup action for groundwater unless it can be shown that a more permanent option is not practicable and the groundwater plume will degrade in a reasonable time frame.

b) Ecology will provide additional comments on the feasibility study once the Site had been adequately characterized for the purpose of the remedial investigation. Please propose a meeting date or conference call with Ecology prior to submitting the next iteration of the Draft RIFS Report to discuss remedial alternatives to include in the feasibility study.

In accordance with Agreed Order No. DE 14016, Ecology's comments shall be addressed in a Draft Remedial Investigation Work Plan (Work Plan). The Work Plan shall be submitted to Ecology for review within 90 calendar upon receipt of this letter.

Please contact me at (360) 407-7529 or matthew.morris@ecy.wa.gov if you have any questions regarding the comments provided.

Sincerely,

Matthew Morris, P.E.
Cleanup Project Manager
Department of Ecology
Southwest Regional Office Toxics Cleanup Program

By Certified Mail: [91 7199 9991 7037 1758 8778]

cc: Tom Colligan, LHG, Floyd Snider
Rebecca S. Lawson, P.E., LHG, Ecology
Marian Abbett, P.E., Ecology

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix B
Sampling Analysis Plan/
Quality Assurance Project Plan

Table of Contents

List of Tables

List of Attachments

List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
bgs	Below ground surface
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FS	Feasibility Study
IDW	Investigation-derived waste
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MDL	Method detection limit
MS	Matrix spike
MSD	Matrix spike duplicate
NAPL	Non-aqueous phase liquid
PLP	Potentially liable person
PPE	Personal protective equipment
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
RI	Remedial investigation
RPD	Relative percent difference
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound
Work Plan	Remedial Investigation Data Gaps Work Plan

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1.0 Project Description

This Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) presents the specific field protocols and field and laboratory quality assurance (QA) and quality control (QC) procedures associated with the Remedial Investigation Data Gaps Work Plan (Work Plan) activities for the former West Coast Door Site (Site) generally located at 3120 South Pine Street and 3102 South Pine Street (formerly adjoined as 3133 South Cedar Street) in Tacoma, WA on behalf of 3102 TIC (Tenants in Common).

1.1 INTRODUCTION

The Work Plan describes general site investigation field activities to be performed as part of the Remedial Investigation (RI) including the following:

- Permanent monitoring well installation and development
- Groundwater sampling via new and existing wells
- Soil sampling via roto-sonic borings
- Soil vapor sampling

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2.0 Project Organization and Responsibility

The various QA field, laboratory, and management responsibilities of key project personnel are defined below.

2.1 MANAGEMENT RESPONSIBILITIES

Kimberly Seely—Coastline Law Group Agreed Order Project Coordinator

Kimberly Seely will be the primary point of contact with the Washington State Department of Ecology (Ecology) and the potentially liable persons (PLPs) for the Site. She will perform the following tasks:

- Facilitate access for field activities.
- Review and approve all reports (deliverables) before their submittal Ecology on behalf of the PLPs.

Tom Colligan—Floyd|Snider Project Manager, Licensed Hydrogeologist

Tom Colligan, Project Manager, will have overall responsibility for project implementation and be responsible for all geologic and hydrogeologic work performed pursuant to this Order.

As Project Manager he will be responsible for maintaining QA on this project and ensuring that the Work Plan objectives are met. He will perform the following tasks:

- Review the Work Plan.
- Monitor project activity and quality.
- Provide overview of field activities to West Coast Door and Ecology.
- Prepare and review the draft RI and Feasibility Study (FS) reports.
- Provide technical representation of project activities at meeting.

2.2 QUALITY ASSURANCE RESPONSIBILITIES

Kristin Anderson—Floyd|Snider QA Manager

The QA Manager reports directly to the Floyd|Snider Project Manager and will be responsible for ensuring that all QA/QC procedures for this project are followed. The QA Manager will be responsible for coordinating the data validation of all sample results from the analytical laboratories.

The QA Manager will also perform the following:

- Oversee and review field QA/QC.
- Coordinate supply of performance evaluation samples and review results from performance audits.

- Coordinate review and data validation of laboratory QA/QC.
- Advise on data corrective action procedures.
- QA/QC representation of project activities.

Chell Black—Floyd|Snider Data Manager

The Data Manager will be responsible for the data validation of all sample results from the analytical laboratories and entering the data into a database. The Data Manager will also perform the following:

- Review laboratory reports.
- Load analytical data to Ecology's Environmental Information Management (EIM) database.
- Advise on data corrective action procedures.
- Perform QA/QC on analytical data reports.
- Oversee database management and queries.

2.3 LABORATORY RESPONSIBILITIES

Fremont Analytical, Inc. will perform all analytical services in support of the proposed soil, groundwater, and air analyses. Data validation will be conducted by Floyd|Snider.

Mike Ridgeway (President/Laboratory Director)

The Laboratory Project Manager will report directly to the Floyd|Snider QA Manager. Responsibilities include the following:

- Ensure all resources of the laboratory are available.
- Advise Floyd|Snider's QA Manager of laboratory status.
- Review and approve final analytical reports.
- Coordinate laboratory analyses.
- Supervise in-house chain-of-custody procedures.
- Schedule sample analyses.
- Oversee data review.

2.4 FIELD RESPONSIBILITIES

Pam Osterhout—Floyd|Snider Field Lead

The Field Lead will be responsible for leading and coordinating the day-to-day activities in the field. The Field Lead will report directly to the Floyd|Snider Project Manager.

The Field Lead will perform the following:

- Coordinate with the Project Manager and QA Manager.
- Coordinate and manage field staff including sampling staff and drillers.
- Review field data including field logs and field measurement data.
- Adhere to the work schedule.
- Coordinate and oversee subcontractors.

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3.0 Laboratory Quality Assurance Objectives

The objective of this section is to clarify laboratory data QA objectives for field sampling and laboratory analyses. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventative maintenance of field/laboratory equipment, and corrective action are described in subsequent sections of this SAP/QAPP.

3.1 LABORATORY QUALITY ASSURANCE OBJECTIVES

The quality of analytical data generated by the laboratory will be assessed by the frequency and type of internal QC checks developed for analysis type. Laboratory results will be evaluated against QA objectives by reviewing results for analysis of method blanks, matrix spikes (MSs), duplicate samples, laboratory control samples (LCSs), calibrations, performance evaluation samples, and interference checks as required by the specific analytical methods. Data quality objectives are summarized in Table B.1.

3.2 PRECISION

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, precision is a quantitative measure of the variability of a group of measurements compared to their average values. Analytical precision is measured through MS/matrix spike duplicate (MSD) samples for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision measurements will be carried out on project-specific samples at a minimum laboratory duplicate frequency of 1 per laboratory analysis group or 1 in 20 samples, whichever is more frequent per matrix analyzed, as practical. Laboratory precision will be evaluated against quantitative relative percent difference (RPD) performance criteria.

Blind field duplicates will be collected for groundwater and non-volatile soil analyses to assess field precision (i.e., low-flow groundwater sampling and soil sample collection and homogenization). Field duplicates will be collected at a minimum frequency of 1 per laboratory analysis group or 1 in 20 samples. Currently, no performance criteria have been established for field duplicates. Field duplicate precision will, therefore, be screened against a RPD of 75 percent for all samples. However, no data will be qualified based solely on field duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit (MDL), where the percent error (expressed as RPD) increases. The equations used to express precision are as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:
RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values

3.3 ACCURACY

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Analytical accuracy may be assessed by analyzing "spiked" samples with known standards (surrogates, LCSs, and/or MS) and measuring the percent recovery. Accuracy measurements on MS samples will be carried out at a minimum frequency of 1 in 20 samples per matrix analyzed. Because MS/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MS/MSDs only on samples from this investigation and not from other projects. Surrogate recoveries will be determined for every sample analyzed for organics.

Laboratory accuracy will be evaluated against quantitative LCS, MS, and surrogate spike recoveries using limits for each applicable analyte. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \times (S-U)/C_{sa}$$

Where:
%R = percent recovery
S = measured concentration in the spiked aliquot
U = measured concentration in the unspiked aliquot
C_{sa} = actual concentration of spike added

3.4 REPRESENTATIVENESS

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Care will be taken in the design of the sampling program to ensure sample locations are properly selected, sufficient numbers of samples are collected to accurately reflect conditions at the location(s), and samples are representative of the sampling location(s). A sufficient volume of sample will be collected at each sampling location to minimize bias or errors associated with sample particle size and heterogeneity.

3.5 COMPARABILITY

Comparability is a qualitative parameter expressing the confidence with which one dataset can be compared to another. In order to insure results are comparable, samples will be analyzed using standard U.S. Environmental Protection Agency (USEPA) methods and protocols. Calibration and reference standards will be traceable to certified standards and standard data reporting formats will be employed. Data will also be reviewed to verify that precision and accuracy criteria were achieved and, if not, that data were appropriately qualified.

3.6 COMPLETENESS

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{\text{(Number of acceptable data points) x 100}}{\text{(Total number of data points)}}$$

The data quality objective for completeness for all components of this project is 95 percent. Data that were qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that are qualified as rejected will not be considered valid for the purpose of assessing completeness.

3.7 QUALITY CONTROL PROCEDURES

3.7.1 Field Quality Control Procedures

Trip blanks will be included in each cooler with samples being analyzed for volatile organic compounds (VOCs) to identify any artifacts of improper sample handling, storage, or shipping. A rinsate blank QC sample will also be collected for each sampling event on the non-dedicated field equipment (i.e., stainless steel bowl and spoon) to ensure field decontamination procedures are effective. All field QC samples will be documented in the field logbook and verified by the QA Manager or designee. A blind field duplicate will be collected at a frequency of 1 in 20 samples for groundwater and non-volatile soil analyses to evaluate the efficacy and repeatability of field sample collection procedures, variability from sample handling, and site heterogeneity.

3.7.2 Laboratory Quality Control Procedures

Laboratory Quality Control Criteria. One sample from each delivery group will be spiked and the recoveries of spiked compounds compared to the QC criteria. Results of the laboratory QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine whether control limits were exceeded. If control limits are exceeded in the sample group, corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to documented and reliable commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities identified in the standard will be documented.

The following paragraphs summarize the procedures that will be used to assess data quality throughout sample analysis.

Laboratory Duplicates. Laboratory duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. A minimum of 1 project-specific duplicate will be analyzed per sample group or for every 20 samples, whichever is more frequent.

Matrix Spikes and Matrix Spike Duplicates. Analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing MSD analyses, information on the precision of the method is also provided for organic analyses. A minimum of 1 MS/MSD will be analyzed for every sample group or for every 20 samples, whichever is more frequent. MS/MSD analyses will be performed on project-specific samples (i.e., batch QC using samples from other projects is not permitted). When there are fewer than 20 samples, a MS/MSD will still be analyzed. When there are more than 20 samples, a second MS/MSD will be analyzed.

Laboratory Control Samples and Laboratory Control Sample Duplicate. An LCS is a method blank sample carried throughout the same process as the samples to be analyzed, with a known amount of standard added. The blank spike compound recovery assesses analytical accuracy in the absence of any sample heterogeneity or matrix effects. All LCS and laboratory control sample duplicate (LCSD) data for metals and organic compounds will be reported. The LCS/LCSD will be performed once per analysis batch.

Surrogate Spikes. All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; sample results may be qualified based on surrogate compound recovery; however, no sample result will be adjusted for recovery using these values.

Method Blanks. Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of 1 method blank will be analyzed for every extraction batch or 1 for every 20 samples, whichever is more frequent.

4.0 Sample Handling and Custody Documentation

Sample possession and handling must be traceable from the time of sample collection, through laboratory and data analysis, to the time sample results are reported. A field form or field logbook entries will be completed for each location occupied and each sample collected.

4.1 SAMPLE HANDLING

To control the integrity of the samples during transit to the laboratory and during hold prior to analysis, established preservation and storage measures will be taken. Sample containers will be labeled with the client name (i.e., Floyd|Snider), location name/number, sample number, and sampling date and time. The Field QA Officer will check all container labels, chain-of-custody form entries, and logbook entries for completeness and accuracy at the end of each sampling day.

4.2 SAMPLE CHAIN-OF-CUSTODY

Sample labeling and custody documentation will be performed as described in this document. Custody procedures will be used for all samples at all stages in the analytical or transfer process and for all data and data documentation whether in hardcopy or electronic format.

4.3 SAMPLE PRESERVATION

Samples requiring field preservation will be placed into pre-preserved sample jars supplied by the laboratory (e.g., VOCs and metals, depending on media). Immediately after the sample jars are filled with each media, they will be held in an appropriate cooler with ice packs or crushed ice until delivery to the laboratory. Sample handling requirements for specific analyses are presented in further detail in Table B.2.

4.4 SAMPLE SHIPMENT

Technical field staff will be responsible for sample preservation and handling and chain-of-custody procedures in the field. The Field QA Officer will review the chain-of-custody forms and requested analyses and will maintain sample custody documentation. At the end of each day, and prior to transfer, chain-of-custody form entries will be made for all samples. Each shipment of coolers will be accompanied by chain-of-custody forms; the forms will be signed at each point of transfer. Copies of all chain-of-custody forms will be retained and included in the laboratory report.

Prior to shipping or transport, sample containers will be wrapped and securely packed inside the cooler with ice packs or crushed ice by the field technician or designee. The original, signed chain-of-custody forms will be transferred with the cooler. The cooler will be secured and appropriately sealed and labeled for immediate shipping or transport via vehicle. Samples will be delivered to the laboratory under custody following completion of sampling activities.

4.5 SAMPLE RECEIPT

The designated sample custodian at the laboratory will accept custody of the samples and verify that the chain-of-custody form matches the samples received. The Laboratory Project Manager will ensure that the chain-of-custody forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity, cooler temperature, or the requested analyses. The Laboratory Project Manager will contact the QA Manager if discrepancies are discovered between the chain-of-custody forms and the sample shipment upon receipt.

5.0 Data Reduction, Validation, and Reporting

Raw analytical data reduction, QA evaluation, and report generation will be carried out by the laboratory as described in the appropriate analytical protocols and the laboratories' QA Manuals. QC data resulting from methods and procedures described earlier in this document will also be reported.

5.1 DATA REDUCTION AND REPORTING

The laboratories will perform QA review of the laboratory reports prior to transmittal and will correct any errors identified during this review. The QA Manager will work with the laboratories to resolve any QC problems in a timely manner. The analytical laboratories will be required, where applicable, to report the following as part of the formal completed data package:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered (actual or perceived) and their resolutions will be documented in as much detail as necessary.
- **Sample IDs.** Records will be produced that clearly match all field and laboratory sample identification codes.
- **Chain-of-Custody Records.** Copies of the chain-of-custody forms will be provided as part of the laboratory report. This documentation will include the time of receipt and condition of each sample received by the laboratories.
- **Sample Results**. The laboratory report will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code.
  - Sample matrix.
  - Date of sample extraction.
  - Date and time of analysis.
  - Weight and/or volume used for analysis.
  - Final dilution volumes or concentration factor for the sample.
  - Percent moisture in solid samples.
  - Identification of the instrument used for analysis.
  - Method reporting and quantitation limits.
  - Analytical results reported with reporting units identified.
  - All data qualifiers and their definitions.
  - Electronic data deliverables (EDDs).

- **Quality Assurance/Quality Control Summaries.** This section will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (refer to above). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
  - **Method Blank Analysis.** The method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks will be reported.
  - **Surrogate Spike Recovery.** All surrogate spike recovery data for organic compounds will be reported. The name and concentration of all compounds added, percent recoveries, and range of recoveries will be listed.
  - **Matrix Spike Recovery.** All MS recovery data for metals and organic compounds will be reported. The name and concentration of all compounds added, percent recoveries, and range of recoveries will be listed. The RPD for all duplicate analyses will be reported.
  - **Matrix Duplicate.** The RPD for all matrix duplicate analyses will be reported.
  - **Laboratory Control Samples and Laboratory Control Sample Duplicates.** All LCS/LCSD for metals and organic compounds will be reported. The RPD for all duplicate analyses shall be reported.

5.2 DATA VALIDATION

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

A Level 2A summary validation will be performed on all data following USEPA National Functional Guidelines in accordance with the QAPP limits (USEPA 2016a and 2016b). The laboratory reports will be reviewed for internal consistency, transmittal errors, laboratory protocols, and adherence to the data quality objectives as specified in this SAP/QAPP.

All chemical data will be reviewed with regard to the following:

- Chain-of-custody/documentation.
- Sample preservation and holding times.
- Method blanks.
- Reporting limits.
- Surrogate recoveries.
- MS/MSD recoveries and RPDs.
- LCS/LCSD recoveries and RPDs.
- Laboratory and field duplicate RPDs.
- Field blanks.

Data usability, conformance with the data quality objectives, and any deviations that may have affected the quality of the data, as well as the basis of application of qualifiers, will be included in the final reporting of the data. Any required corrective actions based on the evaluation of the analytical data will be determined by the Laboratory Project Manager in consultation with the Floyd|Snider QA Manager and may include qualification or rejection of the data.

The Data Validation summary report will be presented as an appendix to the RI/FS. Validated data will be entered into the project database and uploaded to Ecology's EIM system.

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6.0 Corrective Actions

Corrective action procedures are described in this section.

6.1 CORRECTIVE ACTION FOR FIELD SAMPLING

The Field Lead will be responsible for correcting or documenting field errors in sampling or equipment malfunctions and will be responsible for reporting these issues to the Project Manager and also resolving situations in the field that may result in non-compliance with this SAP/QAPP. All corrective measures will be documented in the field logbook.

6.2 CORRECTIVE ACTION FOR LABORATORY ANALYSES

The laboratories are required to comply with their Standard Operating Procedures. The Laboratory Project Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this SAP/QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

Test sample and QC sample data will be reviewed to determine if there is an exceedance of QC limits. If any QC sample exceeds the project-specified control limits, the analyst will identify and correct the anomaly before continuing with the sample analysis. The analyst will document the corrective action taken in a memorandum submitted to the QA Manager. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and/or re-extraction) will be submitted with the data package.

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7.0 Field Investigation Procedures

The following sections describe the specific protocols that will be used to gather site data as described in the Work Plan. Floyd|Snider standard guidelines for all field sampling activities included in the Work Plan are provided in Attachment B.1.

7.1 GROUNDWATER RECONNAISSANCE SAMPLE COLLECTION PROCEDURES

Reconnaissance groundwater samples will be collected by direct-push drilling. A 3-foot retractable stainless steel screen fitted with an expendable drill point will be driven to a bottom depth of 40 feet below ground surface (bgs), which is within the most heavily contaminated zone of groundwater. After reaching the target depth, the outer casing surrounding the screen will be retracted. The water inside the screen will be purged using a peristaltic pump to remove fine-grained particles. Samples for laboratory analysis will be collected once the purge water is visually clear.

7.1.1 Reconnaissance Groundwater Sample Nomenclature and Handling

The sample number format for reconnaissance groundwater samples will be “well number-start of depth interval-end of depth interval-W.” For example, a sample collected from a depth interval of 37 to 40 feet bgs from well MW-18 would be labeled MW-18-37-40-W. A blind field duplicate sample would be labeled with a fictitious sample location such as “MW-13.” Other information that will be included on the bottle label is the date, time, analyses, and initials of sampler.

The samples will be shipped or delivered to the laboratory at the end of the day or at the conclusion of the sampling event, ensuring that the analytical holding times specified in Table B.2 are met while minimizing the number of sample delivery groups to the extent possible for the purposes of laboratory QA analyses.

7.1.2 Laboratory Analysis

The analyses to be performed on reconnaissance groundwater samples are summarized in Table B.3.

7.2 MONITORING WELL INSTALLATION, SOIL SAMPLING, AND DEVELOPMENT PROCEDURES

The proposed monitoring wells will be installed as resource protection wells in accordance with WAC 173-160. Specific procedures are summarized in this section and described further in the Floyd|Snider standard guidelines (Attachment B.1).

Borings will be advanced and wells completed by a licensed driller. Proposed well locations are shown in Figure 4.1 of the Work Plan. Prior to conducting the subsurface exploration program, each location will be checked for the presence of underground utilities by submitting a locate request of public utilities to the Washington Utility Notification Center and each proposed location (including alternative locations) screened for additional utilities by a private utility location company. Exploration locations may be moved to a limited degree based on field conditions and if underground or aboveground utility locations, and/or site operational constraints, are present. The boreholes for the wells will be drilled using standard roto-sonic drilling techniques. Sonic boreholes will be advanced using either a 6- or 8-inch-inner-diameter sonic core barrel.

Soil cores will be collected continuously during roto-sonic drilling and each core sample logged and photographed by the field geologist. In order to better understand Site conditions, the soil borings inside the warehouse will be the first field activity conducted. Following this, the boring for the deep well (MW-14) will be advanced and the screened interval chosen based on depth of observed soil contamination and the presence of low permeability silt or clay lenses.

At MW-14, the drill will advance until the deeper low permeability unit is encountered, which is anticipated to be about 70 to 80 feet bgs. Ultimately, the screen depth for this deep well will be a joint decision made in consultation with Ecology.

At the shallower well locations, borings will be advanced to the anticipated depth of the upper silt layer between 35 and 45 feet bgs and screened above the silt layer. If the silt layer is not encountered above 55 feet bgs, the screen will be placed from 35 to 45 feet, or at the depth with the greatest field indications (if encountered).

The monitoring wells will be constructed with 10-foot screens. All wells will be constructed of 2-inch-diameter, flush-threaded, Schedule 40 polyvinyl chloride (PVC) well casings and screens. Well screen assemblies will consist of a 10-foot length of 0.010-inch (10-slot) or 0.020-inch (20-slot) machine-slotted, flush-threaded, Schedule 40 PVC set in a 10/20 sand or equivalent silica sand filter pack. The well design includes a 0.3-foot-long flush-threaded, Schedule 40 PVC sump with a flush-threaded end cap. The sand filter pack will be installed by pouring sand into the annular space between the well casing and the borehole as the outer steel casing is withdrawn. A weighted tape will be used to monitor filter pack placement and depth during installation. The sand filter pack will extend a minimum of 1 foot above the top of the screened interval. A minimum 2-foot-thick seal of hydrated bentonite chips will be installed in the annular space immediately above the sand filter pack and hydrated with potable water if installed above the water table. The remainder of the annular space will be sealed with bentonite grout or hydrated bentonite chips to within 2 feet of the ground surface.

The monitoring wells will be secured with flush-to-ground locking steel protective monuments with gaskets on the well casing to minimize the potential for surface water entering the monument. The monument will be set in concrete to a depth of 2 feet. Well surging and development will be performed by the driller and will be completed by continuous pumping at a steady rate using a portable submersible pump and surge block. All new wells will be developed prior to sampling, and existing site wells will be additionally assessed for integrity, including the condition of surface seals and presence of sedimentation, and may be redeveloped or repaired prior to sampling if warranted. Wells will be allowed to equilibrate a minimum of 7 days after development before collecting groundwater samples. Specific procedures for well development are included in the Floyd|Snider standard guidelines (Attachment B.1).

7.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater samples will be collected from monitoring wells after purging with low-flow techniques in accordance with Floyd|Snider standard guidelines (Attachment B.1). Water level measurements during each event will be collected immediately prior to purging for an accurate representation of the potentiometric surface.

7.3.1 Groundwater Sample Nomenclature and Handling

The sample number format for all groundwater samples will be the well number. A blind field duplicate sample would be labeled with a fictitious sample location such as "MW-13." Other information that will be included on the bottle label is the date, time, analyses, and initials of sampler.

The samples will be shipped or delivered to the laboratory at the end of the day or at the conclusion of the sampling event, ensuring that the analytical holding times specified in Table B.2 are met while minimizing the number of sample delivery groups to the extent possible for the purposes of laboratory QA analyses.

7.3.2 Laboratory Analysis

The analyses to be performed on groundwater samples are summarized in Table B.3.

7.4 SOIL SAMPLING PROCEDURES

Specific procedures for soil sampling are summarized in this section and further described in the Floyd|Snider standard guidelines (Attachment B.1). Four soil borings will be advanced radially around MW-07 near the Former Creosoting Retort Area. The proposed borings will be advanced using standard roto-sonic drilling techniques at the locations shown in Figure 4.2 of the Work Plan. These borings will be advanced to the depth of the deeper low permeability silt layer. Soil will be continuously collected and logged during drilling. Samples will be screened for field indications of contamination to define the extent of impacts, and two to three representative samples of impacted soil will be collected for analysis. A soil sample will be also collected just below the deepest observed impacts.

Soils will be logged for soil type and moisture and also for visual evidence of oily contamination; tactile evidence of sticky or oily soil; olfactory evidence of creosote, naphthalene, or other hydrocarbon odors, and the presence of volatiles measured using a photoionization detector (PID). Additionally, soils will be screened for the presence of non-aqueous phase liquid (NAPL) using sheen tests, ultraviolet light to detect fluorescence, and water shake tests with an oil soluble dye to make qualitative assessments of the presence and volume of NAPL and its relative mobility.

7.4.1 Soil Sample Nomenclature and Handling

The sample number format for all soil samples will be "well number—start of depth interval—end of depth interval." For example, a sample collected from the 2- to 4-foot depth interval of well MW-01, would be labeled MW-01-2-4. A blind field duplicate sample would be labeled with a fictitious sample location. For example, a field duplicate could be named "MW-13-2-4." Every soil sample will have a unique identifier, and the collection date will be known from the sample bottle and chain-of-custody form. Sample labels will include the time of collection and initials of sampler on the bottle label.

The samples will be shipped or delivered to the laboratory as soon as feasible following collection to ensure that the analytical holding times specified in Table B.2 are met.

7.4.2 Laboratory Analysis

The analyses to be performed on soil samples collected during the RI/FS field investigation are summarized in Table B.3.

7.5 SOIL VAPOR SAMPLING PROCEDURES

Specific procedures for soil vapor sampling are summarized in this section and described in the Floyd|Snider standard guidelines (Attachment B.1). Sub-slab soil vapor samples will be collected from permanent monitoring points installed adjacent to existing boring SP2 and MW-7 in the Former Creosoting Retort Area of the warehouse, where shallow creosote-impacted soil was noted during previous investigations. Samples will be collected in evacuated SUMMA® canisters using flow rate regulators to allow sample collection at a controlled purge rate.

If indoor air samples are determined to be necessary, air samples will be collected. The approach for air sampling will be developed in coordination with Ecology and summarized in a memorandum after receipt of the sub-slab data.

7.5.1 Soil Vapor Sample Nomenclature and Handling

The sample number format for all soil vapor samples will be "location number-vapor-month/day/year of collection." For example, a sample collected from location SP2 on December 15, 2018, would be labeled SP2-vapor-121517. Every soil vapor sample will have a unique identifier. Sample labels will include the time of collection and initials of sampler on the bottle label.

The samples will be shipped or delivered to the laboratory as soon as feasible following collection to ensure that the analytical holding times specified in Table B.2 are met.

7.5.2 Laboratory Analysis

The analyses to be performed on air samples collected during the RI/FS field investigation are summarized in Table B.4. Analyses of chemicals in air will be conducted using USEPA Method TO-15, consistent with the methods described in the CalEPA Advisory for Active Soil Gas

Investigations (CalEPA 2015) including laboratory methods for container cleaning and stability testing.

7.6 EQUIPMENT DECONTAMINATION

Field sampling equipment, such as stainless steel bowls and the water level indicators, will be cleaned between uses at each sampling location. Equipment for reuse will be decontaminated, according to the procedure below, before each sample interval.

1. Water will be sprayed over equipment to dislodge and remove any remaining soil.
2. Surfaces of equipment contacting sample material will be scrubbed with brushes using an Alconox solution.
3. Scrubbed equipment will be rinsed with clean water.
4. Equipment will undergo a final spray rinse of deionized water.
5. Heavily contaminated equipment will also undergo wiping with a non-toxic spray cleaner (e.g., Simple Green) followed by a supplemental rinse with deionized water.

7.7 SURVEYING

All wells will be professionally surveyed after sampling is complete. Elevations will be reported relative to the North American Vertical Datum of 1988 (NAVD 88). Well and boring logs will include the horizontal datum of North American Datum of 1983 (NAD 83) High Accuracy Reference Network (HARN), the Washington State Plane South coordinates of the well, and the top of well casing elevation (for the wells). The coordinate and elevation reference systems will also be noted on the well log. Soil boring locations will be measured and recorded relative to permanent Site features such as building corners.

7.8 INVESTIGATION-DERIVED WASTE MANAGEMENT

Generated waste will be managed and disposed of in accordance with applicable waste management regulations. Investigation-derived waste (IDW) includes the following liquids and solids:

- Purge water
- Decontamination wash water
- Soil drill cuttings, including non-soil debris that may be removed from the subsurface during drilling
- Disposable materials used during fieldwork that may be impacted by contaminated media, or decontamination wash water (e.g., disposable personal protective equipment [PPE], used filters, plastic sheeting, paper towels, tubing, etc.)

The approach to handling and disposal of these materials is as follows: For IDW that is containerized (e.g., soil cuttings and groundwater purge water), 55-gallon drums will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “soil cuttings”), the dates on which the wastes were placed in the container, the owner’s name and contact information of the field person generating the waste, the Site name, and the boring(s) or well(s) from which they were obtained or extracted. At the end of each day, the drums will be transferred to a designated temporary storage area on-site.

This waste will be managed in accordance with applicable regulations and standards. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used as appropriate for disposal.

All disposable sampling material and PPE (e.g., paper towels, disposable coveralls, and gloves) will be placed in heavyweight garbage bags or other appropriate containers for disposal at a solid waste landfill.

7.9 DATA REPORTING

The January 7, 2014, Draft RI/FS Report for the Site will be updated to include the results of the activities summarized in the Work Plan and described in this SAP/QAPP. Data presentation and analysis will be provided in accordance with Ecology’s August 2, 2017, comment letter (refer to Appendix A of the Work Plan).

Following data validation, and within 180 days of receipt of data, analytical data will be uploaded to the Ecology EIM database. In addition, any outstanding Site analytical data collected after 2005 will be uploaded to the EIM database.

8.0 References

California Environmental Protection Agency (CalEPA). 2015. *Advisory Active Soil Gas Investigation.* Prepared by CalEPA Department of Toxic Substances Control, Los Angeles Regional Water Quality Board, and San Francisco Regional Water Quality Board. July.

U.S. Environmental Protection Agency (USEPA). 2014a. *National Functional Guidelines for Superfund Organic Methods Data Review*. Prepared by USEPA Office of Superfund Remediation and Technology Innovation, Washington, D.C. OSWER 9355.0-132/EPA-540-R-014-002. August.

_____. 2014b. *National Functional Guidelines for Inorganic Superfund Data Review*. Prepared by USEPA Office of Superfund Remediation and Technology Innovation, Washington, D.C. OSWER 9355.0-131/EPA-540-R-013-001. August.

Washington State Department of Ecology (Ecology). 2010. *Standard Operating Procedure for the use of Submersible Pressure Transducers during Groundwater Studies*. 20 October.

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix B
Sampling Analysis Plan/
Quality Assurance Project Plan

Tables

Table B.1
Data Quality Assurance Criteria

Analyses[1]	Matrix	Method	Units	Precision	Accuracy	Completeness
Groundwater Samples						
Semivolatile Organic Compounds	Water	USEPA 8270	µg/L	± 20%	± 30%	95%
Volatile Organic Compounds	Water	USEPA Method 8260C	µg/L	± 20%	± 30%	95%
Soil Samples						
Metals	Soil	USEPA 6020/7471 (Hg)	mg/kg	± 20%	± 30%	95%
Semivolatile Organic Compounds	Soil	USEPA 827/8270 SIM	mg/kg	± 20%	± 30%	95%
Volatile Organic Compounds	Soil	USEPA 8260C	mg/kg	± 20%	± 30%	95%
Air Samples						
Volatile Organic Compounds	Air	USEPA TO-15	µg/m^3	± 30%	± 30%	95%

Note:

1 Individual analytes are presented in Tables B.3 and B.4.

Abbreviations:

BTEX Benzene, toluene, ethylbenzene, and xylenes
cPAH Carcinogenic polycyclic aromatic hydrocarbon
µg/L Micrograms per liter
µg/m^3 Micrograms per cubic meter
mg/kg Milligrams per kilogram

Table B.2
Analytical Requirements, Methods, Preservation, Bottle Type, and Holding Times

Analyses[1]	Matrix	Method	Bottle Type	Preservative	Holding Time
Groundwater Samples					
Semivolatile Organic Compounds	Water	USEPA Method 8270	2 x 1 L amber glass	None, cool to <4 °C	7 days to extract, then 40 days to analyze
Volatile Organic Compounds	Water	USEPA Method 8260C	Three 40-mL vials[2]	HCl to pH <2.0, cool to <4 °C	7 days (unpreserved), 14 days (preserved)
Soil Samples					
Metals	Soil	USEPA Method 6020, USEPA Method 7471 (Hg)	One 4-oz WMG	None, cool to <4 °C	6 months (or freeze for 1 year) 28 days for Hg
Semivolatile Organic Compounds	Soil	USEPA Method 8270/8270 SIM	One 8-oz WMG	None, cool to <4 °C	14 days to extract, then 40 days to analyze (or freeze for 1 year)
Volatile Organic Compounds	Soil	USEPA Method 8260C	Three pre-tared or MeOH-preservative	Cool to <4 °C	Three pre-tared or MeOH-preservative vials
Air Samples					
Volatile Organic Compounds	Air	USEPA TO-15	1 L evacuated Summa canister	Air	30 days to extract, then 3 days to analyze

Notes:

1 Individual analytes are presented in Tables B.3 and B.4.

2 No head space in sample container.

Abbreviations:

BTEX Benzene, toluene, ethylbenzene, and xylenes
°C Degrees Celsius
cPAH Carcinogenic polycyclic aromatic hydrocarbon
HCl Hydrochloric acid
Hg Mercury
L Liter
MeOH Methanol
mL Milliliters
oz Ounces
WMG Wide-mouth glass jar

Table B.3
Analytical Methods, Detection Limits, and Reporting Limits for Chemicals in Groundwater and Soil

Analyte	Method	Groundwater (µg/L)[1]			Soil (mg/kg)[2]		
		Screening Level[3]	Screening Level Basis	Reporting Limit[3,4]	Screening Level[3]	Screening Level Basis	Reporting Limit[3,4]
Metals							
Antimony	USEPA 6020/ 7471 (Hg)	NA	NA	NA	32	MTCA B	0.20
Arsenic		NA	NA	NA	20	MTCA A	0.10
Beryllium		NA	NA	NA	160	MTCA B	0.20
Cadmium		NA	NA	NA	2.0	MTCA A	0.20
Chromium (Total)[5]		NA	NA	NA	2,000	MTCA A	0.10
Copper		NA	NA	NA	3,200	MTCA B	0.20
Lead		NA	NA	NA	250	MTCA A	0.20
Mercury		NA	NA	NA	2.0	MTCA A	0.25
Nickel		NA	NA	NA	1,600	MTCA B	0.50
Selenium		NA	NA	NA	400	MTCA B	0.50
Silver		NA	NA	NA	400	MTCA B	0.10
Thallium		NA	NA	NA	0.80	MTCA B	0.20
Zinc		NA	NA	NA	24,000	MTCA B	0.50
Volatile Organic Compounds[6]							
1,1,1-Trichloroethane	USEPA 8260C	200	MTCA A	1.0	320	MTCA B	0.025
1,1-Dichloroethane		7.7	MTCA B	1.0	--	--	0.020
1,2,4-Trimethylbenzene		--	--	1.0	NA	NA	0.020
1,3,5-Trimethylbenzene		80	MTCA B	1.0	800	MTCA B	0.025
Benzene		5.0	MTCA A	1.0	0.030	MTCA A	0.020
Chloroform		1.4	MTCA B	1.0	32	MTCA B	0.020
Chloromethane		--	--	2.0	--	--	0.050
cis-1,2-Dichloroethene		16	MTCA B	1.0	160	MTCA B	0.020
Ethylbenzene		1,000	MTCA B	1.0	6.0	MTCA A	0.025
Isopropylbenzene (Cumene)		800	MTCA B	1.0	8,000	MTCA B	0.025
Methyl isobutyl ketone (4-Methyl-2-pentanone (MIBK))		640	MTCA B	1.3	6,400	MTCA B	0.25
Naphthalene		160	MTCA A	1.0	5.0	MTCA A	0.050
n-Propylbenzene		800	MTCA B	1.0	8,000	MTCA B	0.025
Styrene		1,600	MTCA B	1.0	16,000	MTCA B	0.025
Toluene		700	MTCA A	1.0	7.0	MTCA A	0.020
Trichloroethene (TCE)		5.0	MTCA A	0.50	0.030	MTCA A	0.020
Xylene (meta & para)		1,000	MTCA A	1.0	9.0	MTCA A	0.050
Xylene (ortho)		1,000	MTCA A	1.0	9.0	MTCA A	0.025
Total Xylenes[7]		1,000	MTCA A	NA	9.0	MTCA A	0.050
Semivolatile Organic Compounds[6]							
1-Methylnaphthalene	USEPA 8270/ 8270 SIM	1.5	MTCA B	0.10	34	MTCA B	0.040
2,4,5-Trichlorophenol		NA	NA	NA	8,000	MTCA B	0.10
2,4,6-Trichlorophenol		NA	NA	NA	80	MTCA B	0.10
2,4-Dichlorophenol		NA	NA	NA	240	MTCA B	0.10
2,4-Dimethylphenol		NA	NA	NA	1,600	MTCA B	0.10
2,4-Dinitrophenol		NA	NA	NA	160	MTCA B	0.10
2-Chlorophenol		NA	NA	NA	400	MTCA B	0.10
2-Methylnaphthalene		32	MTCA B	0.10	320	MTCA B	0.040
2-Methylphenol (o-cresol)		NA	NA	NA	4,000	MTCA B	0.10
2-Nitrophenol		NA	NA	NA	--	--	0.10
4,6-Dinitro-2-methylphenol		NA	NA	NA	--	--	0.20
4-Chloro-3-methylphenol		NA	NA	NA	--	--	0.20
3&4-Methylphenol (m,p-cresol)		NA	NA	NA	4,000	MTCA B	0.10
4-Nitrophenol		NA	NA	NA	--	--	0.50
Acenaphthene		960	MTCA B	0.10	4,800	MTCA B	0.040
Acenaphthylene		--	--	0.10	--	--	0.040
Anthracene		4,800	MTCA B	0.10	24,000		0.040
Benzo(a)anthracene		--	--	0.10	1.4	--	0.040
Benzo(a)pyrene		--	--	0.10	0.10	--	0.040
Benzo(b)fluoranthene		--	--	0.10	1.4	--	0.040
Benzo(k)fluoranthene		--	--	0.10	14	--	0.040
Chrysene		--	--	0.10	137	--	0.040
Dibenzo(a,h)anthracene		--	--	0.10	0.14	--	0.040
Indeno(1,2,3-c,d)pyrene		0.12		0.10	1.4	--	0.040
Total cPAH TEQ (Ecology 2007) (U = 0)[8]		0.10	MTCA A	NA	0.10	MTCA A	NA
Total cPAH TEQ (Ecology 2007) (U = 1/2)[8]		0.10	MTCA A	NA	0.10	MTCA A	NA
Benzo(g,h,i)perylene		--	--	0.10	--	--	0.040
Fluoranthene		640	MTCA B	0.10	3,200	MTCA B	0.040
Fluorene		640	MTCA B	0.10	3,200	MTCA A	0.040
Naphthalene		160	MTCA A	0.10	5.0	MTCA A	0.040
Pentachlorophenol		0.22	MTCA B	0.10	2.5	MTCA B	0.040

Table B.3
Analytical Methods, Detection Limits, and Reporting Limits for Chemicals in Groundwater and Soil

Analyte	Method	Groundwater (µg/L)[1]			Soil (mg/kg)[2]		
		Screening Level[3]	Screening Level Basis	Reporting Limit[3,4]	Screening Level[3]	Screening Level Basis	Reporting Limit[3,4]
Semivolatile Organic Compounds[6] (cont.)							
Phenanthrene	USEPA 8270/ 8270 SIM	--	--	0.10	--	--	0.040
Phenol		NA	NA	NA	24,000	MTCA B	0.10
Pyrene		480	MTCA B	0.10	2,400	MTCA B	0.040
Total Naphthalenes[9]		160	MTCA A	NA	5.0	MTCA A	NA

Notes:

-- Not available or not established.

1 Groundwater criteria protective of drinking water use were considered when developing criteria. Criteria include MTCA Method A unrestricted land use criteria where available, or the most stringent MTCA Method B (cancer or non-cancer direct contact) criteria.

2 Soil criteria protective of human health for unrestricted site use were considered when developing criteria. Criteria include MTCA Method A unrestricted land use criteria where available, or the most stringent MTCA Method B (cancer or non-cancer direct contact) criteria.

3 All criteria and LOQs are rounded to two significant figures. Analytical results will be reported to two significant figures.

4 LOQs provided are typical of the method in the media indicated, but may be elevated in some samples due to matrix interferences, and/or may be elevated for some compounds due to spectral or other interferences associated with the analysis. The laboratory will make every effort to obtain LOQs that are less than the applicable soil or groundwater cleanup standard in this table using the indicated method.

5 Groundwater and soil standard for chromium(III).

6 Volatile and semivolatile organic compounds include those previously detected at the Site or potentially associated with wood treatment.

7 Xylenes are typically analyzed and reported by laboratories as m,p-xylene and o-xylene; these values are summed and reported as total xylenes. When evaluating relevant criteria for xylenes, the criteria developed in soil and groundwater for total xylenes was selected as the relevant criterion.

8 Calculation of cPAH TEQ concentrations was performed using the California Environmental Protection Agency 2005 Toxic Equivalency Factors, presented in Table 708-2 of WAC 173-340-900. The cPAHs in the TEQ total include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. TEQ concentrations are calculated with non-detect values set to one-half the reporting limit and non-detect values set to zero.

9 Naphthalenes to be analyzed are naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

Abbreviations:

cPAH Carcinogenic polycyclic aromatic hydrocarbo
Hg Mercury
LOQ Limit of quantitation
µg/L Micrograms per liter
mg/kg Milligrams per kilogram
MTCA Model Toxics Control Act
NA Not applicable
Site West Coast Door Site
TEQ Toxic equivalent
WAC Washington Administrative Code

Table B.4
Analytical Methods, Detection Limits, and Reporting Limits for Chemicals in Soil Vapor

Analyte	Method	Air (µg/m³)		
		Soil Vapor Screening Level[1]	Screening Level Basis[1]	Reporting Limit[2]
Volatile Organic Compounds				
Benzene	USEPA TO-15[3]	10.7	MTCA B	0.128
Ethylbenzene		15,200	MTCA B	0.217
Naphthalene		2.45	MTCA B	0.299
Toluene		76,200	MTCA B	0.188
Xylene (meta & para)		1,520	MTCA B	0.261
Xylene (ortho)		1,420	MTCA B	0.174
Total Xylenes[3]		1,520	MTCA B	NA

Notes:

1 Air criteria protective of human health exposure to indoor air via vapor intrusion were considered when developing criteria. Criteria include the lowest of the MTCA Method B cancer and non-cancer shallow soil vapor and indoor air screening levels.

2 LOQs provided are typical of the method in the media indicated, but may be elevated in some samples due to matrix interferences, and/or may be elevated for some compounds due to spectral or other interferences associated with the analysis. The laboratory will make every effort to obtain LOQs that are less than the applicable soil or groundwater cleanup standard in this table using the indicated method.

3 Xylenes are typically analyzed and reported by laboratories as m,p-xylene and o-xylene; these values are summed and reported as total xylenes. When evaluating relevant criteria for xylenes, the criteria developed in air for total xylenes was selected as the relevant criterion.

Abbreviations:

LOQ Limit of quantitation
µg/m³ Micrograms per cubic meter
MTCA Model Toxics Control Act
NA Not applicable

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix B
Sampling Analysis Plan/
Quality Assurance Project Plan

Attachment B.1
Standard Guidelines

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F|S STANDARD GUIDELINE

Groundwater Sample Collection with a Direct-Push (i.e., Geoprobe) Drill Rig

DATE/LAST UPDATE: September 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This standard guideline provides details necessary for collecting representative groundwater samples using a direct-push drill rig. These guidelines are designed to meet or exceed guidelines set forth by the Washington State Department of Ecology (Ecology).

2.0 Equipment and Supplies

Groundwater Sampling Equipment and Tools:

- Peristaltic pump and battery (typically provided by driller; confirm prior to mobilization)
- Water level meter
- Multi-parameter water quality meter (if applicable)
- Polyethylene tubing, Teflon tubing, or similar
- MasterFlex (silicone) tubing
- Filters (if field filtering)

- Tube cutters, razor blade, or scissors
- 55-gallon drum and clamp (or 5-gallon drum) and labels
- 5-gallon bucket
- Paper towels
- Alconox (or similar decontamination solution)
- Distilled or deionized water
- Spray bottles
- Trash bags

Lab Equipment:

- Sample jars/various types of pre-cleaned bottles (as applicable)
- Coolers
- Chain-of-Custody Forms
- Labels
- Ice
- Ziploc bags

Paperwork:

- Field notebook with site maps and previous boring logs, if available
- Sampling forms
- Purge water plan
- Rite-in-the-Rain pens, paper, and permanent markers
- Site-Specific Health and Safety Plan (HASP)
- Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP), or other similar work plan

Personal Protective Equipment (PPE):

- Steel-toed boots
- Safety vest
- Hard hat
- Nitrile gloves
- Safety glasses

- Rain gear
- Work gloves

3.0 Standard Procedures

The following sections describe the procedure for sampling groundwater using direct-push methods. Before entering the field, project considerations including the target aquifer or depth for sampling and screen placement (i.e., across or within the water table) should be discussed with the Project Manager. Any deviations from these procedures should be approved by the Project Manager and fully documented. Groundwater sampling from a direct-push boring consists of purging and sampling water within the borehole with a peristaltic pump. Direct-push drilling activities will typically follow Floyd|Snider Standard Guidelines for Soil Sampling.

3.1 CALIBRATION OF WATER QUALITY METERS

Water quality meters used during groundwater sampling (if applicable) will be calibrated prior to each sampling event. Calibration procedures are outlined in each instrument's specific user manual.

3.2 PURGING AND SAMPLING PROCEDURES

Once the direct-push drilling activities have reached the desired depth, a new polyvinyl chloride (PVC) or decontaminated stainless steel casing and screen is temporarily installed in the borehole by the driller. Record the depth-to-water and total depth of the well to calculate the volume (this is calculated by multiplying the area inside the casing by the height of water in the casing). Slowly lower new polyethylene or Teflon tubing down the temporary casing and use a peristaltic pump to purge and collect groundwater samples. The discharge line should be directed to a 55-gallon drum (or 5-gallon drum or bucket), provided by the drilling subcontractor to contain the purge water generated. Purging will continue until the groundwater is visually clear (if achievable) or at least 3 well volumes have been removed.

After the well has been purged and the sample bottles have been labeled, the groundwater sample will be collected by directly filling the laboratory-provided bottles from the pump discharge line. All sample containers should be filled with minimum disturbance by allowing the water to flow down the inside of the bottle or vial. When collecting a volatile organic compound (VOC) sample, fill to the top to form a meniscus over the mouth of the vial prior to placing the cap in order to eliminate air bubbles. Do not overfill preserved sample jars or pre-cleaned Volatile Organic Analyte (VOA) sampling vials.

If sampling for dissolved analytes (such as metals), collect these samples last and with attention to the flow direction arrow, fit an in-line filter at the end of the discharge line. A minimum of 0.5 to 1 liter of groundwater must pass through the filter prior to collecting the sample.

Sample labels will clearly identify the project name, sampler's initials, sample location and unique sample ID, analysis to be performed, date, and time. Upon collection, samples will be placed in a cooler maintained at a temperature of approximately 4 to 6 degrees Celsius (°C) using ice. Chain-of-Custody Forms will be completed. Upon transfer of the samples to the laboratory, the Chain-of-Custody Form will be signed by the persons transferring custody of the sample containers to document change in possession.

When sample collection is completed at a designated location, remove and properly dispose of the tubing and temporary well screen and casing. In most cases, this waste is considered solid waste and can be disposed of as refuse.

4.0 Decontamination

Prior to moving to the next sampling location, all reusable equipment that has come into contact with groundwater should be decontaminated using the processes described in this section.

Water Level Meter: The water level indicator and tape will be decontaminated between direct-push sampling locations and at the end the day by spraying the entire length of tape that came in contact with groundwater with an Alconox (or similar)/water mixture followed by a thorough rinse with distilled or deionized water.

Water quality sensors and flow-through cell (if used): Use distilled or deionized water to rinse the water quality sensors and flow-through cell. No other decontamination procedures are recommended since the equipment is sensitive. After the sampling event, the water quality meters will be cleaned and maintained according to the specific manual.

Submersible Pump: Decontaminating the pump requires running the pump in three progressively cleaner grades of water.

1. Fill a bucket with approximately 4 gallons or more to sufficiently cover the pump of an Alconox (or similar)/clean water solution. Place the pump and the length of the power cord (if applicable) that was in contact with water into the bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.
2. Fill a second bucket containing approximately 4 gallons or more to sufficiently cover the pump of clean water. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.
3. Fill a third bucket with approximately 4 gallons or more to sufficiently cover the pump of distilled or deionized water. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.

The Alconox/water solution may be re-used; however rinse water should be collected for disposal as described in Section 5.0 below. When done for the day, dry the exterior of the pump and cord with clean towels to the extent practical prior to storage: all decontaminated water (including Alconox solution) should be managed in accordance with Section 5.0 below.

All reusable equipment on the drill rig (such as casings and rods) that comes into contact with soil or groundwater will be decontaminated by the driller between locations. The drilling subcontractor will store all decontaminated water in labeled 55-gallon drums on-site for proper disposal unless otherwise specified.

5.0 Investigation-Derived Waste (IDW)

Unless otherwise specified in the project-specific work plan, water generated during groundwater sampling activities will be contained and stored in a designated area until it can be transported and disposed of off-site in accordance with applicable laws.

The approach to handling and disposal of these materials for a typical cleanup site is as follows.

For IDW that is containerized, (such as purge water), 55-gallon drums (or other smaller sized drums) approved by the Washington State Department of Transportation will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “purge water”), the dates on which the wastes were placed in the container, the owner’s name, contact information for the field person who generated the waste, and the site name.

IDW containerized within drums will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used, as appropriate, for disposal.

Disposable sampling materials and incidental trash such as paper towels and PPE used in sample processing will be placed in heavy-duty garbage bags or other appropriate containers and disposed of as trash in the municipal collection system.

6.0 Field Documentation

Drilling and groundwater sampling activities will be documented in field sampling forms and/or notebooks and Chain-of-Custody Forms. Information recorded will at a minimum include personnel present (including subcontractors), purpose of field event, weather conditions, sample collection date and times, sample analytes, depths to water, water quality field measurements (if collected), amount of purged water generated, and any deviations from the SAP.

F|S STANDARD GUIDELINE

Well Construction

DATE/LAST UPDATE: May 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines and should review and understand these procedures prior to going in the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This standard guideline presents commonly used procedures for the installation of resource protection wells, in accordance with applicable sections of the Washington State Minimum Standards for Construction and Maintenance of Wells (Washington Administrative Code [WAC] 173-160, Part Two) and ASTM Standard Practice for Design and Installation of Groundwater Monitoring Wells (ASTM D5092-04[2010]e1). These wells may include groundwater monitoring wells, piezometers, groundwater extraction wells, injection wells, or vapor extraction wells. The guideline is intended to be used by field staff who are overseeing well drilling and construction.

2.0 Equipment and Supplies

Well Installation Equipment and Tools:

- Tape measure or measuring wheel
- Weighted tape or leadline
- Water level meter
- Hand-held Global Positioning System (GPS; optional)
- Camera
- Trash bags

- Well construction materials including polyvinyl chloric (PVC) screen and riser, sandpack, bentonite and well monument will be provided by the drilling subcontractor.

Paperwork:

- Work Plan and/or Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)
- Copies of figures showing previous boring locations and boring logs from previous investigations and historical depth to water levels, if available
- Well installation forms (printed on Rite in the Rain paper)
- Permanent markers and pencils

Personal Equipment:

- Steel-toed boots
- Hard hat
- Safety vest
- Safety glasses
- Nitrile gloves
- Ear plugs
- Rain gear
- Work gloves

3.0 Standard Procedures

3.1 PREPARATION

First, before going into the field, it is important to discuss the project needs with the Project Manager (PM). These include the appropriate aquifer for well screening (especially if it is not the shallowest aquifer), soil sampling interval (if applicable to drilling method), screen length and placement (especially important at tidally influenced sites), well construction materials (i.e., screen slot size and grain size of the filter pack), surface completion of the wells, and any other important construction details. Any non-standard materials needed for well construction should also be communicated to the drilling firm when the work is scheduled, or a minimum of two weeks prior to the field event. Select a boring log template that is appropriate for the project needs.

Next, review the work plan and existing materials such as cross-sections, historical depth to water levels, or boring logs from previous investigations (if available) to familiarize yourself with the site geology. In addition to site-specific information (or alternatively if other information is not available), a geologic map of the area from a reputable source such as the U.S. Geological Survey (USGS) may also be reviewed.

Finally, check the area of the site where drilling will occur for underground objects. A OneCall locate request should be made at least one week and no less than three days prior to commencement of drilling in order to give public utility locators time to mark known, buried utility lines. All planned boring locations should be marked on the ground with white spray paint prior to making a locate request. In almost all cases, site maintenance managers or equivalent should be consulted for site selection and a private utility locator should clear any underground objects using electromagnetic techniques from the drilling area. If drilling in close proximity to buried utilities, field staff may need to request authorization for use of an air knife or vacuum extraction to clear the borehole to a depth below the utility lines.

3.2 DRILLING

1. Mark the desired well location using coordinates pre-loaded into a handheld GPS, or by measuring from known Site features. It is best to use both methods, if possible.
2. Before drilling begins, record the following information on each log:
    a. Operator's name and company, equipment make/model, equipment measurements (i.e., sampler length and diameter, hammer weight and stroke if using hollow stem auger, boring diameter).
    b. Your name, date, project, boring name, and approximate descriptive location relative to existing site features. Include a description of the ground surface and whether or not concrete coring was necessary; if so, include core diameter, concrete thickness, and subcontractor information.
    c. A small hand drawn map showing your location with measurements to a stationary reference point, or GPS coordinates (or ideally, both). This is also a good place to note if you have had to move a boring location because of underground utilities, access issues, etc. It is important to record the reason for relocation and the direction and distance moved (i.e., moved 10 feet to the north due to presence of subsurface water line).
3. If you are using a hollow stem auger, it is important to communicate to the driller how often you would like a split spoon sample collected. Typically this would be continuous or every 5 feet but may be different depending on the project needs. Usually this is established before the driller issues a quote. Any changes will affect the cost of the work and should be discussed with the PM.
    a. Record any feedback from the driller about the drilling conditions. This may include difficult drilling or rig chatter (usually caused by hard materials), heaving sands (usually caused by hydrostatic pressure on the borehole), caving, or hole instability.

4. For split spoon samples, record the number of hammer blows (blow counts) necessary to drive the sampler each 6-inch increment, as reported by the driller. If more than 50 blows are needed, record the distance that the sampler was driven in 50 blows (i.e., 2-inches in 50 blows). This is referred to as the standard penetration test (SPT).
5. For all drilling methods, create a log of the soils encountered according to the Floyd|Snider Soil Logging Standard Guideline. Pay particular attention to the moisture content of the soils, making careful notation of the water table where free water is first encountered. After drilling has been completed to the desired depth, confirm the depth to the water table using a water level meter.

3.3 WELL DESIGN AND CONSTRUCTION

1. Determine the length and placement of the well screen based on the observed depth to the water table, the specifics of the work plan, and the observed lithology. The well screen is typically set across the water table of shallow aquifers for monitoring wells and piezometers. However, the screened interval may be fully submerged for groundwater extraction wells, sites with very shallow groundwater, or wells installed in deeper aquifers below confining units. If an area is tidally influenced, note the tide elevation during well completion; if the tide is at a high or low at the time of drilling the well screen may need to be lowered or raised accordingly so that the screen spans the water table when the tide is at zero. The hydraulic conductivity of the aquifer material will also factor into well screen placement. For example, wells screened in tight silts may not produce enough water to adequately develop and sample. In this case, it may be preferable to screen the well in a more transmissive unit. Include the length of any required bottom caps or sumps below the well casing when determining the total depth of the boring required to place the well screen at the desired interval. The Washington State minimum standards also require that the diameter of the well screen relative to the diameter of the borehole (annual space) be small enough to allow placement of a filter pack that is 4 inches in diameter larger than the screen. For example, a 2-inch diameter monitoring well should be completed within a borehole that has a minimum 6-inch diameter.
2. Determine the filter pack material. The purpose of the filter pack is to prevent fine-grained aquifer material from entering the well while still allowing groundwater to flow through. Filter pack is composed of clean, rounded, relatively uniform silica sand. The choice of sand for the filter pack will depend on the grain size range of the aquifer material, with emphasis on the finest aquifer material. Filter pack material should be approximately 10 to 15 times the grain size of the surrounding aquifer material. The particle size ranges of fine, medium, and coarse sand, and the particle size ranges of common filter pack materials are given in the two tables below. As indicated in these tables, suitable filter pack choices for an aquifer with appreciable fine sand would include a range from 20-40 to 10-20 sand. For aquifers where the smallest particle size is medium sand, a filter pack of 2-12 sand or similar may be appropriate. More precise filter pack designs are possible based on grain size curves (see Driscoll 1986, Blair 2006).

Unified Soil Classification System (USCS) Classification	**U.S. Sieve Size**	**Grain Size (inches)**	**Grain Size (millimeters)**
Fine Sand	40 to 200	.003 to 0.16	.074 to .42
Medium Sand	10 to 40	.016 to .06	.42 to 1.68
Coarse Sand	10 to 4	.06 to 0.19	1.68 to 4.76

Example Sand Pack Gradations (U.S. Sieve Sizes)	**Grain Size (inches)**	**Grain Size (millimeters)**
32-40	.016 to .02	.42 to .55
20-40	.016 to .03	.42 to .84
16-30	.05 to .02	.59 to 1.2
10-20	.03 to .08	.84 to 2
2-12	.06 to .3	1.7 to 8

3. Determine the screen slot diameter. The purpose of the well screen is to allow groundwater to flow into and through the well screen for sample collection. Monitoring well casings are typically constructed of PVC (Washington State minimum standards require Schedule 40 or thicker-walled PVC for borings up to 200 feet deep); however, materials such as stainless steel may be used for the purposes of longevity, heat, specific chemical resistance, or other site-specific concerns. The screened interval of the well consists of a series of slots that are commonly 0.01 inch or 0.02 inch in width. Similar to filter pack material, narrower slots allow less fine-grained material and also less groundwater to pass through them. The screen slot size should be selected to retain approximately 90% or greater of the filter pack material. The largest screen slot size practical should be selected.
4. Once the driller has assembled the well casing of the appropriate length, oversee placement of the casing and filter pack. The casing should be centered in the borehole and level. When using a hollow stem auger, the sand is typically poured from the surface while the augers are being lifted from the borehole. When using sonic drilling or other methods where the drill rods are removed prior to sand placement, it is preferable to use a Tremie tube lowered to the bottom of the borehole to deliver the sand, which helps to ensure that the sand has actually reached the bottom of the borehole. As the driller is pouring sand into the annular space, monitor the height of the sand in the borehole using a weighted tape or leadline to ensure that the space is being filled evenly. If possible, use a surge block to force water from the well out into the sand pack periodically to eliminate any bridges or gaps in the sand. The sand pack

placement is complete when it has reached a height minimum of 1 foot (but no more the 5 feet) above the top of the well screen.

5. A bentonite seal must be placed above the sand pack to isolate the screened interval of the aquifer and to prevent the annular space from acting as a preferential pathway for surface water, water above the screen zone, or other liquid (i.e., free product). The purpose of the bentonite plug is to prevent downward migration inside the borehole, which has the potential to cause groundwater contamination. Monitor the placement of the bentonite plug above the sand pack. The bentonite plug is typically composed of dehydrated bentonite chips, which are poured into the annual space from the surface; or a bentonite slurry, which is pumped into the space via a Tremie tube. A bentonite chip seal is still recommended (but not necessary) immediately above the sand pack when using bentonite slurry to minimize migration of the slurry into the sandpack. Pumping is preferable in situations where bentonite will be placed below the water table. The U.S. Environmental Protection Agency (USEPA) recommends that the bentonite seal consist of a minimum of 2 feet of bentonite placed above the sand pack. If using a bentonite chip seal, hydrate the chips with clean water so that they expand to seal the borehole.
6. Communicate the desired surface completion to the driller (i.e., an aboveground well monument or a monument flush with the ground surface) if you have not already done so. Verify that the well monument has been installed correctly. For flush-mounted wells, ensure that the well is level with the surrounding grade, especially in areas with pedestrian or vehicle traffic. In areas with frequent or heavy vehicle traffic, heavy-duty traffic-rated monuments or manholes should be used. For aboveground well monuments (i.e., stand pipes), ensure that the monument is level, anchored in a minimum of 2 feet of concrete, and protected by steel bollards, unless otherwise specified in the work plan. The concrete surrounding any well monument should seal the borehole at the ground surface.

4.0 Decontamination

All reusable equipment that comes into contact with soil and groundwater should be decontaminated as follows prior to moving to the next sampling location.

Split spoons, stainless steel bowls and spoons, the water level tape, and any other tools used for well drilling and installation must be decontaminated between boring locations. If collecting soils samples for chemical analysis, split spoons and any tools used for sample processing will be decontaminated between each sample; alternatively, disposable bowls and spoons may be used. Equipment decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an alconox (or similar)/clean water solution, and a final rinse with distilled or deionized water.

5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, waste soils, liquids, and other drilling materials generated during well drilling and installation will be contained in accordance with applicable laws, and stored in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials is as follows. For investigation-derived waste (IDW) that is contained, such as waste soils, 55-gallon drums approved by the Washington State Department of Transportation (WSDOT) will be supplied by the driller and used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled with its contents (e.g., “soil cuttings”), the date(s) on which the wastes were placed in the container, the owner’s name, contact information for the field person who generated the waste, and the site name.

IDW contained within drums will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used as appropriate for disposal.

Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy-duty garbage bags or other appropriate containers and disposed of as solid waste in the municipal collection system (i.e., site dumpster).

6.0 Field Documentation

All observations should be recorded on a soil boring/well completion form appropriate for the drilling method or in a bound field notebook. Field staff should record as much detail as possible in the field log (including well construction materials, Ecology well ID tag number, and surface completions) and note any anomalies or details that varied from the SAP. After the field work is complete, a set of final well construction logs (usually electronic) that serve as the record for the project will be completed in consultation with the project manager or field manager.

F|S STANDARD GUIDELINE

Well Development

DATE/LAST UPDATE: May 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines and should review and understand these procedures prior to going in the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This Standard Guideline for Well Development presents commonly used procedures for monitoring well development for newly installed monitoring wells and/or existing wells that may require redevelopment. Monitoring well development restores hydraulic conductivity with the surrounding formations that were disturbed during the drilling process. Development removes residual fines from well filter pack materials and the borehole wall and reduces the turbidity of the water, which provides more representative groundwater samples. These wells may include groundwater monitoring wells, piezometers, or groundwater extraction wells. This guideline describes the purge and surge method of development and is intended to be used by field staff who are overseeing or completing well development. Often, the drilling subcontractors are asked to complete well development activities subsequent to new well installations, in which case, Floyd|Snider staff would oversee the development. Other development methods, such as jetting, are not described herein, but may be used if specified in the project-specific Work Plan or Sampling and Analysis Plan (SAP).

Well development shall be completed by continuous pumping at a steady rate using a portable pump and polyethylene tubing, with regular surging (e.g., using a surge block) to force water through the filter pack and surrounding formation. Wells should ideally be developed either during installation (following sand placement but prior to sealing) or soon after installation, unless otherwise specified in the work plan, using the described methodologies or equivalents. For wells that are completed using a grout or concrete seal, if development does not take place prior to sealing, it should be completed within 48 hours following well installation in order allow for grout and concrete to cure.

2.0 Equipment and Supplies

Well Development Equipment and Tools:

- Appropriate high volume pump (centrifugal, submersible, etc.) and correct diameter tubing, or bailer
- Hose clamps (optional)
- Power source (generator, 12-volt battery, or car battery) and appropriate power adapter for pump
- Water quality meter or turbidity meter (if needed)
- 2-, 4-, or 6-inch surge block (typically provided by the driller)
- Water level meter
- Washington State Department of Transportation (WSDOT)-approved 55-gallon drums
- Equipment decontamination supplies including:
    - Scrub brushes
    - Alconox or other soap
    - Distilled or deionized water
    - Paper towels
- Trash bags
- Camera

Paperwork:

- Work Plan and/or SAP/Quality Assurance Project Plan (QAPP)
- Bound field notebook or appropriate field forms
- Well development form (printed on Rite in the Rain paper)
- Health and Safety Plan (HASP)
- Well installation forms (printed on Rite in the Rain paper)

Personal Equipment:

- Steel-toed boots
- Safety vest
- Safety glasses
- Nitrile gloves
- Rain gear
- Work gloves

3.0 Standard Procedures

3.1 OFFICE PREPARATION

Meet with the project manager to identify key information and goals of the well development, including how long after construction the wells should be developed. Determine if Floyd|Snider or the driller will be doing the development.

3.2 WELL DEVELOPMENT PROCEDURES

The following procedures are general guidelines for monitoring well development. These same procedures are also appropriate for extraction wells, injection wells, and/or piezometers. Specific instructions provided in individual work plans shall supersede these procedures in the event there are discrepancies.

Visually inspect all well development equipment for damage; repair as necessary.

1. Decontaminate all hoses, surge blocks, and/or submersible pump by scrubbing with brush and alconox or other soap solution and rinsing with deionized water.
2. Prior to development, use a water level meter to measure the depth in each well to the static water level and total depth to a reference mark on the top of the well casing.
3. Attach a length of clean or disposable tubing, approximately 5 feet longer than the well casing, to the outlet of the submersible pump.
4. Each well development cycle consists of surging followed by well evacuation (pumping). Surging may be accomplished with a surge block sized to fit snugly inside the well casing, or with the submersible pump. Surging using a pump increases the hydraulic gradient and velocity of groundwater near the well by drawing the water level down and moving more fine-grained soil particles into the well casing. Surging using a pump is only effective if the well produces enough water for continuous pumping and the pump is of a large enough diameter relative to the well casing. If

pumping must be stopped to allow the well to recharge, a surge block is preferable for surging. If using a surge block, connect polyvinyl chloride (PVC) pipe or other rods longer than the well casing to the surge block. Lower the surging device into the well to a depth within the screened interval. A bailer can be used to surge in situations when a surge block is not available and the well has insufficient recharge for the submersible pump.

5. During development, it is important to note the color and clarity of the water and any other visual or olfactory observations on the field form or in the field notebook. Note any significant changes as development progresses.

6. Surging should consist of a minimum of ten consecutive surges (i.e., quickly raise and lower surge block or pump in well) with an appropriately sized surge block or pump over the full length of the screen. For long well screens (greater than 10 feet), surging should be done in short intervals of 2 to 3 feet at a time. In cases where the screen extends to above the water table, clean water may have to be added to the well to develop the top of the filter pack.

7. After surging, water is purged from well until the pumped stream starts to run clear. At that point, stop pumping and initiate another surge cycle. If a well has more hydraulic head than the pump is able to overcome, or if an insufficient volume of water for pumping is present, a disposable bailer may also be used for purging.

8. Repeat this procedure until evacuated water is visibly clear and essentially free of sediment. Perform a minimum of three surge and pump cycles.

9. Well development will be terminated when the variation in the turbidity Nephelometric Turbidity Units (NTUs) readings is less than 10 percent or until the discharge is visibly clear and free of sediment after a minimum of three surge and purge cycles. As an alternative, periodic water samples can be collected for field measurements of temperature, specific conductivity, and pH; well development should continue until field parameters stabilize to within ±5 percent on three consecutive measurements or 10 well volumes have been purged. If it is not possible reduce the turbidity further, the well should be purged up to a maximum of four hours or as determined sufficient by the field geologist or project manager.

10. Report field observations and volume of water removed on the standard well development form (attached). Take final water level measurements and record then on the field form or in the field notebook.

11. Contain the purged water and manage in accordance with the project-specific SAP or Section 5.0 below. Prior to developing the next well or after the completion of development activities, decontaminate all reusable equipment used in development in accordance with Section 4.0 below.

12. If feasible, it is best to wait at least two weeks after development to sample the wells. Wells can be sampled a minimum of 48 hours after the completion of development if

the project schedule requires a quick turnaround. However, the groundwater sample will be more representative of static conditions in the aquifer if allowed to stabilize for at least one to two weeks after development.

4.0 Decontamination

All reusable equipment that comes into contact with groundwater should be decontaminated as follows prior to moving to the next sampling location.

Water level meter and surge block: The water level indicator and tape will be decontaminated between sampling locations and at the end the day by spraying the entire length of tape that came in contact with groundwater with an Alconox (or similar)/clean water solution followed by a thorough rinse with distilled or deionized water. Surge block decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an alconox (or similar)/clean water solution and a final rinse with distilled or deionized water.

Submersible Pump: Decontaminating the pump requires running the pump in three progressively cleaner grades of water. Place the pump and the length of the power cord that was in contact with water into a bucket containing approximately four gallons of an Alconox (or similar)/clean water solution. Run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted. Next, place the pump and cord into a second bucket containing approximately four gallons of clean water and run the pump for approximately two minutes or until the volume of water in the bucket is exhausted. Lastly, place the pump and power cord into a third bucket containing approximately four gallons of distilled or deionized water and run the pump for approximately two minutes or until the volume of water in the bucket is exhausted. The soap/water solution and rinse water may be re-used. When done for the day, dry the exterior of the pump and power cord with clean paper towels to the extent practical prior to storage. All decontamination water and rinse water (including soapy solution) should be managed in accordance with Section 5.0 below.

5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, well development and decontamination water generated during development and any drilling materials will be contained and stored in a designated area until transported off-site for disposal in accordance with applicable laws.

The approach to handling and disposal of these materials is as follows. For investigation-derived waste (IDW) that is contained, such as well development water, WSDOT-approved 55-gallon drums will be supplied by the driller and used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “MW-1 Well development water”), the date(s) on which the wastes were placed in the container, the owner's name, contact information for the field person who generated the waste, and the site name.

IDW contained within drums will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used as appropriate for disposal.

Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy duty garbage bags or other appropriate containers and disposed of as trash in the municipal collection system (i.e., site dumpster).

6.0 Field Documentation

Well development procedures will be documented on the well development field form (attached) or a bound field notebook. Information recorded will at a minimum include date, personnel present (including subcontractors), purpose of field event, weather conditions, depth of water, well construction details for the well(s) being developed (i.e., diameter, total depth, screen interval), water quality field measurements (if collected), amount of purged water generated, and any deviations from the SAP.

Enclosure: Well Development Field Form

WELL DEVELOPMENT FIELD FORM

FLOYD | SNIDER

Project Name:______________________________ Date: ______________

Project Number:_____________________________ Field Personnel: ______________________________

Driller (if applicable): ______________________

Purge Data

Well ID:	Total Well Depth:	Well Condition/Damage Description:
Well Casing Type/Diameter/Screened Level:	One Casing Volume (gal):	
Method of Development (Circle): Surge Block Pump Surge Bailer	Equipment Used (type of pump, etc.):	

Begin Purge (time):	
End Purge (time):	
Gallons Purged (time):	
Purge Water Disposal Method (circle): On-site Storage Tank On-site Treatment Drum Other:	

Volume of Schedule 40 PVC Pipe

Diameter	O.D.	I.D.	Volume (Gal/Linear Ft.)	Weight of Water (Lbs/Lineal Ft.)
1 ¼"	1.660"	1.380"	0.08	0.64
2"	2.375"	2.067"	0.17	1.45
3"	3.500"	3.068"	0.38	3.2
4"	4.500"	4.026"	0.66	5.51
6"	6.625"	6.065"	1.5	12.5

Time	Depth to Water (feet)	Vol. Purged (gallons)	Rate (gpm)	pH	Conductivity	Turbidity	Temp	Comments
			--	--	--	--	--	Prior to purging

Notes:

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F|S STANDARD GUIDELINE

Low-Flow Groundwater Sample Collection

DATE/LAST UPDATE: August 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This standard guideline provides details necessary for collecting representative groundwater samples from monitoring wells using low-flow methods. These guidelines are designed to meet or exceed guidelines set forth by the Washington State Department of Ecology (Ecology). Low-Flow sampling provides a method to minimize the volume of water that is purged and disposed from a monitoring well, and minimizes the impact that purging has on groundwater chemistry during sample collection.

2.0 Equipment and Supplies

Groundwater Sampling Equipment and Tools:

- For wells with head less than 25 feet:
    - Peristaltic pump with fully-charged internal battery or standalone battery and appropriate connectors

- For wells with head greater than 25 feet:
  - Bladder pump and controller, as well as an air cylinder, or air compressor (with extension cord if near an electrical outlet; with battery and appropriate connectors or generator if not near an outlet)

    OR
  - Low-flow submersible pump and controller (with extension cord if near an electrical outlet; with battery and appropriate connectors or generator if not near an outlet)
- Multi-parameter water quality meter
- Water level meter
- Poly tubing
- Silicone tubing
- Filters (if field filtering)
- Tools for opening wells (1/2-inch, 9/16-inch, and 5/8-inch sockets, ratchet, screwdriver)
- Well keys
- Tube cutters, razor blade, or scissors
- 5-gallon buckets and clamp
- Paper towels
- Bailer or pump to drain well box if full of stormwater
- Hammer
- Alconox (or similar decontamination solution), deionized water, spray bottles
- Tape measure
- Trash bags

Lab Equipment:

- Sample jars/bottles
- Coolers
- Chain-of-Custody Forms
- Labels
- Ice
- Ziploc bags

Paperwork:

- Field notebook with site maps
- Table of well construction details and/or well logs, if available
- Sampling forms
- Purge water plan
- Rite-in-the-Rain pens, paper, and permanent markers
- Site-Specific Health and Safety Plan (HASP)
- Sampling and Analysis Plan (SAP) and/or Quality Assurance Project Plan (QAPP) (including tables of analytes and bottle types)

Personal Protective Equipment (PPE):

- Boots/waders
- Safety vest
- Safety glasses
- Rain gear
- Nitrile gloves
- Work gloves

3.0 Standard Procedures

Low-Flow groundwater sampling consists of purging groundwater within the well casing at a rate equal to or less than the flow rate of representative groundwater from the surrounding aquifer into the well screen. The flow rate will depend on the hydraulic conductivity of the aquifer and the drawdown, with the goal of minimizing drawdown within the monitoring well. Field parameters are monitored during purging and groundwater samples are collected after field parameters have stabilized. Deviations from these procedures should be approved by the Project Manager and fully documented.

3.1 CALIBRATION OF WATER QUALITY METERS

All multi-parameter water quality meters to be used will be calibrated prior to each sampling event. Calibration procedures are outlined in each instrument's specific user manual.

3.2 MONITORING, MAINTENANCE, AND SECURITY

Prior to sampling, depth to water and total depth measurements will be collected and recorded for accessible monitoring wells onsite (or an appropriate subset for larger sites). Check for an existing measuring point (notch or visible mark on top of casing). If a measuring point is not observed, a measuring point should be established on the north side of the casing. The conditions of the well box and bolts will also be observed and deficiencies will be recorded on the sampling forms or logbook (i.e., missing or stripped bolt). The following should also be recorded:

- Condition of the well box, lid, bolts, locks, and gripper cap, if deficiencies
- Condition of gasket if deficient and if water is present in the well box
- Note any obstructions or kinks in the well casing
- Note any equipment in the well casing, such as transducers, bailers, or tubing
- Condition of general area surrounding the well, such as subsidence, potholes, or if the well is submerged within a puddle.

Replace any missing or stripped bolts, and redevelop wells if needed.

3.3 LOW-FLOW PURGING METHOD AND SAMPLING PROCEDURES

Groundwater samples will be collected using low-flow purging and sampling procedures consistent with Ecology guidelines and the U.S. Environmental Protection Agency (USEPA) standard operating procedures (USEPA 1996). The following describes the Low-Flow purging and sampling procedures for collecting groundwater samples using a peristaltic pump. If the water level is greater than 20 feet below ground surface (bgs), Grundfos or Geotech submersible pumps or bladder pumps can be used since their pumping rates can be adjusted to low-flow levels.

- Place the peristaltic pump and water quality equipment near the wellhead. Slowly lower new poly tubing down into the well casing approximately to the middle of the well screen. If the depth of the well screen is not known, lower the tubing to the bottom of the well, making sure that the tubing has not been caught on the slotted well casing, and then raise the tubing 3 to 5 feet off the bottom of the casing. Document the estimated depth of the tubing placement within the well. Connect the tubing to the peristaltic pump using new flex tubing and connect the discharge line to the flow-through cell of the water quality meter. The discharge line from the flow cell should be directed to a bucket to contain the purged water.
- If using a low-flow submersible pump, connect the pump head to dedicated or disposable tubing. If using a bladder pump, connect both the air intake and water discharge ports to decontaminated or disposable tubing, using the manufacturer's instructions to ensure a secure connection. Lower the pump with tubing into the well as described above and connect the water discharge tubing directly to the flow-through cell.
- Measure the depth to water to the nearest 0.01 foot with a decontaminated water level meter and record the information on a sampling form.
- Start pumping the well at a purge rate of 0.1 to 0.2 liters per minute and slowly increase the rate. Purge rate is adjusted using a speed control knob or arrows on peristaltic and low-flow submersible pumps. The purge rate for bladder pumps is controlled by the air compressor, which first pressurizes the pump chamber in order

to compress the flexible bladder and force water through the discharge line, and then vents the chamber in order to allow the bladder to refill with water.

- A good rule of thumb is to pressurize to 10 psi + 0.5 psi/foot of tubing depth and begin with 4 discharge/refill cycles per minute; using greater air pressure and accelerating the pump cycles will increase the purge rate.

- Check the water level. If the water level is dropping, lower the purge rate. Maintain a steady flow with no or minimal drawdown (less than 0.33 feet according to USEPA 2002). Maintaining a drawdown of less than 0.33 feet may not be feasible depending on hydrogeological conditions. If possible, measure the discharge rate of the pump with a graduated cylinder or use a stopwatch when filling sampling jars (500 milliliters [mL] polyethylene or glass ambers) to estimate the rate. When purging water through a flow cell, the maximum flow rate for accurate water quality readings is about 0.5 liters per minute (L/minute).
- Monitor and record water quality parameters every three to five minutes after one tubing volume (including the volume of water in the flow cell) has been purged.
  - One foot of ¼-inch interior diameter tubing holds about 10 mL of water, and flow-through cells typically hold less than 200 mL of water; one volume should be purged after about 5 minutes at a flow rate of 0.1 L/minute.
- Water-quality indicator parameters that will be monitored and recorded during purging include:
  - pH
  - Specific conductivity
  - Dissolved oxygen
  - Temperature
  - Turbidity
  - Oxidation reduction potential (ORP)
- Purging will continue until temperature, pH, turbidity, and specific conductivity are approximately stable (when measurements are within 10 percent) for three consecutive readings, or 30 minutes have elapsed. Because these field parameters (especially dissolved oxygen and ORP) may not reach the stabilization criteria, collection of the groundwater sample will be based on the professional judgment of field personnel at the time of sampling.
- The water sample can be collected once the criteria above have been met.
- If drawdown in the well cannot be maintained at 0.33 feet or less, reduce the flow or turn off the pump for 15 minutes and allow for recovery. If the water quality parameters have stabilized, and if at least two tubing volumes and the flow cell volume have been purged, then sample collection can proceed when the water level has recovered and the pump is turned back on. This should be noted on the sampling form.

- To collect the water sample, maintain the same pumping rate. After the well has been purged and the sample bottles have been labeled, the groundwater sample will be collected by directly filling the laboratory-provided bottles from the pump discharge line prior to passing through the flow cell. All sample containers should be filled with minimum disturbance by allowing the water to flow down the inside of the bottle or vial. When collecting a volatile organic compound (VOC) sample, fill to the top to form a meniscus over the mouth of the vial prior to placing the cap to eliminate air bubbles. Be careful not to overflow preserved bottles/pre-cleaned Volatile Organic Analyte (VOA) vials.
- If sampling for filtered metals, collect these samples last and fit an in-line filter at the end of the discharge line. Take note of the flow direction arrow on the filter prior to fitting. A minimum of 0.5 to 1 liter of groundwater must pass through the filter prior to collecting the sample.
- Sample labels will clearly identify the project name, sampler's initials, sample location and unique sample id, analysis to be performed, date, and time. After collection, samples will be placed in a cooler maintained at a temperature of approximately 4 to 6 degrees Celsius (°C) using ice. Chain-of-Custody Forms will be completed. Upon transfer of the samples to the laboratory, the Chain-of-Custody Form will be signed by the persons transferring custody of the sample containers to document change in possession.
- When sample collection is complete at a designated location, remove and properly dispose of the non-dedicated tubing. In most cases, this waste is considered solid waste and can be disposed of as refuse. Close and lock the well.

4.0 Decontamination

All reusable equipment that comes into contact with groundwater should be decontaminated using the processes described in this section prior to moving to the next sampling location.

Water Level Meter: The water level indicator and tape will be decontaminated between sampling locations and at the end the day by spraying the entire length of tape that came in contact with groundwater with an Alconox (or similar)/clean water solution followed by a thorough rinse with distilled or deionized water.

Water Quality Sensors and Flow-Through Cell: Distilled water or deionized water will be used to rinse the water quality sensors and flow-through cell. No other decontamination procedures are recommended since they are sensitive equipment. After the sampling event, the water quality meters will be cleaned and maintained according to the specific manual.

Submersible Pump (if applicable: Decontaminating the pump requires running the pump in three progressively cleaner grades of water.

1. Fill a bucket with approximately 4 gallons or more to sufficiently cover the pump of an Alconox (or similar)/clean water solution. Place the pump and the length of the

power cord (if applicable) that was in contact with water into the bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.

2. Fill a second bucket containing approximately 4 gallons or more to sufficiently cover the pump of clean water. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.
3. Fill a third bucket with approximately 4 gallons or more to sufficiently cover the pump of distilled or deionized water. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.

Bladder Pump: Clean the inside and outside of the pump body with an Alconox (or similar)/clean water solution, followed by a thorough rinse with distilled or deionized water. The outside of the air supply line that came in contact with groundwater may also be cleaned with Alconox (or similar) solution and re-used; bladders and water discharge lines must be replaced after each sample is collected.

5.0 Investigation-Derived Waste (IDW)

Unless otherwise specified in the project work plan, water generated during groundwater sampling activities will be contained, transported, disposed of in accordance with applicable laws, and stored in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials for a typical cleanup site is as follows. For IDW that is containerized, such as purge water, 55-gallon drums (or other smaller sized drums) approved by the Washington State Department of Transportation will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “purge water”), the dates on which the wastes were placed in the container, the owner’s name and contact information for the field person who generated the waste, and the site name.

IDW containerized within drums will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used, as appropriate for disposal.

Disposable sampling materials and incidental trash such as paper towels and PPE used in sample processing will be placed in heavy-duty garbage bags or other appropriate containers and disposed of as trash in the municipal collection system.

6.0 Field Documentation

Groundwater sampling activities will be documented in field sampling forms and/or field notebooks, and Chain-of-Custody Forms. Information recorded will, at a minimum, include personnel present (including subcontractors or client representatives), purpose of field event, weather conditions, sample collection date and times, sample analytes, depths to water, water quality parameters, well box/lid conditions, amount of purged water generated, and any deviations from the SAP. Photographs of damaged well casings or well boxes should be taken.

7.0 References

USEPA. 1996. Low-Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision 2. Region 1. July 30, 1996.

_____. 2002. Groundwater Sampling Guidelines for Superfund and CAR Project Managers. Office of Solid Waste and Emergency Response. EPA 542.S-02-001. May 2002.

GROUNDWATER OR SURFACE WATER SAMPLE COLLECTION FORM

Project Name:______________________________ Date of Collection: ______________________________

Project Number:______________________________ Field Personnel: ______________________________

Purge Data

Well ID: ____________________ Secure: ☐ Yes ☐ No Well Condition/Damage Description: ______________________________

____

Depth Sounder decontaminated Prior to Placement in Well: ☐ Yes ☐ No One Casing Volume (gal): ______________________________

Depth of water (from top of well casing): ____________________ Well Casing Type/Diameter/Screened Interval: ______________________________

After 5 minutes of purging (from top of casing): ____________________

Begin purge (time):____________________

End purge (time): ____________________

Gallons purged: ____________________

Purge water disposal method: ____________________

Volume of Schedule 40 PVC Pipe

Diameter	O.D.	I.D.	Volume (Gal/Linear Ft.)	Weight of Water (Lbs/Lineal Ft.)
1 ¼"	1.660"	1.380"	0.08	0.64
2"	2.375"	2.067"	0.17	1.45
3"	3.500"	3.068"	0.38	3.2
4"	4.500"	4.026"	0.66	5.51
6"	6.625"	6.065"	1.5	12.5

Time	Depth to Water	Vol. Purged	pH	DO	Conductivity	Turbidity	Temp	ORP	Comments

Sampling Data

Sample No:______________________________ Location and Depth: ______________________________

Date Collected (mo/dy/yr): ____________________ Time Collected: ____________ ☐ AM ☐ PM Weather: ______________________________

Type: ☐ Ground Water ☐ Surface Water Other: ____________________ Sample: ☐ Filtered ☐ Unfiltered Other:____________________

Sample Collected with: ☐ Bailer ☐ Pump Other: ____________________ Type: ______________________________

Water Quality Instrument Data Collected with: Type: ☐ Horiba U-22 ☐ Horiba U-50 Other:______________________________

Sample Decon Procedure: Sample collected with (circle one): decontaminated <u>all</u> tubing; disposable and/or dedicated silicon and poly tubing Other: ____________

Sample Description (Color, Turbidity, Odor, Other): ______________________________

Sample Analyses

TPH-D	(HCl)	☐	Chlor / Fluor	(unpres)	☐	COD / TOC	(H2SO4)	☐	Orthophos	(FILTER)	☐	Diss. Metals	(HNO3)	☐
TPH-G	(HCl)	☐	BTEX	(HCl)	☐	Total Metals	(HNO3)	☐	TKN/Phos	(N2SO4)	☐	VOCs	(HCl)	☐

Additional Information

Types of Sample Containers:	Quantity:	Duplicate Sample Numbers:	Comments:

Signature: ______________________________ **Date:** ____________________

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F|S STANDARD GUIDELINE

Soil Logging

DATE/LAST UPDATE: May 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step by step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines and should review and understand these procedures prior to going in the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

These soil logging standard guidelines should be used by the field staff performing subsurface investigations, such as a direct push or roto-sonic soil boring, installation of a monitoring well via hollow stem auger, or roto-sonic or mud rotary drilling. While many projects will not necessarily have a Licensed Geologist (LG) or Hydrogeologist (LHG) who reviews and stamps every boring log, it is important that the field staff discusses the soil logging needs for a particular investigation with the project geologist, the project manager, or whoever will ultimately be responsible for interpreting the findings of the field investigation. This discussion is in addition to field training and general knowledge about soil logging, and should happen prior to entering the field, with additional follow-up before drafting a final set of electronic logs, after the investigation is complete.

2.0 Equipment and Supplies

Logging Equipment and Tools:

- 100-foot tape measure or measuring wheel
- Handheld Global Positioning System (GPS; optional)
- Unified Soil Classification System (USCS) Soil Classification Field Guide

- Soil logging kit containing:
  - Stainless steel spoons
  - Paint scraper or trowel
  - Small Ziploc bags
  - Small stainless steel bowls or black mining pans for sheen testing
  - Spray bottle filled with water
  - Paper towels (preferably white)
  - Engineers tape
  - Note cards
  - Optional items include:
    - Empty VOA vials or small glass jars
    - Munsell color chart
    - Sieves
    - White and grayscale color cards for photographs
- Plastic sheeting and duct tape or clamps to cover the sampling table
- Camera
- Trash bags
- Coolers
- Jars
- Labels
- Ice

Paperwork:

- Work Plan and/or Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)
- Copies of figures showing previous boring locations and boring logs from previous investigations, if available
- Boring log forms appropriate for drilling method, printed in Rite in the Rain paper and/or bound field notebook
- Permanent markers and pencils

Personal Equipment:

- Steel-toed boots
- Hard hat

- Safety vest
- Safety glasses
- Nitrile gloves
- Ear plugs
- Rain gear
- Work gloves

3.0 Standard Procedures

3.1 OFFICE PREPARATION

First, meet with the project manager or field manager to identify the key information and goals of the soil boring investigation. These may include fill history, known or suspected sources of contamination and potential field indications of these contaminants, identification of specific units, or important geotechnical measurements. If possible, select a boring log template that is appropriate for the project needs.

Next, review the work plan and all available existing materials such as cross-sections or boring logs from previous investigations to familiarize yourself with the site geology. In addition (or alternatively if other information is not available), you may also review a geologic map of the area from a reputable source such as United States Geological Survey (USGS).

Finally, check the area of the site where drilling will occur for underground objects. At minimum, a OneCall locate request should be made at least one week in advance of drilling in order to give public utility locators time to mark known buried utility lines. All planned boring locations should be marked on the ground with white spray paint prior to making a locate request. In almost all cases, a private utility locator should also clear the area of drilling any underground objects using electromagnetic techniques. If drilling is to occur in close proximity to buried utilities, the work plan may specify use of an air knife or vacuum to clear the borehole to a depth below the utility lines.

3.2 COLLECTING SOIL SAMPLES FOR CLASSIFICATION

1. Before beginning drilling, record the following information on each log:
   a. Operator's name and company, equipment make/model, equipment measurements (i.e., sampler length and diameter, hammer weight and stroke if using hollow stem auger, boring diameter)
   b. Your name, date, project, boring name and approximate descriptive location (i.e., where is the soil boring relative to known site features). Include a description of the ground surface and whether or not coring was necessary, if coring was necessary, include core diameter, concrete thickness, and subcontractor information.

   c. A small hand drawn map showing your location with measurements to a stationary reference point, or GPS coordinates (ideally, both). This is also a good place to note if you have had to move a boring location because of underground utilities, access issues, etc. It is important to note the reason for relocation and the direction and distance moved (i.e., moved 10 feet to the north due to presence of subsurface water line).

2. If you are using a hollow stem auger drilling method, it is important to communicate to the driller how often you would like a split spoon sample collected. Typically this would be continuous or every 5 feet but may be different depending on the project needs.

3. Note any feedback from the driller about the drilling conditions. This may include difficult drilling or rig chatter (usually caused by hard materials), heaving sands (usually caused by hydrostatic pressure on the borehole), caving, or hole instability.

4. For split spoon samples, record the number of hammer blows (blow counts) necessary to drive the sampler each 6-inch increment, as reported by the driller. If more than 50 blows are needed, record the distance that the sampler was driven in 50 blows (i.e., 2-inches in 50 blows). This is referred to as the standard penetration test.

5. Cover the sampling table with plastic sheeting. Lay an engineer's tape lengthwise across the sampling table. Once a sample has been collected, orient it on the table so that the top is aligned with the 0-foot mark on the tape.

6. Split open the sampler, core barrel liner, or sample collection bag. Record the depth interval that the sampler was driven and the depth interval of soil that was recovered. For split spoons or single-cased core barrels, such as Geoprobe direct-push rods, determine whether any loose 'slough' soil has been dislodged by the drilling equipment and deposited at the top of your core (AMS direct push rods are double cased and do not create slough). Do not include slough in the measurement of the soil recovered. Often the core will be filled with an uninterrupted column of soil that is shorter in length than the total drive interval. In such cases, record the recovery interval as it is situated in the core unless you are able to determine the actual depth where the soil sample originated.

7. Before further disturbing the soil, take volatile organic compound (VOC) measurements with a photoionization detector (PID), if using. Take measurements by making crevices in the soil with a spoon or scraper and inserting the PID probe into these openings. Alternatively, collect small spoonfuls of soil into Ziploc bag(s), seal the bag(s), gently shake the bag(s), and insert the PID probe through the top of the bag(s) and into the headspace once the soil vapor has been allowed to equilibrate with the surrounding air (headspace method). The bag headspace screening method is typically more accurate and is useful at sites with low concentrations of VOCs, whereas the in-situ method is a faster and more qualitative method, best used at sites with higher VOC concentrations. If sampling for VOCs by the U.S. Environmental Protection Agency (USEPA) Method 5035, these soil samples should also be collected

prior to disturbing the core. Soil sampling procedures using USEPA Method 5035 are described in detail in the Soil Sample Collection Standard Guideline.

8. Use a straight edge to scrape the soil level and expose the center of the core. Photograph the core alongside the measuring tape and an index card displaying the soil boring location/ID and depth interval.

3.3 SOIL CLASSIFICATION

Soils are described using the following characteristics: Moisture content, color, consistency, MAJOR CONSTITUENT, minor constituent, geotechnical properties, other observations (e.g. visual or olfactory indications of contamination). The USCS field guide is included in this guidance for reference. The steps below should help guide the logger in classifying soils according to the USCS.

1. Note the moisture content of the soil, using “dry,” “moist,” “wet,” or “saturated.” Mark the water table at the time of drilling on the log at the depth where saturated soil is first observed
2. Record the color of the soil. A descriptive color (i.e., light brown) or a color identified using the Munsell color chart are both valid.
3. Determine whether organic matter influences the properties of the material. If so, record as an organic soil.
4. If the soil is predominantly inorganic, identify whether the major constituent is coarse- or fine-grained. Coarse-grained soils include sands and gravels; fine-grained soils include silts and clays.
    a. For coarse grained soils, determine:
        i. Grain size(s) present including fine, medium, or coarse, and grain size distribution including well-graded (a mixture of fine to coarse grains) or poorly-graded (uniform in size). The USCS guide is helpful for determining grain sizes. If the major constituent is gravel, note its angularity using “rounded,” “sub-angular” or “angular.”
        ii. Minor constituent(s). If a minor constituent represents less than approximately 15% of the sample, note this as “with [minor constituent]” and optionally, whether it is “trace” (<5%) or “few” (5-15%). If a minor constituent represents more than 15% of the sample, use “[minor constituent]-y.” For example, a sand with 5% silt would be classified as a “SAND with trace silt” and sand with 30% silt would be classified as a “SILTY SAND.” For coarse-grained soils with fines between 5% and 15%, the USCS includes several dashed classifications, such as SW-SM. It is often helpful to record an estimated percentage for soil constituents to aid in classification according to the USCS.

b. For fine-grained soils, determine:

   i. Major constituent. To determine whether a material is silt or clay, a simple settling test may be performed in a glass vial or gloved hand by spraying a small amount of the sample with water. Silt particles will settle out of suspension in water within a few minutes, whereas clay particles will remain suspended for a longer period of time.

   ii. Minor constituent(s). As described above, determine the approximate percentage and record as "with [minor constituent]" or "[minor constituent]-y" as appropriate. It is often helpful to record an estimated percentage to aid in classification according to the USCS.

   iii. Geotechnical properties. Depending on project data needs, geotechnical properties may be optional but often provide helpful information. Geotechnical properties include plasticity (ranging from "non-plastic" to "highly plastic" as determined by a thread test) and consistency (ranging from "loose" to "very dense" for coarse-grained soils and "soft" to "hard" for fine-grained soils). When using split spoon samplers, blow counts recorded during the standard penetration test (also referred to as N-values) are used to determine consistency; when using direct-push or sonic drilling, consistency is described qualitatively.

5. Using the USCS guide and the description of the soil, determine the appropriate USCS symbol and record it on the log. If it is difficult to distinguish the major constituent of a soil, a borderline "/" symbol may be used to denote the two potential major constituents present. This is not the same as the USCS classifications that utilize a dash, such as SW-SM.

6. Determine whether contacts between stratigraphic units are abrupt, or gradational. Note abrupt contacts using a solid line and gradational contacts using a dotted line. If the contact between units is not visible and was missed between sample depths, a dashed line is used.

7. If the site or area geology is known, and you are confident in your identification of a specific stratum, note the geologic unit. At a site where the geology is uncertain, you may make some more general notes about the depositional environment, such as identifying probable estuarine deposits, colluvium, glacial till, etc.

3.4 OTHER OBSERVATIONS

1. Record other materials observed in the sample. These may include minor amounts of rootlets or other plant matter, evidence of organisms such as shell fragments, and/or anthropogenic debris such as brick fragments, plastic, or metal debris.

2. Record potential indications of contamination. These may include odors, colored or black staining on soils, colored crystals, hydrocarbon sheens, or non-aqueous phase liquid (NAPL) product.
   a. To test for hydrocarbon sheen, put a small amount of soil in a bowl, saturate with water and swirl, noting whether a rainbow sheen appears on the surface of the water. Alternatively, place a small amount of water in the bottom of the bowl and a small amount of soil along the side, then tilt the bowl so that the water slowly touches the soil. If observed, note the color of the sheen and describe as slight (discontinuous on the water surface), moderate (continuous but spreading slowly) or high (rainbow sheen covering entire surface water).
   b. To test for the presence of NAPL, use a clean paper towel to blot the surface of the core and note the proportion of the towel that is saturated with oil (be sure to allow the towel to dry when blotting moist to wet soils to distinguish between saturation due to NAPL and due to water).
3. Note the final depth of the boring and any reasons for early termination of the boring (i.e., refusal).
4. If monitoring wells will be installed, follow the Standard Guidelines for monitoring well construction and well development.

4.0 Decontamination

All reusable equipment that comes into contact with soil should be decontaminated as follows prior to moving to the next sampling location.

Split spoons, stainless steel bowls and spoons, and any other tools used for soil classification must be decontaminated between boring locations. If collecting soil samples for chemical analysis, split spoons and any tools used for sample processing must be decontaminated between each sample; alternatively, disposable bowls and spoons may be used. Equipment decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an alconox (or similar)/clean water solution and a final rinse with distilled or deionized water.

5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, waste soils and other drilling materials generated during soil boring activities will be contained, transported, disposed of in accordance with applicable laws, and stored in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials is as follows. For investigation-derived waste (IDW) that is contained, such as waste soils, 55-gallon drums approved by the Washington State Department of Transportation (WSDOT) will be supplied by the driller and used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “soil cuttings”), the dates on which the wastes were placed in the container, the owner's name, contact information for the field person who generated the waste, and the site name.

Whenever possible, IDW contained within drums will be characterized relative to applicable waste criteria using data from the sampling locations. Material that is designated for off-site disposal will be transported to an off-site facility that is permitted to accept the waste. Manifests will be used as appropriate for disposal.

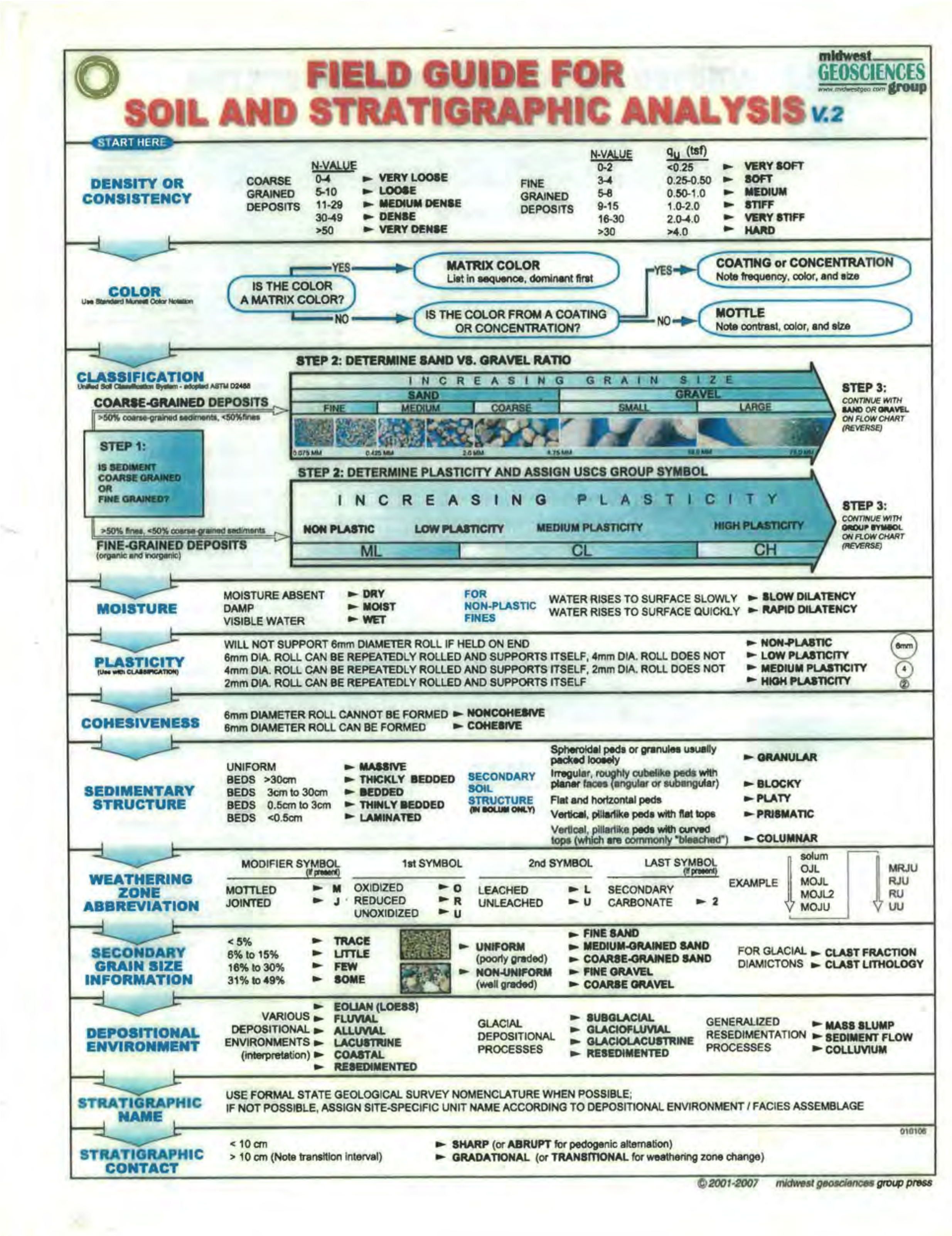
Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy duty garbage bags or other appropriate containers and disposed of as solid waste in the municipal collection system (i.e., site dumpster).

6.0 Field Documentation

All observations should be recorded on a soil boring form appropriate for the drilling method or in a bound field notebook. Field staff should make an effort to record as much detail as possible in the field log. After the field work is complete, a set of final logs (usually electronic) that serve as the record for the project will be completed in consultation with the project manager or field manager.

Enclosure: USCS Soil Classification Field Guide

USCS SOIL CLASSIFICATION FIELD GUIDE



FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS V.2

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START HERE

DENSITY OR CONSISTENCY

COARSE GRAINED DEPOSITS

N-VALUE	
0-4	► VERY LOOSE
5-10	► LOOSE
11-29	► MEDIUM DENSE
30-49	► DENSE
>50	► VERY DENSE

FINE GRAINED DEPOSITS

N-VALUE	q_u (tsf)	
0-2	<0.25	► VERY SOFT
3-4	0.25-0.50	► SOFT
5-8	0.50-1.0	► MEDIUM
9-15	1.0-2.0	► STIFF
16-30	2.0-4.0	► VERY STIFF
>30	>4.0	► HARD

COLOR
Use Standard Munsell Color Notation

IS THE COLOR A MATRIX COLOR?
- YES → MATRIX COLOR — List in sequence, dominant first
- NO → IS THE COLOR FROM A COATING OR CONCENTRATION?
  - YES → COATING or CONCENTRATION — Note frequency, color, and size
  - NO → MOTTLE — Note contrast, color, and size

CLASSIFICATION
Unified Soil Classification System - adopted ASTM D2488

STEP 1: IS SEDIMENT COARSE GRAINED OR FINE GRAINED?

COARSE-GRAINED DEPOSITS (>50% coarse-grained sediments, <50% fines)

STEP 2: DETERMINE SAND VS. GRAVEL RATIO

INCREASING GRAIN SIZE

SAND: FINE, MEDIUM, COARSE — GRAVEL: SMALL, LARGE

0.075 MM — 0.425 MM — 2.0 MM — 4.75 MM — 19.0 MM — 75.0 MM

STEP 3: CONTINUE WITH SAND OR GRAVEL ON FLOW CHART (REVERSE)

FINE-GRAINED DEPOSITS (organic and inorganic) (>50% fines, <50% coarse-grained sediments)

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL

INCREASING PLASTICITY

NON PLASTIC — LOW PLASTICITY — MEDIUM PLASTICITY — HIGH PLASTICITY

ML — CL — CH

STEP 3: CONTINUE WITH GROUP SYMBOL ON FLOW CHART (REVERSE)

MOISTURE

- MOISTURE ABSENT ► DRY
- DAMP ► MOIST
- VISIBLE WATER ► WET

FOR NON-PLASTIC FINES
- WATER RISES TO SURFACE SLOWLY ► SLOW DILATENCY
- WATER RISES TO SURFACE QUICKLY ► RAPID DILATENCY

PLASTICITY (Use with CLASSIFICATION)

- WILL NOT SUPPORT 6mm DIAMETER ROLL IF HELD ON END ► NON-PLASTIC
- 6mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 4mm DIA. ROLL DOES NOT ► LOW PLASTICITY
- 4mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 2mm DIA. ROLL DOES NOT ► MEDIUM PLASTICITY
- 2mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF ► HIGH PLASTICITY

(6mm) (4) (2)

COHESIVENESS

- 6mm DIAMETER ROLL CANNOT BE FORMED ► NONCOHESIVE
- 6mm DIAMETER ROLL CAN BE FORMED ► COHESIVE

SEDIMENTARY STRUCTURE

- UNIFORM ► MASSIVE
- BEDS >30cm ► THICKLY BEDDED
- BEDS 3cm to 30cm ► BEDDED
- BEDS 0.5cm to 3cm ► THINLY BEDDED
- BEDS <0.5cm ► LAMINATED

SECONDARY SOIL STRUCTURE (IN SOLUM ONLY)
- Spheroidal peds or granules usually packed loosely ► GRANULAR
- Irregular, roughly cubelike peds with planar faces (angular or subangular) ► BLOCKY
- Flat and horizontal peds ► PLATY
- Vertical, pillarlike peds with flat tops ► PRISMATIC
- Vertical, pillarlike peds with curved tops (which are commonly "bleached") ► COLUMNAR

WEATHERING ZONE ABBREVIATION

MODIFIER SYMBOL (if present)		1st SYMBOL		2nd SYMBOL		LAST SYMBOL (if present)	
MOTTLED	► M	OXIDIZED	► O	LEACHED	► L	SECONDARY CARBONATE	► 2
JOINTED	► J	REDUCED	► R	UNLEACHED	► U		
		UNOXIDIZED	► U				

EXAMPLE: solum, OJL, MOJL, MOJL2, MOJU — MRJU, RJU, RU, UU

SECONDARY GRAIN SIZE INFORMATION

- < 5% ► TRACE
- 6% to 15% ► LITTLE
- 16% to 30% ► FEW
- 31% to 49% ► SOME

- ► UNIFORM (poorly graded)
- ► NON-UNIFORM (well graded)

- ► FINE SAND
- ► MEDIUM-GRAINED SAND
- ► COARSE-GRAINED SAND
- ► FINE GRAVEL
- ► COARSE GRAVEL

FOR GLACIAL DIAMICTONS
- ► CLAST FRACTION
- ► CLAST LITHOLOGY

DEPOSITIONAL ENVIRONMENT

VARIOUS DEPOSITIONAL ENVIRONMENTS (interpretation)
- ► EOLIAN (LOESS)
- ► FLUVIAL
- ► ALLUVIAL
- ► LACUSTRINE
- ► COASTAL
- ► RESEDIMENTED

GLACIAL DEPOSITIONAL PROCESSES
- ► SUBGLACIAL
- ► GLACIOFLUVIAL
- ► GLACIOLACUSTRINE
- ► RESEDIMENTED

GENERALIZED RESEDIMENTATION PROCESSES
- ► MASS SLUMP
- ► SEDIMENT FLOW
- ► COLLUVIUM

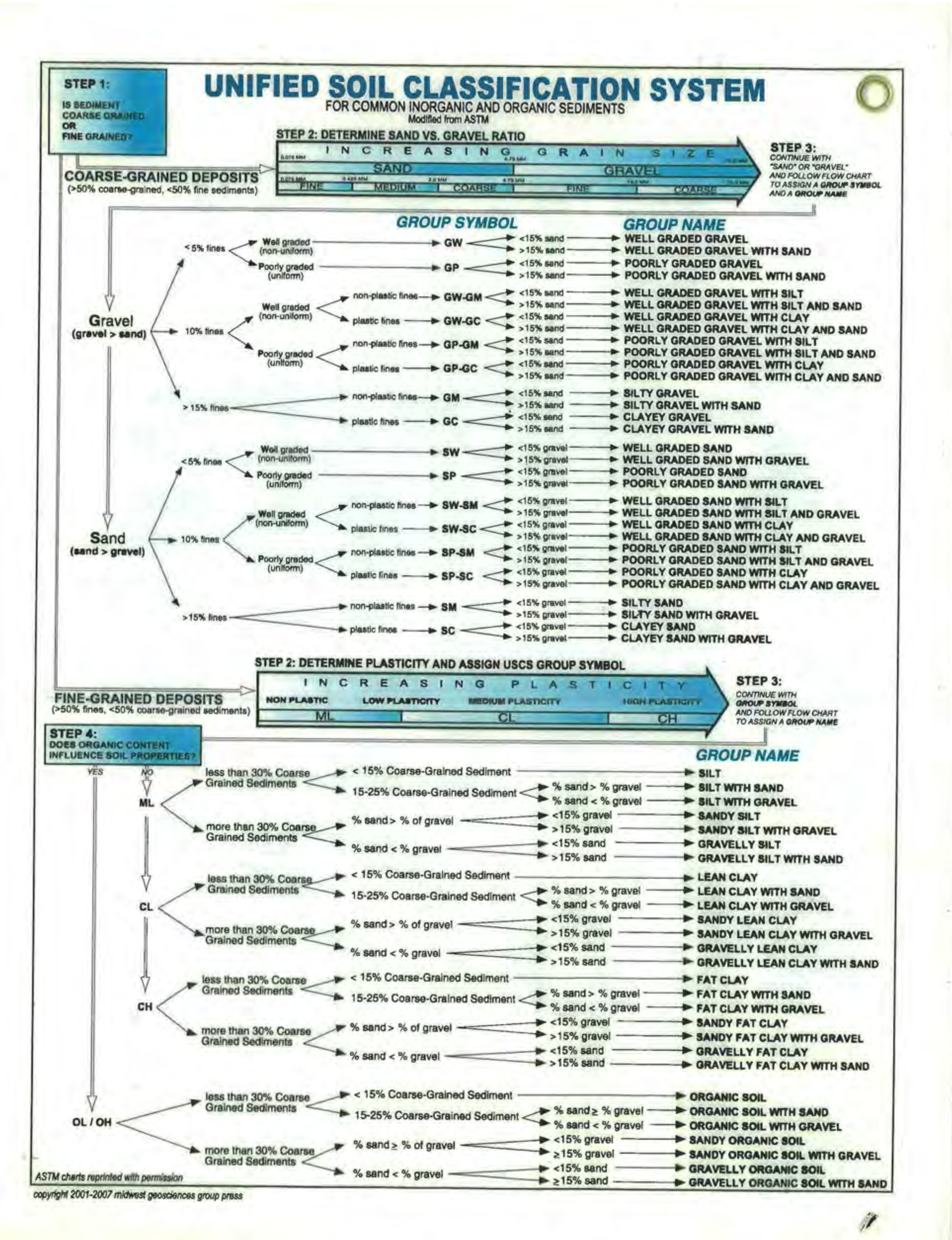
STRATIGRAPHIC NAME

USE FORMAL STATE GEOLOGICAL SURVEY NOMENCLATURE WHEN POSSIBLE;
IF NOT POSSIBLE, ASSIGN SITE-SPECIFIC UNIT NAME ACCORDING TO DEPOSITIONAL ENVIRONMENT / FACIES ASSEMBLAGE

STRATIGRAPHIC CONTACT

010106

- < 10 cm ► SHARP (or ABRUPT for pedogenic alternation)
- > 10 cm (Note transition interval) ► GRADATIONAL (or TRANSITIONAL for weathering zone change)


STEP 1:
IS SEDIMENT COARSE GRAINED OR FINE GRAINED?
UNIFIED SOIL CLASSIFICATION SYSTEM
FOR COMMON INORGANIC AND ORGANIC SEDIMENTS
Modified from ASTM
STEP 2: DETERMINE SAND VS. GRAVEL RATIO
INCREASING GRAIN SIZE
SAND
GRAVEL
FINE
MEDIUM
COARSE
FINE
COARSE
COARSE-GRAINED DEPOSITS
(>50% coarse-grained, <50% fine sediments)
STEP 3:
CONTINUE WITH "SAND" OR "GRAVEL" AND FOLLOW FLOW CHART TO ASSIGN A GROUP SYMBOL AND A GROUP NAME
GROUP SYMBOL
GROUP NAME
Gravel
(gravel > sand)
<5% fines
10% fines
>15% fines
Well graded (non-uniform)
Poorly graded (uniform)
non-plastic fines
plastic fines
GW
GP
GW-GM
GW-GC
GP-GM
GP-GC
GM
GC
<15% sand
>15% sand
WELL GRADED GRAVEL
WELL GRADED GRAVEL WITH SAND
POORLY GRADED GRAVEL
POORLY GRADED GRAVEL WITH SAND
WELL GRADED GRAVEL WITH SILT
WELL GRADED GRAVEL WITH SILT AND SAND
WELL GRADED GRAVEL WITH CLAY
WELL GRADED GRAVEL WITH CLAY AND SAND
POORLY GRADED GRAVEL WITH SILT
POORLY GRADED GRAVEL WITH SILT AND SAND
POORLY GRADED GRAVEL WITH CLAY
POORLY GRADED GRAVEL WITH CLAY AND SAND
SILTY GRAVEL
SILTY GRAVEL WITH SAND
CLAYEY GRAVEL
CLAYEY GRAVEL WITH SAND
Sand
(sand > gravel)
SW
SP
SW-SM
SW-SC
SP-SM
SP-SC
SM
SC
<15% gravel
>15% gravel
WELL GRADED SAND
WELL GRADED SAND WITH GRAVEL
POORLY GRADED SAND
POORLY GRADED SAND WITH GRAVEL
WELL GRADED SAND WITH SILT
WELL GRADED SAND WITH SILT AND GRAVEL
WELL GRADED SAND WITH CLAY
WELL GRADED SAND WITH CLAY AND GRAVEL
POORLY GRADED SAND WITH SILT
POORLY GRADED SAND WITH SILT AND GRAVEL
POORLY GRADED SAND WITH CLAY
POORLY GRADED SAND WITH CLAY AND GRAVEL
SILTY SAND
SILTY SAND WITH GRAVEL
CLAYEY SAND
CLAYEY SAND WITH GRAVEL
STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL
INCREASING PLASTICITY
NON PLASTIC
LOW PLASTICITY
MEDIUM PLASTICITY
HIGH PLASTICITY
ML
CL
CH
FINE-GRAINED DEPOSITS
(>50% fines, <50% coarse-grained sediments)
STEP 3:
CONTINUE WITH GROUP SYMBOL AND FOLLOW FLOW CHART TO ASSIGN A GROUP NAME
STEP 4:
DOES ORGANIC CONTENT INFLUENCE SOIL PROPERTIES?
YES
NO
GROUP NAME
less than 30% Coarse Grained Sediments
more than 30% Coarse Grained Sediments
< 15% Coarse-Grained Sediment
15-25% Coarse-Grained Sediment
% sand > % gravel
% sand < % gravel
% sand > % of gravel
<15% gravel
>15% gravel
<15% sand
>15% sand
SILT
SILT WITH SAND
SILT WITH GRAVEL
SANDY SILT
SANDY SILT WITH GRAVEL
GRAVELLY SILT
GRAVELLY SILT WITH SAND
LEAN CLAY
LEAN CLAY WITH SAND
LEAN CLAY WITH GRAVEL
SANDY LEAN CLAY
SANDY LEAN CLAY WITH GRAVEL
GRAVELLY LEAN CLAY
GRAVELLY LEAN CLAY WITH SAND
FAT CLAY
FAT CLAY WITH SAND
FAT CLAY WITH GRAVEL
SANDY FAT CLAY
SANDY FAT CLAY WITH GRAVEL
GRAVELLY FAT CLAY
GRAVELLY FAT CLAY WITH SAND
OL / OH
% sand ≥ % gravel
% sand ≥ % of gravel
≥15% gravel
≥15% sand
ORGANIC SOIL
ORGANIC SOIL WITH SAND
ORGANIC SOIL WITH GRAVEL
SANDY ORGANIC SOIL
SANDY ORGANIC SOIL WITH GRAVEL
GRAVELLY ORGANIC SOIL
GRAVELLY ORGANIC SOIL WITH SAND
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strategy ▪ science ▪ engineering

PROJECT:	LOCATION:	WELL ID:	
LOGGED BY:	DRILL DATE:	ECOLOGY WELL ID:	
DRILLED BY:	BORING DIAMETER:	COORDINATE SYSTEM:	
DRILLING EQUIPMENT:	SCREENED INTERVAL:	NORTHING:	EASTING:
DRILLING METHOD:		GROUND SURFACE ELEV.:	TOC ELEVATION:
SAMPLING METHOD:		TOTAL DEPTH (ft bgs):	DEPTH TO WATER (ft bgs):

Depth (feet)	USCS	Description	Drive	Recovery	# of Blows	PID (ppm)	Sample ID	Well Construction
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

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	PROJECT:	LOCATION:	WELL ID:
	LOGGED BY:	DRILL DATE:	ECOLOGY WELL ID:
DRILLED BY:	BORING DIAMETER:	COORDINATE SYSTEM:	
DRILLING EQUIPMENT:	SCREENED INTERVAL:	NORTHING:	EASTING:
DRILLING METHOD:		GROUND SURFACE ELEV.:	TOC ELEVATION:
SAMPLING METHOD:		TOTAL DEPTH (ft bgs):	DEPTH TO WATER (ft bgs):

Depth (feet)	USCS	Description	Drive	Recovery	# of Blows	PID (ppm)	Sample ID	Well Construction
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

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F|S STANDARD GUIDELINE

Soil Sample Collection

DATE/LAST UPDATE: May 2015

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step by step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This standard guideline presents commonly used procedures for collection of soil samples for characterization and laboratory analysis. The methods presented in this guideline apply to the collection of soil samples during the following characterization activities: soil borings via drilling, manual collection of shallow soil samples, test pit excavation, excavation confirmation, and stockpile characterization. Specific details regarding the collection of discrete and composite samples, and special sampling techniques for volatile organic compounds (VOCs) are also included. The guideline is intended to be used by staff who collect soil samples in the field.

It is important that the field staff completing the soil sample collection discusses the specific needs for a particular investigation with the project geologist, the project manager, or whoever will ultimately be responsible for interpreting the findings of the field investigation. This discussion is in addition to field training and general knowledge about soil sampling, and should happen prior to entering the field, with additional follow-up before finalizing the field forms, after the investigation is complete.

2.0 Equipment and Supplies

Soil Sampling Equipment and Tools:

- Tape measure or measuring wheel
- Stainless steel bowls and spoons
- Graduated plunger and collection tubes for VOC samples (if needed)
- Trash bags
- Decontamination tools including:
  - Paper towels
  - Spray bottles of alconox (or similar) solution
  - Deionized or distilled water
- Adhesive drum labels, or paint or grease pen
- Washington State Department of Transportation- (WSDOT) approved drums for investigation-derived waste (IDW) disposal, if needed (if drilling, to be provided by driller)
- Camera
- Hand-held global position system (GPS; optional)
- Coolers, sample jars, labels, ice

Paperwork:

- Work Plan and/or Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP)
- Health and Safety Plan (HASP)
- Sample collection forms printed in Rite in the Rain paper, or Rite in the Rain field notebook

Personal Equipment:

- Steel-toed boots
- Safety vest
- Safety glasses
- Nitrile gloves
- Rain gear
- Work gloves

3.0 Standard Procedures

3.1 OFFICE PREPARATION

Prior to going into the field, review the SAP/QAPP tables to become familiar with the desired sample intervals, nomenclature, field Quality Assurance (QA) samples, analytes, sample containers, and holding times for each analytical method.

At least one week prior to sampling, coordinate with the laboratory specified in the SAP/QAPP to get coolers and appropriate sample containers. Familiarize yourself with the volume requirements and container types, preservation methods, and holding times for each class of analytes.

3.2 GENERAL SOIL SAMPLE COLLECTION PROCEDURES

1. Locate the desired sample location and depth interval using a handheld GPS or by taking field measurements from known site features. Note the soil type and any other observations or indications of contamination on a soil boring log, soil sample collection form or field notebook, as described in the Soil Logging Standard Guideline. Note the location and depth of the sample and take a photograph, if possible.
2. Refer to subsections 3.2.1 through 3.2.4 for the appropriate soil collection procedures for drilling, shallow soil, test pit excavation, excavation confirmation, and stockpiles. If collecting samples for VOC analysis by the U.S. Environmental Protection Agency (USEPA) Method 5035, refer to Section 3.3 for specific sample collection procedures for this method. If composite soil sampling is recommended, refer to Section 3.4 for details.
3. Once soil has been collected from the desired depth or interval, mix thoroughly until the sample is homogenous in color, texture, and moisture.
4. Fill the required laboratory-provided jars, taking care not to overfill. If large gravels (diameter greater than ~ 1 inch) are encountered, these should be discarded to ensure that an adequate soil volume is collected for analysis. If necessary, use a clean paper towel to remove soil particles from the threaded mouth of the jar before securing lids to ensure a good seal.
5. Label each jar with the sample name, date, time, field staff initials and required analyses. If collecting a field duplicate, use the sample nomenclature specified in the work plan and note the field duplicate name and sample time in the sample log. If extra volume for matrix spike/matrix spike duplicate (MS/MSD) analysis is being collected, use the same name on all jars. Soil samples should be protected from moisture by placing the filled sample jars into separate sealed Ziploc bags before placing them into a cooler.

6. Complete a chain-of-custody form for all samples, including sample names, date and time of collection, number of containers, and required analyses and methods. Keep samples on ice to maintain temperatures of 4-6 degrees Celsius (°C) and transport to the laboratory under chain-of-custody procedures.

3.2.1 Soil Sample Collection via Drilling

These procedures should be used for drilling via direct-push, hollow stem auger, or roto-sonic methods where a pre-designated sample interval (i.e. 0 to 5 feet below ground surface [bgs]) is retrieved from the subsurface using a split spoon sampling device, lined core, or bag sampler.

1. Ensure that reusable sampling equipment has been thoroughly decontaminated prior to sampling.
2. Use a stainless steel spoon or trowel, or disposable scoop to remove an equal volume of soil across the targeted depth interval from the sampler.
    a. If using a split spoon sampler or other reusable sampler, avoid collecting the soil that is touching the sides of the sampler to the extent practical.
    b. If the soil touching a reusable sampler must be collected to obtain adequate volume for analysis, notify the PM and record in the field logbook.

3.2.2 Manual Collection of Shallow Soil Samples

These procedures should be used for shallow soil sampling via scoop, trowel, shovel, or hand auger.

1. Dig or auger to the bottom depth of the shallowest sample to be collected, using a tool that has been cleaned and decontaminated. Verify that the target depth has been reached using a measuring tape.
2. If using a scoop or trowel, collect the soil directly into a decontaminated stainless steel bowl.
3. If using a shovel, the soil may either be collected in bowls or set as aside on plastic sheeting in favor of collecting the sample from the sidewall of the hole. If sampling the sidewall, use a decontaminated or disposable scoop or trowel to collect soil from the target depth, or scrape along the sidewall to collect soil across a target depth interval. Transfer soil to a decontaminated stainless steel bowl, repeating until a sufficient volume has been collected.
4. If using a hand auger, empty the cylinder of the auger directly into a decontaminated stainless steel bowl. It may be necessary to empty the hand auger onto plastic sheeting or into a bowl in order to reach the target depth without overflowing the sampler.
5. Any soil from depth intervals that are not targeted for sampling should be set aside on plastic sheeting and returned to the hole after sampling.

3.2.3 Sample Collection from Test Pits or Limited Soil Excavations

These procedures should be used for collecting samples from test pit explorations excavated using a back hoe or excavator. These same general procedures should also be followed for post-excavation soil samples used to confirm that an excavation has removed contaminated material or to document post-excavation conditions after target excavation limits have been reached.

1. Measure the length, width, and depth of the test pit or excavation area to verify that the target extents have been reached. The lateral spacing of the test pit or excavation confirmation samples, or exact location of samples should be specified in the work plan and typically depend on the size of the excavation area but can vary significantly from project to project.
2. If not specified in the work plan, sidewall samples may be collected either midway between the ground surface and base of the excavation, or incrementally along the entire height of the sidewall. Both sidewall and base (bottom) samples should penetrate a minimum of 6 inches beyond the excavated surface.
3. If the test pit or excavation is less than 4 feet deep, or has been benched to accommodate safe entry, a sample may be collected directly from the sidewall(s). To collect soil from a sidewall, use a decontaminated or disposable scoop, trowel, or shovel to obtain soil from the desired depth or depth interval directly into a decontaminated stainless steel bowl.
4. If a test pit or excavation cannot be safely entered, instruct the excavator operator to scoop sidewall material from the target depth or depth interval. Collect the soil sample from the excavator bucket using a decontaminated stainless steel spoon, trowel, or disposal scoop, avoiding material that has come into contact with the teeth or sides of the bucket. Place an adequate volume of soil into a decontaminated stainless steel bowl. If necessary, follow the compositing procedures in Section 3.4.

3.2.4 Stockpile Sampling

These procedures should be used for classifying stockpiled soil, including excavated soil and imported backfill material.

1. Where potentially contaminated soils have been previously excavated and stockpiled on site, Washington State Department of Ecology (Ecology) guidance recommends using a decontaminated or disposable scoop or trowel, penetrating 6 to 12 inches beneath the surface of the pile at several locations until sufficient volume for analysis is achieved. A decontaminated shovel may also be used to facilitate collection of soil from large piles. The locations for soil collection should be where contamination is most likely to be present based on field screening (i.e. staining, odor, sheen, or elevated photoionization detector [PID] readings). If there are not field indications of contamination, the locations should be distributed evenly around the stockpile.

2. The stockpile may need to be broken up into sections for sample collection depending on the size of the pile (i.e., segregate the pile in half or quarters). If this is necessary, it is important to document where each set of samples were collected from (i.e., north quadrant) and create a field sketch of the pile for reference.
3. If a sampling frequency is not specified in the work plan, the general rule of thumb for contaminated soil stockpile profiling is to collect and submit 3 analytical samples (these samples can be multi-point composites or grabs) for stockpiles less than 100 cubic yards (CY), 5 samples for stockpiles between 100 and 500 CY, 7 samples for stockpiles 500 to 1,000 CY, 10 samples for stockpiles 1,000 to 2,000 CY, and 10 samples for stockpiles larger than 2,000 CY with an additional sample collected for every 500 CY of material. This rule of thumb is consistent with Ecology guidance for site remediation.
4. Samples for characterization of stockpiles of imported backfill or other presumed clean material should also be collected as described above. If not described in the work plan, the typical sample frequency for imported or clean material characterization is one sample per 500 CY.

3.3 SOIL SAMPLE COLLECTION FOR VOC ANALYSIS

If collecting soil samples for VOC analysis by USEPA Method 5035, collect these samples first before disturbing the soil. This method uses a soil volume gauge fitted with a disposable soil sampling plunger tube to collect a soil plug that can be discharged directly to a VOA vial, limiting the loss of volatiles during sampling. The collection of VOC samples using the 5035 method specifies use of an airtight VOA vial with a septum lid. Ecology's interpretation of the USEPA 5035 method allows for field preservation of the sample with methanol or sodium bisulfate, or laboratory preservation (i.e. field collection into an un-preserved vial). It is important to note that if laboratory preservation is the selected method, samples must be received at the laboratory within 48-hours of sample collection. The method of sample preservation for the 5035 method will vary for each site and is dependent on site-specific conditions. Preservation method selection should be coordinated with the laboratory and specified in the sampling plan.

1. Note the volume of soil needed for analysis as specified by the laboratory (commonly 5 or 10 grams). Raise the handle of the soil volume gauge to the slot in the gauge body corresponding to the desired volume and turn clockwise until the tabs in the handle lock into the slot.
2. Insert a sample tube at the open end of the gauge body and turn clockwise until the tabs on the tube lock into the "0 gram" slot. Remove the cap from the sample tube and press directly (where possible) into the shallow soil, soil core/sampler, excavation base or sidewall, or stockpile.
3. Continue pressing the sample tube until the plunger is stopped by the sample volume gauge. If a depth interval (for example 9 to10 feet) is targeted for VOC sampling, collect small volumes of soil across this interval until the sample tube is filled

4. Twist counterclockwise to disengage the sample tube, then depress the plunger to eject the soil plug directly into a laboratory-provided VOA vial. If multiple vials per sample are required, the same plunger may be re-used to fill the remaining vials.

3.4 COMPOSITE SAMPLE COLLECTION

For this guideline, composites are considered to be samples that are collected across more than one location, or multiple depth intervals at a single location. Samples collected over continuous depth intervals within a sampling device (i.e. split spoon) are addressed for each sampling method in Section 3.2 above.

Compositing of sample material may be performed in the field, or by the analytical laboratory. To collect a field composite sample, identify the locations and depth(s) that will comprise the composite. Collect soil from the first target sub-sample depth or depth interval and hold in a decontaminated stainless steel bowl, covered with aluminum foil to prevent cross contamination and label with the location and depth. Continue to collect and hold individual sub-samples until all components of the composite have been collected, then transfer an equal amount of each sub-sample to a clean bowl and homogenize. Fill necessary sample jars from homogenized composite. In some cases, project plans may require that each individual sample that comprised the composite be collected in jars and submitted to the laboratory in the event that individual sample analysis is desired, or if laboratory compositing is requested in addition to field compositing as a field quality control measure. In this case, label each individual jar, but indicate HOLD on the chain-of-custody, and note that the sample is part of composite XYZ.

To collect a laboratory composite sample, collect, and label each sub-sample using the procedures described above in Section 3.2. Record each sub-sample on the chain-of-custody form, and indicate on this form which samples should be composited by the laboratory and the desired name of the composite sample. It is important to communicate to the laboratory if discrete samples will also require analysis (in some cases) or only the composite sample.

4.0 Decontamination

All reusable equipment that comes into contact with soil should be decontaminated prior to moving to the next sampling location.

Stainless steel bowls and spoons, and any tools used for sample processing will be decontaminated between each sample; alternatively, disposable bowls and spoons may be used. Equipment decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an alconox (or other soap)/clean water solution and a final rinse with distilled or deionized water.

5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, waste soils will be contained, transported, disposed of in accordance with applicable laws, and stored in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials is as follows. For IDW that is containerized, such as waste soils, 55-gallon drums approved by WSDOT will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., "soil"), the dates on which the wastes were placed in the container, the owner's name and contact information for the field person who generated the waste, and the site name.

IDW that is placed into drums for temporary storage will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used, as appropriate for disposal.

Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy duty garbage bags or other appropriate containers and disposed of as solid waste in the municipal collection system (i.e., site Dumpster).

6.0 Field Documentation

All observations including sample collection locations, soil descriptions, sample depths, collection times, analyses, and field QC samples should be recorded on a boring log, soil sample collection form, or bound field notebook. Information recorded should additionally include personnel present (including subcontractors), purpose of field event, weather conditions, sample collection date and times, sample analytes, and any deviations from the SAP.

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F|S STANDARD GUIDELINE

Vapor Intrusion

DATE/LAST UPDATE: December 2016

These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.

All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.

1.0 Scope and Purpose

This standard guideline provides details necessary to complete vapor intrusion monitoring, which may include soil vapor point and sub-slab installation, soil vapor point monitoring and/or sampling, indoor air sampling, and remediation system compliance monitoring. Field screening for volatile organic compounds (VOCs) is most often conducted with a photoionization detector (PID) and confirmed via analytical sample collection. The most common sampling methods are included herein. These guidelines are designed to meet or exceed guidelines set forth by the Draft Washington State Department of Ecology's (Ecology's), *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2015 and 2016a). In addition, refer to Ecology's *Updated Process for Initially Assessing the Potential for Petroleum Vapor Intrusion: Implementation Memorandum No. 14* (Ecology 2016b) and the U.S. Environmental Protection Agency's (USEPA's) *Technical Guide For Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites* (USEPA 2015). Defining the lateral and vertical inclusion zones will determine if soil vapor sampling is required. The Interstate Technology and Regulatory Council (ITRC) online guidance for soil vapor intrusion (ITRC 2014) is another good source of information.

2.0 Equipment and Supplies

The following is a list of typical equipment and supplies necessary to complete vapor intrusion monitoring. It is important to note that this list is for a typical project; site-specific conditions may warrant additional or different equipment for completion of the work.

Sub-Slab and Soil Vapor Point Installation:

- Rotary hammer drill
- Drill bit
- Vapor point (AMS or similar)
- Stainless steel (SST) dummy tip (optional)
- Teflon™, nylon, or stainless steel tubing
- Sand pack
- Bentonite chips
- Protective cover for permanent point
- Swagelok® on/off valve (optional)
- Caps or compression fittings
- Quick set (concrete) or hydraulic cement
- Paper towels
- Nylon ferrules
- Shop vac

Soil Vapor Point or Remediation System Screening and/or Sampling:

- PID
- Connector
- Teflon™ or nylon tubing
- SKC air sampling pump or peristaltic pump
- Tedlar® bag or SUMMA® canisters
- Two adjustable wrenches (to tighten SUMMA® canister connections)
- Duplicate sampling (as necessary if duplicate sample collection is required)
- Soil gas manifolds
- Ferrules/fittings
- Helium (or other detection gas if leak detection is necessary)

- Helium detector (if leak detection is necessary with helium)
- Soil vapor sampling sheet (enclosed)

Indoor Air Sampling:

- PID
- Regulator
- SUMMA® canisters (6-liter, lab certified)
- Sampling cane (optional)
- At least two adjustable wrenches
- Indoor air building survey form (enclosed)

3.0 Standard Procedures

Soil vapor samples and/or indoor air samples should be collected from a sufficient number of locations to assess the presence of VOCs and potential exposure to workers or occupants of potentially impacted buildings or future building locations.

3.1 PRE-SCREENING ASSESSMENT

When completing a vapor intrusion survey or indoor air sampling, it is important to complete a pre-sampling survey to document potential activities or storage items that may cause interference with sample results. Some important things to note (list is not comprehensive):

- If smoking has occurred in the building
- Storage of potential contaminants (cleaners, fuels, paints, or paint thinners, etc.)
- HVAC system operation (on or off)
- Temperature and weather (wind direction, barometric pressure, etc.)
- Vehicle maintenance or industrial activities on the property or in the immediate vicinity (especially upwind)
- If new carpet or furniture is present

A pre-sampling soil vapor building survey form can be found at the end of this document. Be mindful of your surroundings and make a comprehensive list of potential factors that may influence sample results.

3.2 SOIL VAPOR POINT INSTALLATION

Soil vapor points can be installed along the outside perimeter of a building or in the lowest level of a building directly through the slab (or beneath the floor into the subsurface if there is not a slab). It is important to evaluate the presence of utilities prior to drilling into the subsurface or through a concrete slab.

If the sampling point is for one time use, tubing inserted into a hole drilled in the slab is sufficient. However, if the sampling is to be part of a long-term monitoring program, a more robust sampler, such as a Geoprobe or AMS probe for permanent soil gas point is recommended. Four different methods for installing soil vapor installation points are described here.

1. For temporary sub-slab points:
    a. Drill a hole into the subsurface. Using a rotary hammer drill and a 3/8-inch drill bit (typical diameter size but not necessary), drill a hole through the concrete floor slab of the building and into the sub-slab material to some depth (e.g., 7 to 8 centimeters [cm] or 3 inches). Drilling into the sub-slab material will create an open cavity, which will prevent obstruction of the tubing intake by small pieces of gravel. Once the thickness of the slab is known, the tubing will be cut to ensure that the probe tubing does not reach the bottom of the hole in order to avoid obstruction with sub-slab material. Sample tubing can be placed directly into the sub-slab. Evaluate and note the sub-slab conditions.
    b. Care should be taken to reduce cross-contaminating sub-slab vapor and indoor air vapor. This may be done by sealing the sample point with VOC-free hydraulic cement, hydrated bentonite, or with VOC-free putty to the top of the slab. Once sealed, wait 15 to 30 minutes before sampling.
2. Suggested installation guidelines for temporary outdoor soil gas points using a rotary hammer and drill bit:
    a. Manufacturers, such as Geoprobe or AMS, make soil gas implant systems designed for use with their equipment. Stainless steel or polyvinyl chloride (PVC) screen can also be used to construct an appropriate soil gas point. The probe screen will be fitted with a Swagelok® or similar fitting and connected to a length of 0.25-inch outer diameter, rigid wall nylon or Teflon™ tubing that will be above grade. Refer to the manufacturer or driller's instructions for specific details regarding assembly and deployment.
    b. To seal the point, the implant should be surrounded with a clean sand pack. Concrete (VOC-free hydraulic cement preferred) should be used above the seal to the top of the slab. Placement of some sort of cap or protective device is recommended if the sampling point will remain in place for some time after the soil gas sample is collected. Once sealed, wait 15 to 30 minutes before sampling.
3. Suggested installation guidelines for outside permanent points installed with a Geoprobe rig or hand auger:
    a. Advance the boring using a geoprobe or hand auger to the required maximum depth. Install a 6-inch long by 0.75-inch diameter stainless steel screen that is capped on the bottom end and fitted with a Swagelok® fitting connected on the

other end (or similar approved screen or soil vapor point). Attach a length of 0.25-inch outer diameter rigid wall nylon or Teflon™ tubing to the probe screen that will be above grade. The above grade end of the probe should be fitted with a stainless steel Swagelok® on/off control valve or similar valve (optional), which is used to prevent short-circuiting of ambient air into the probes and to conduct closed-valve tests. Teflon™ tape should be used on threaded joints to ensure a good seal. Depending on the work plan, it might be necessary to collect an air equipment blank sample through the vapor probe components prior to installation.

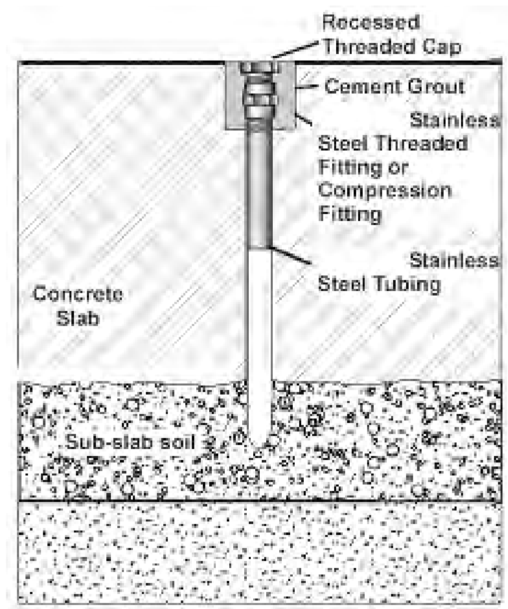
b. The 6-inch screen tip should be vertically centered in a 1-foot long interval containing standard sand pack, resulting in 3 inches of sand above and below the screen. The sand pack will be covered with a 1-foot interval of dry granular bentonite, which should be covered with at least 2 feet of pre-hydrated granular bentonite. The dry granular bentonite is emplaced immediately above the sand pack to ensure that pre-hydrated granular bentonite slurry does not flow down to the probe screen and seal it. The remainder of the borehole will be filled with pre-hydrated granular bentonite slurry (mixed at the surface and poured in) to approximately 12 inches below ground surface (bgs). The top portion should be completed with a 1-foot thick cement cap. A flush-mounted well box or other suitable protective cover should be installed to protect the nylon/Teflon™ tubing and on/off control valve.

4. The following contains suggested equipment and installation guidelines for permanent sub-slab vapor points within a building; however, site-specific conditions may warrant additional or different equipment for completion of the work:

   a. To install the sub-slab vapor probes, a rotary hammer drill will be used to create a “shallow” hole (e.g., ¼-inch deep) that partially penetrates the slab (do not completely penetrate the slab). A portable vacuum can be used to remove the drill cuttings from the hole without compromising the soil vapor samples. Next, a smaller diameter “inner” hole (e.g., 0.8 cm or 5/16 inch diameter) will be drilled through the remainder of the slab and into the sub-slab material to some depth (e.g., 7 to 8 cm or 3 inches). Drilling into the sub-slab material will create an open cavity which will prevent obstruction of the probes by small pieces of gravel. Once the thickness of the slab is known, the tubing will be cut to ensure that the probe tubing does not reach the bottom of the hole and in order to avoid obstruction with sub-slab material.

   b. Each sub-slab vapor point should consist of vacuum-rated Nylon, Teflon™, or stainless steel tubing with ¼-inch outer diameter by 0.15-inch inner diameter, and stainless-steel compression to thread fittings (e.g., ¼-inch outer diameter Swagelok® (SS-400-7-4) NPT female thread connectors or similar equipment). This will be capped with sub-slab tamper resistant cap or other similar protective caps that will be inset into the floor to avoid trip hazards. When time to sample, the sub-slab tamper resistant cap will be removed and Nylon tubing will be attached to the sub-slab vapor point with a ¼-inch out diameter (SS-400-1-4) male NPT. Prior to the installation of one of the sub-slab vapor probes, an air equipment blank sample will be collected if required by the work plan (See Section 3.4.3).

c. Teflon™ tape should be used with all stainless steel treads. All fittings should be attached prior to installing the probe in the sub-slab. A sub-slab tamper resistant cap will be used to ensure that the top of the probe is flush with the surface so as not to interfere with day-to-day use of the building. Portland cement can be used as a surface seal and allowed to cure for at least 24 hours prior to sampling. Hydraulic cement may also be used if free of VOCs, and requires less cure time (typically less than one hour) prior to sample collection. A typical soil gas probe schematic is provided here for reference.



Sub-slab soil gas probe schematic (Source: Ecology 2016a)

3.3 SOIL VAPOR POINT SAMPLING USING TEDLAR® BAGS

The objective of the vapor sampling procedures is to collect representative samples of the targeted media and analyze the gas for the presence of VOCs. Typically, a low volume air pump is used to pull a sample through the sampling train.

1. Connect proper tubing to your sampling point and to your low volume air pump.
2. Purge for 3 to 5 minutes to ensure that you are collecting a representative sample.
3. After purging, connect your Tedlar® bag to your air pump and collect your sample (Note: Tedlar® bags should be filled at a rate of approximately 5 liters per minute).
4. A PID is typically used in conjunction with sample collection in a Tedlar® bag.
   a. Connect the PID probe to the sample container using a section of tubing
   b. Use the PID to read the organic vapor level present in the sample.

Soil Vapor samples are typically collected into 1-liter Tedlar® bags and have a short (typically less than 72-hours) holding time. Samples collected into Tedlar® bags should be transported to the laboratory immediately under chain-of-custody protocol and stored in a dark container at ambient temperature during transport out of direct UV-light. Do not ship Tedlar® bags to the laboratory using an air transportation method as the pressure could compromise the sample or the bag. If air transport is necessary, do not completely fill the Tedlar® to avoid bursting. Soil vapor grab samples can also be collected into 1-liter SUMMA® canisters to provide additional holding time, lower laboratory method detection limits for some analytes, or sample delivery alternatives.

3.4 SOIL VAPOR AND SUB-SLAB SAMPLING WITH SUMMA® CANISTERS

Prior to soil vapor sampling, check all soil vapor sampling supplies to ensure the right sampling equipment arrived from the lab including duplicate Tees, if duplicate sample collection is necessary, and purging canisters. Conduct the following:

- Confirm that all SUMMA® canisters have at least 27 to 30 inches of mercury (in. Hg) prior to going out in the field to sample.
- Check and record all manifold and SUMMA® canister tags and numbers.
- Make sure all connections on the SUMMA® canisters and manifolds are tight.
- Order Helium (or other tracer gas) if needed and rent a helium detector.

Once the sub-slab or soil vapor probes are installed and the concrete well seal at each vapor point has fully cured, vapor sampling activities may commence (ideally a minimum of 2 hours is necessary for probe equilibration, depending on surface seal cure time). Alternatively, existing monitoring wells that are appropriately screened for a vapor intrusion assessment may be used. If indoor air samples will be collected, they may be collected simultaneously during the sub-slab sampling activities (details found in Section 3.6) if required by the work plan. If feasible, vapor sampling should not be conducted during or immediately after a significant rain event (i.e., greater than an inch of rainfall) due to the reduced effective diffusion coefficient and decrease in relative vapor saturation in the unsaturated zone. For sub-slab or soil vapor probe sampling, 1-liter lab certified SUMMA® canisters should be used in order to minimize the volume of soil vapor collected.

A closed-valve test should be conducted prior to soil vapor sample collection to check for leaks in the sampling train. A closed-valve test is conducted by capping the ends with proper Swagelok caps and/or closing any valves at the sampling point and purge canister. Once all ends are closed tight, turn the sampling canister valve on for 5 minutes. If the sampling train maintains its original vacuum for 5 minutes, the equipment will be assumed to be functional and there are no leaks. If the vacuum reading starts to drop, turn off the valves right away, check all connections, tighten if necessary, and re-test. If this passes, the only location that a leak can occur is from the soil ground seal around the vapor probe, which will be tested using helium or another tracer gas during sampling (See Section 3.4.1).

After the close-valve test, a minimum of three tubing volumes should be purged. Purging can be completed using a non-certified 6-Liter SUMMA® canister or a vacuum pump. The maximum flow rate during purging will not exceed the flow rate limit used for subsequent sampling and care will be taken not to over purge. An excel spreadsheet to help calculate tubing volume and purging time can be found at the end of this document.

After the sampling train has been purged, sub-slab soil vapor samples will be collected over a 10 minute period at a flow rate of less than 167 milliliters per minute (ml/min). The flow rate will be controlled by a flow regulator, which is set by the lab. Sub-slab soil vapor samples will be collected in laboratory-certified and pre-evacuated 1-liter SUMMA® canisters. Each SUMMA® canister will be supplied with an analytical test report certifying that the canister is “clean” to concentrations less than the respective method detection limits (MDLs). Each canister will be equipped with a pre-calibrated flow controller sampling train to allow collection of the desired sample. Prior to collecting the samples, the SUMMA® canister ID numbers will be recorded in the field notebook along with the initial canister vacuums, prior to sampling.

Soil vapor samples will be collected per the following steps:

1. Opening the valve on the top of the SUMMA® canister and recording the time in the log book;
2. Observing the vacuum gauge on the sampling train to ensure that the vacuum in the canister is decreasing over time;
3. Shutting off the valve once the vacuum gage reads between 4.0 and 5.0 inches of mercury (in. Hg).

3.4.1 Leak Testing

In addition to soil gas sampling activities, leak testing may be required at sampling locations and should be conducted using the following soil gas sampling set-up procedures:

- Place a large plastic bag (or other acceptable shroud) around the SUMMA® canister, sampling apparatus, and vapor probe.
- Cut a small hole in the bag to allow tubing to be inserted to introduce tracer gas, such as helium, and to subsequently fill the plastic bag.
- Keep the tracer gas (i.e., helium) concentration in the bag at 10 percent by volume or higher.

Detections of the tracer gas in the soil gas samples would indicate that the canister, valves, or ground surface seal to the sample probe have potentially leaked ambient air into the sample. Small amounts of sample train leakage is permissible, however, the leak percentage should not exceed 10 percent of the soil gas results. If the leak percentage exceeds 10 percent, the sampling point may have to be resampled. The integrity of the soil vapor samples can be assessed by estimating the percent leakage as shown here in micrograms per square meter ($\mu g/m^3$):

$$\% \text{ leakage} = 100 \times \frac{\text{helium concentration in soil vapor sample } [\mu g/m^3]}{\text{average helium concentration measured inside the shroud } [\mu g/m^3]}$$

Tracer gas leaks should not occur if the sampling train passes a properly performed closed-valve test and given the low flow rate of 167 ml/min.

3.4.2 Final Readings

Once the sampling is completed and the final vacuum is recorded, the sampling train will be removed from the canister and a Swagelok® cap will be tightly fitted to the inlet port of the canister. A PID can be used to record vapor readings from the manifold connection and logged in the notebook and/or soil vapor sampling sheet (enclosed). In addition, the initial canister vacuums, vacuum testing times, purging times, purged volumes, helium readings, sampling starts and times, final vacuum readings, and PID readings should be recorded on a vapor sampling sheet. Some of this information will also be required on the chain-of-custody.

3.4.3 Equipment Blank

Occasionally, the work plan requires an equipment blank to be collected. An equipment blank can be conducted by collecting a sample of clean air or nitrogen through the probe materials before installation in the ground. Analysis of the equipment blank can provide information on the cleanliness of new materials. Clean stainless steel, Nylon or Teflon® tubing and a certified regulator should be used. Lab-certified canisters (the sample canister and the source canister/cylinder, if applicable) or Tedlar® bags can be used to collect an equipment blank.

3.5 USE OF MONITORING WELLS FOR SOIL GAS SAMPLING

While dedicated soil gas probes are typically used to collect soil gas samples, existing monitoring wells that are appropriately located and screened can also be used for this purpose, with limitations. This is an advantage when evaluating the risk of vapor intrusion solely from contaminated aquifers (as compared to contaminated vadose zone soil) as the soil gas that will be sampled can reflect a soil gas sample that lies close to the zone of saturation and represents a worse case condition for equilibrium partitioning of contamination in groundwater to the gas phase. Also, monitoring wells are typically constructed at a deeper depth than soil vapor probes and are less influenced by changes in barometric pressure. They are also inherently constructed to be well sealed against breakthrough from atmospheric air (while purging and sampling). For an existing well to be used for soil gas sampling, it must have at least 2 to 3 feet of open screen above the water table during sample collection.

The main disadvantage of using existing monitoring wells is that the required purge volume would be much greater because of the significantly larger diameter of the well screen as compared to probes. This requires the use of a larger air pump or small blower instead of the SKC hand pump or peristaltic pump. While purging, care must be taken to minimize the vacuum in the well casing which may be large enough to raise the water column high enough to cover the exposed well screen and invalidate the use of the well for sampling soil gas. Appropriate temporary fittings will need to be installed to allow the reduction of the well casing sufficient to allow connection to the collection tubing.

3.6 INDOOR AIR SAMPLE COLLECTION

Indoor air samples are typically collected into 6-liter SUMMA® canisters, and can either be a grab (not often recommended) or time weighted samples. For time weighted samples, the laboratory will provide preprogrammed flow controllers for the samples for your desired sample duration. An 8-hour flow controller is the most common to assess typical working conditions or to provide a time-weighted average (TWA) to assess residential risk (a 24-hour flow controller may also be used for residential assessments). SUMMA® canisters should be placed in an area that is close to the breathing zone (i.e., 3 to 4 feet above the floor level), a sampling cane can be connected to the SUMMA® canister to sample indoor air at breathing zone height. As a basic guideline and starting point, indoor air samples should at a minimum be collected from the basement (if applicable), first floor living or work area, and from outdoors (ambient/upwind). Other site-specific factors will influence the specific placement location of the SUMMA® canisters, such as proximity to subsurface source area(s) or penetrations through the slab or foundation.

3.6.1 Connection Guidelines

Refer to specific guidelines provided by the laboratory, as equipment can be slightly different from lab to lab. It is important to note the initial vacuum reading on the gauge as well as the post-sampling vacuum. For reference, initial vacuum should be between 27 and 30 inches of mercury, while post-sample vacuum should be between 4 and 5 inches of mercury. Sample collection start and finish times should also be recorded. After sample collection, the SUMMA® canister valve should be shut and the flow controllers should be disconnected from the SUMMA® canisters. Both the controller and the canister ID (unique laboratory tracking ID) should be recorded on the chain-of-custody and the samples should be packed appropriately for delivery to the laboratory following chain-of-custody protocol.

3.7 REMEDIATION SYSTEM VAPOR SAMPLE COLLECTION

Remediation systems that have a soil vapor extraction (SVE) component often require compliance monitoring to evaluate mass removal and effluent discharge limits. Both screening (with a PID) and sampling are routinely conducted during active operation. Tedlar® bags are often used to simplify SVE system screening. Fill a bag following the procedures described in this section and use a PID to measure the VOCs in the sample. Record the maximum observed concentration. Vapor samples for laboratory analysis are most often collected in 1-liter Tedlar® bags, but SUMMA® canisters can also be used. It is a good idea to fill out the label on the Tedlar® bag prior to sample collection.

If the sample port is under vacuum (i.e., SVE manifold or wellhead), it is often necessary to reduce the flow somewhat and to use a hand or mechanical pump to extract the vapor from the line. If the sample port is under a high vacuum, it may be necessary to step down the flow (i.e., close the flow valve) in order to collect a sample. Follow steps in Section 3.3 for sample collection and delivery.

If the sample port is under pressure (i.e., SVE system discharge), the sample can be collected without the use of a pump. Simply attach a clean piece of tubing securely to the sample port, connect the Tedlar® bag to the tubing, open the Tedlar® bag, slowly open the sample port valve, and be careful not to overfill the bag. Remove the Tedlar® bag when full, close the Tedlar® bag (do not over-tighten), and close the sample port valve. Follow steps in Section 3.3 for sample delivery.

4.0 Field Documentation

Soil vapor probe and monitoring point installation field activities should be documented in field notebooks and completion diagrams or boring logs should be completed to document construction. Information recorded will include personnel present, total depth, type and length of implant or screen, screen and filter pack intervals, bentonite seal intervals and surface completion details. Photographs of construction activities should be taken. After probe and monitoring point installation is complete, location coordinates should be recorded with a global positioning system (GPS). If GPS cannot be used (i.e., location within a building), it is important to document the location by recording representative measurements to fixed points.

All sampling activities must be documented in a field notebook and/or on field forms appropriate for the sampling activity. Information recorded will include at a minimum personnel present, weather conditions, date, and time of sample collection, length of sample purge time, and any deviations from the project's work plan or sampling and analysis plan.

5.0 References

Interstate Technology Regulatory Council (ITRC). 2014. Petroleum Vapor Intrusion: Fundamentals of Screening, Investigation, and Management. <http://www.itrcweb.org/PetroleumVI-Guidance/>. October.

Washington State Department of Ecology (Ecology). 2015. Vapor Intrusion Table Update. (Replaces Table B-1 of Ecology's Guidance for Evaluating Soil Vapor Intrusion in Washington State). <http://www.ecy.wa.gov/programs/tcp/policies/VaporIntrusion/Vapor%20Intrusion%20Table%20update%20April%206%202015.xlsx>. 6 April.

_____. 2016a. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*. Review Draft. Prepared by the Toxics Cleanup Program. Publication No. 09-09-047. Originally published October 2009; revised February.

_____. 2016b. *Updated Process for Initially Assessing the Potential for Petroleum Vapor Intrusion: Implementation Memorandum No. 14*. Publication No. 16-09-046. 31 March.

U.S. Environmental Protection Agency (USEPA). 2015. *Technical Guidance for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites*. Prepared by the Office of Underground Storage Tanks. EPA 510-R-15-001. June.

Enclosures: Indoor Air Building Survey Form
Purge Volume Calculations during Soil Vapor Sampling
Soil Vapor Sampling Sheet

INDOOR AIR BUILDING SURVEY FORM

Date:

Site Name:

Title:

Building Use:

Occupants: ______________________________

Building Address: ______________________________

Property Owner: ______________________________

Contact's Phone: ______________________________

Number of Occupants: ______________________________

Business or Residential: ______________________________

Building Characteristics

Building Type: ☐ Residential ☐ Multifamily ☐ Office

☐ Commercial ☐ Industrial ☐ Mall

Describe Building:____

____

Number of Floors Below Grade: _____________ ☐ Basement ☐ Slab-On-Grade ☐ Crawl Space

Bldg Dimensions: Width:______ Length: ________ Height: __________

Basement Floor: Dirt / Concrete / Painted? Foundation Walls: Concrete / Cinder Blocks / Stone

VENTILATION SYSTEM

☐ Central Air Conditioning ☐ Mechanical Fans ☐ Bathroom Vans

☐ Conditioning Units ☐ Kitchen Range Hood ☐ Outside Air Intake

Other:________________________

HEATING SYSTEM

☐ Hot Air Circulation ☐ Hot Air Radiation ☐ Wood ☐ Steam Radiation

☐ Heat Pump ☐ Hot Water Radiation ☐ Kerosene Heater ☐ Electric Baseboard

Other:_____________

Outside Contaminant Sources

Nearby surrounding property sources: Gas Stations / Emission Stacks

Soil Contamination: Petroleum Hydrocarbons / Solvents

Heavy Vehicle Traffic: Yes / No

Indoor Contaminant Sources

Identify all potential sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hrs prior to indoor sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	Location(s)	Removed (Yes / No / NA)
Gasoline storage cans		
Gas powered equipment		
Kerosene storage cans		
Paints / Thinners / Strippers		
Cleaning solvents / Dry cleaners		
Oven cleaners		
Carpet / upholstery cleaners		

Other house cleaning products		
Moth Balls		
Potential Sources	**Location(s)**	**Removed (Yes / No / NA)**
Polishes / waxes		
Insecticides		
Furniture / floor polish		
Nail polish / polish remover		
Hairspray		
Cologne / perfume		
Air fresheners		
Fuel tank (inside building)		
Wood stove or fireplace		
New furniture		
New carpeting / New flooring		
Hobbies – glues, paints		
Other: __________________		
Other: __________________		
Other: __________________		

SAMPLING INFORMATION

Sampler(s) ____

☐ Indoor Air / Outdoor Air ☐ Sub-slab ☐ Soil Vapor Point ☐ Exterior Soil Gas

☐ Tedlar® Bag ☐ Sorbent ☐ SUMMA® ☐ Other _________

Analytical Method: TO-15 / TO-17 / Other: _________________

WEATHER CONDITIONS

Was there a significant rain event in the last 24 hours? Yes / No

Temperature: _________ Atmospheric Pressure: _______________ Pressure: Rising or Falling?

Describe the general weather conditions: ____

Wind Speed and Direction: ____

PURGE VOLUME CALCULATIONS DURING SOIL VAPOR SAMPLING

Sample Tubing Purge												
Tubing Length (feet)	Pi	Casing Radius (inches)	Area of Casing Radius (Pi(R^2)) (inches)	Length of casing (feet)	Conversion of feet to inches	Number of Casing Volumes to Purge	Conversion of cubic inches to ml	Purge Volume (ml)	Purge Volume (l)	Purge rate (ml/min)	Purge Time (min)	
5	3.141593	0.125	0.049087	5	60	1	16.387064	48.263888	0.048264	167	0.29	
5	3.141593	0.125	0.049087	5	60	3	16.387064	144.79166	0.144792	167	0.87	
5	3.141593	0.125	0.049087	5	60	7	16.387064	337.84721	0.337847	167	2.02	

Annular Space Purge												
Annular Space Length (inches)	Pi	Boring Radius (inches)	Area of Boring Radius (radius^2)	Volume of Annular Space (inches)	Assumed Porosity of Sand Pack*	Air Filled Volume of Annular Space (cubic inches)	Number of Casing Volumes to Purge	Conversion of cubic inches to ml	Purge Volume (ml)	Purge Volume (l)	Purge rate (ml/min)	Purge Time (min)
12	3.141593	2	12.56637	150.7964	0.3	45.23893	1	16.387064	741.3333	0.741333	167	4.44
12	3.141593	2	12.56637	150.7964	0.3	45.23893	3	16.387064	2224	2.224	167	13.32
12	3.141593	2	12.56637	150.7964	0.3	45.23893	7	16.387064	5189.333	5.189333	167	31.07

Summary of Purge Durations	
One Purge Volume	4.73
Three Purge Volumes	14.18
Seven Volumes	33.10

SOIL VAPOR SAMPLING SHEET

Site Reference: ___________________________________ Date: ___________________________________

Address: ___________________________________ Personnel: ___________________________________

	Vacuum Test		Purging				Helium		Sampling				PID		
Soil Vapor Sampling Point ID	Time Start Vacuum Testing	Time Stop Vacuum Testing	Time Start Purging	Time Stop Purging	Purging Rate (ml/min)	Total Volume Purged (ml)	Time of Helium Reading	Helium Reading (%)	Time Start Sampling	Time Stop Sampling	Canister Vacuum Before Sampling (in Hg)	Canister Vacuum After Sampling (in Hg)	Time of PID Reading	PID Reading	Notes
					167										
					167										

Notes:

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____

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West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix C
Health and Safety Plan

Table of Contents

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List of Abbreviations and Acronyms

Acronym/ Abbreviation	Definition
cPAH	Carcinogenic polycyclic aromatic hydrocarbons
CPR	Cardiopulmonary resuscitation
Ecology	Washington State Department of Ecology
°F	Degrees Fahrenheit
FS	Feasibility study
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSO	Health and Safety Officer
OSHA	Occupational Safety and Health Administration
PID	Photoionization detector
PM	Project Manager
PPE	Personal protective equipment
RI	Remedial investigation
Site	West Coast Door Site
SS	Site Supervisor
SSO	Site Safety Officer
STEL	Short-term exposure limit
TWA	Time-weighted average
VOC	Volatile organic compound
WAC	Washington Administrative Code
Work Plan	Remedial Investigation Data Gaps Work Plan

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1.0 Plan Objectives and Applicability

This Health and Safety Plan (HASP) has been written to comply with the standards prescribed by the Occupational Safety and Health Administration (OSHA) and the Washington Industrial Safety and Health Act (WISHA).

The purpose of this HASP is to establish protection standards and mandatory safe practices and procedures for all personnel involved with investigation activities including soil boring installation; monitoring well installation and development; groundwater monitoring; and soil, air, and groundwater sample collection on behalf of the heirs of William B. Swensen, operating as 3102 Tenants in Common (TIC), at the West Coast Door Site (Site; Figure C.1). This HASP assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may occur during field work activities. The plan consists of Site descriptions, a summary of work activities, an identification and evaluation of chemical and physical hazards, monitoring procedures, personnel responsibilities, decontamination and disposal practices, emergency procedures, and administrative requirements.

The provisions and procedures outlined by this HASP apply to all Floyd|Snider personnel on-site. Contractors, subcontractors, other oversight personnel, and all other persons involved with the field work activities described herein are required to develop and comply with their own HASP. All Floyd|Snider staff conducting field activities are required to read this HASP and indicate that they understand its contents by signing the Health and Safety Officer/Site Supervisor's (HSO/SS) copy of this plan.

It should be noted that this HASP is based on information that was available as of the date indicated on the title page. It is possible that additional hazards that are not specifically addressed by this HASP may exist at the work site, or may be created as a result of on-site activities. It is the firm belief of Floyd|Snider that active participation in health and safety procedures and acute awareness of on-site conditions by all workers is crucial to the health and safety of everyone involved. Should project personnel identify a site condition that is not addressed by this HASP or have any questions or concerns about site conditions, they should immediately notify the HSO/SS and an addendum will be provided to this HASP.

The HSO/SS has field responsibility for ensuring that the provisions outlined herein adequately protect worker health and safety and that the procedures outlined by this HASP are properly implemented. In this capacity, the HSO/SS will conduct regular site inspections to ensure that this HASP remains current with potentially changing site conditions. The HSO/SS has the authority to make health and safety decisions that may not be specifically outlined in this HASP should site conditions warrant such actions. In the event that the HSO/SS leaves the Site while work is in progress, an alternate Site Safety Officer (SSO) will be designated. Personnel responsibilities are further described in Section 4.0.

This HASP has been reviewed by the Project Manager (PM) and the HSO/SS prior to commencement of work activities. All Floyd|Snider personnel shall review the plan and be familiar with on-site health and safety procedures. A copy of the HASP will be on-site at all times.

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2.0 Emergency Contacts and Information

2.1 DIAL 911

In the event of any emergency, DIAL 911 to reach fire, police, and first aid.

2.2 HOSPITAL AND POISON CONTROL

Nearest Hospital Location and Telephone: **(Refer to Figure C.2 for map and directions to the hospital.)**	St. Joseph Medical Center 1717 South J Street, Tacoma, Washington 98405 (253) 426-4101
Washington Poison Control Center:	(800) 222-1222

2.3 PROVIDE INFORMATION TO EMERGENCY PERSONNEL

All Floyd|Snider project personnel should be prepared to give the following information:

Information to give to Emergency Personnel

Site Location: **(Refer to Figure C.1 for map showing the Site.)**	Goodwill Outlet (West Coast Door Site) 3120 and 3102 South Pine Street (or 3133 South Cedar Street) Tacoma, Washington 98409
Number that you are calling from:	Look on the phone you are calling from.
Describe accident and/or incident and numbers of personnel needing assistance.	Type of Accident Type(s) of Injuries

2.4 FLOYD|SNIDER AND WASHINGTON STATE DEPARTMENT OF ECOLOGY EMERGENCY CONTACTS

After contacting emergency response crews as necessary, contact the Floyd|Snider PM or a Principal to report the emergency. The Principal may then contact the Washington State Department of Ecology (Ecology) or direct the field staff to do so.

Floyd|Snider Emergency Contacts:

Tom Colligan, Project Manager	Office: (206) 292-2078	Cell: (206) 276-8527
Allison Geiselbrecht, Principal	Office: (206) 292-2078	Cell: (206) 722-2460
Kate Snider, Principal	Office: (206) 292-2078	Cell: (206) 375-0762
Jessi Massingale, Principal	Office: (206) 292-2078	Cell: (206) 683-4307

Washington State Department of Ecology Emergency Contacts:

Matthew Morris Direct Line: (360) 407-7529

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3.0 Background Information

3.1 SITE BACKGROUND

Floyd|Snider will conduct field investigation and data collection activities at the Site, which is located at 3120 South Pine Street and 3102 South Pine Street (formerly adjoined as 3133 South Cedar Street) in Tacoma, Washington. The Site is zoned for industrial use by the City of Tacoma and is approximately 10.43 acres in size. The Site is currently owned by 3102 TIC. The north warehouse, completed in 1985, and south warehouse, completed in 1987, are both occupied by Goodwill Industries. Surrounding properties uses are primarily warehouse or industrial operations.

The subject property was originally the location of the Buffelen Pipe and Creosote Company/American Wood Pipe Company, which operated from the early 1900s to the mid-1930s. Manufacturing operations during this time included log storage, drying kilns, and a creosoting retort area located in the southwestern portion of the current south warehouse footprint. This Former Creosoting Retort Area is the likely source of the polycyclic aromatic hydrocarbon (PAH) contamination discovered in 1986.

Monarch Door and Manufacturing Company began door manufacturing at the Site in the mid-1930s. West Coast Door, Inc. purchased the subject property in 1954. West Coast Door manufacturing operations included cutting, sanding, and gluing of wood-veneered fiberboard core doors. These operations continued in both the north and south portions of the current warehouse after they were constructed in the mid-1980s. William B. Swensen purchased the property in the 1970, and operated it as West Coast Door until 1997. Door manufacturing operations ceased in 1997, at which point the facilities were converted to warehouse and office space use. Tenants in the southern warehouse included Total Recall Information Management, Thrifty Supply, and Goodwill Industries before moving to their current lease location in the north warehouse (PCE 2008). 3102 TIC purchased the property in August of 2000.

The objective of the Remedial Investigation (RI) and Feasibility Study (FS) is to conduct a comprehensive site-wide evaluation and investigation that involves characterization of soil and groundwater to fill data gaps identified by Ecology in a response letter to the January 2014 RI/FS Report and discussed in the 2017 West Coast Door Remedial Investigation Data Gaps Work Plan (Work Plan).

3.2 SCOPE OF WORK

The scope of work for this field investigation and data collection activities is described in detail in the Work Plan. Floyd|Snider will conduct the following fieldwork activities:

- Installation of soil borings using a roto-sonic drilling rig and the collection of soil for field screening and analytical testing.
- Construction of permanent groundwater monitoring wells using a roto-sonic drilling rig and collection of soil samples for field screening and analytical testing.

- Development of new monitoring wells.
- Collection of groundwater samples from new and existing monitoring wells.
- Air sampling using evacuated SUMMA canisters.

4.0 Primary Responsibilities and Requirements

4.1 PROJECT MANAGER

The PM will have overall responsibility for the completion of the project, including the implementation and review of this HASP. The PM will review health and safety issues as needed and as consulted, and will have authority to allocate resources and personnel to safely accomplish the field work.

The PM will direct all Floyd|Snider personnel involved in field work at the Site. If the project scope changes, the PM will notify the HSO/SS so that the appropriate addendum can be included in the HASP. The PM will ensure that all Floyd|Snider personnel on-site have received the required training, are familiar with the HASP, and understand the procedures to follow should an accident and/or incident occur on-site.

4.2 HEALTH AND SAFETY OFFICER AND SITE SUPERVISOR

The HSO/SS will approve this HASP and any amendments, thereof, and will ultimately be responsible for full implementation of all elements of the HASP.

The HSO/SS will advise the PM and project personnel on all potential health and safety issues of the field investigation activities to be conducted at the Site. The HSO/SS will specify required exposure monitoring to assess Site health and safety conditions, modify the Site HASP based on field assessment of health and safety accidents and/or incidents, and recommend corrective action if needed. The HSO/SS will report all accidents and/or incidents to the PM. If the HSO/SS observes unsafe working conditions by Floyd|Snider personnel or any contractor personnel, the HSO/SS will suspend all work until the hazard has been addressed.

4.3 SITE SAFETY OFFICER

The SSO may be a person dedicated to this task, to assist the HSO/SS during field work activities. The SSO will ensure that all personnel have appropriate personal protective equipment (PPE) on-site and PPE is properly used. The SSO will assist the HSO/SS in field observation of Floyd|Snider personnel safety. If a health or safety hazard is observed, the SSO shall suspend all work activity. The SSO will conduct on-site safety meetings daily before work commences. All health and safety equipment will be calibrated daily and records kept in the daily field logbook and/or accompanying field daily forms. The SSO may perform exposure monitoring if needed and will ensure that equipment is properly maintained.

4.4 FLOYD|SNIDER PROJECT PERSONNEL

All Floyd|Snider project personnel involved in field work activities will take precautions to prevent accidents and/or incidents from occurring to themselves and others in the work areas. Employees will report all accidents, incidents, and/or other unsafe working conditions to the

HSO/SS or SSO immediately. Employees will inform the HSO/SS or SSO of any physical conditions that could impact their ability to perform field work.

4.5 TRAINING REQUIREMENTS

All Floyd|Snider project personnel must comply with applicable regulations specified in the Washington Administrative Code (WAC) Chapter 296-843, Hazardous Waste Operations Training, administered by the Washington State Department of Labor and Industries. Project personnel will be 40-hour Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) trained and maintain their training with an annual 8-hour refresher. Personnel with limited tasks and minimal exposure potential will be required to have 24-hour training and a site hazard briefing, and be escorted by a trained employee. Personnel with defined tasks that do not include potential contact with disturbed site soils or waste, groundwater, or exposures to visible dust (e.g., surveying) are not required to have any level of hazardous waste training beyond a site emergency briefing and hazard orientation by the HSO/SS. Floyd|Snider project personnel will fulfill the medical surveillance program requirements.

In addition to the 40-hour course and 8-hour refreshers, the HSO/SS will have completed an 8-hour HAZWOPER Supervisor training as required by WAC 296-843-20015. At least one person on-site during field work will have current cardiopulmonary resuscitation (CPR)/First Aid certification. All field personnel must have a minimum of 3 days of hazardous materials field experience under the direction of a skilled supervisor. Documentation is readily available at the Floyd|Snider's main office.

Additional site-specific training that covers on-site hazards, PPE requirements, use and limitations, decontamination procedures, and emergency response information as outlined in this HASP will be given by the HSO/SS before on-site work activities begin. Daily health and safety meetings will be documented on the Daily Tailgate Safety Meeting form included as Attachment C.1.

4.6 MEDICAL SURVEILLANCE

All Floyd|Snider field personnel are required to participate in Floyd|Snider's medical surveillance program, which includes biennial audiometric and physical examinations for employees involved in HAZWOPER projects. The program requires medical clearance before respirator use or participating in HAZWOPER activities. Medical examinations must be completed before conducting field work activities and on a biennial basis.

5.0 Hazard Evaluation and Risk Analysis

In general, there are three broad hazard categories that may be encountered during site work: chemical exposure hazards, fire/explosion hazards, and physical hazards. Sections 5.1 through 5.3 discuss the specific hazards that fall within each of these broad categories.

5.1 CHEMICAL EXPOSURE HAZARDS

This section describes potential chemical hazards associated with soil boring installation, monitoring well installation and development, groundwater monitoring, and soil and groundwater sample collection. Based on previous site investigation information, the following chemicals have been detected at this Site:

- Semivolatile organic compounds (SVOCs) and volatile organic compounds (VOCs) in soil and groundwater, including naphthalene and benzene, ethylbenzene, and xylenes.
- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and naphthalene in soil.

Human health hazards of these chemicals are discussed in the table below. This information covers potential toxic effects which might occur if relatively significant acute and/or chronic exposure were to happen. This information does not mean that such effects will occur from planned site activities. Potential routes of exposure include inhalation, dermal contact, ingestion, and eye contact. The primary exposure route of concern during site work is ingestion of contaminated water or soil, though such exposure is considered unlikely and highly preventable. In general, the chemicals which may be encountered at this Site are not expected to be present at concentrations which could produce significant exposures. The types of planned work activities and use of monitoring procedures and protective measures will limit potential exposures at this Site. The use of appropriate PPE and decontamination practices will assist in controlling exposure through all pathways to the key contaminants of concern listed in the table on the follow page.

Chemical Hazard	DOSH Permissible Exposure Limits (8-hr TWA/STEL)	Greatest Historical Concentration	Routes of Exposure	Potential Toxic Effects
VOCs				
Naphthalene	10 ppm	18,000 µg/L in groundwater 470 mg/kg in soil	Inhalation, skin absorption, ingestion, skin/eye contact	Irritation to eyes, headache, confusion, excitement, malaise, nausea, vomiting, abdominal pain, irritated bladder, profuse sweating, jaundice, hematuria, renal shutdown, dermatitis, optical neuritis, cornea damage
cPAHs (as coal tar pitch volatiles, benzene-soluble fraction)	0.2 ppm	120 mg/kg in soil	Inhalation, skin absorption, ingestion, skin/eye contact	Cancer
Benzene	1 ppm	14 µg/L in groundwater	Inhalation, skin absorption, ingestion, skin/eye contact	Irritation to eyes, skin, nose and respiratory system; dizziness, headache, nausea, staggered gait, anorexia, weakness, dermatitis, bone marrow suppression
Ethylbenzene	100 ppm	1,000 µg/L in groundwater	Inhalation, skin absorption, ingestion, skin/eye contact	Irritation to eyes, skin, respiratory system, skin burns, dermatitis
Xylenes	100 ppm	1,700 µg/L in groundwater	Inhalation, skin absorption, ingestion, skin/eye contact	Irritation to eyes, skin, nose and respiratory system; dizziness, headache, nausea, staggered gait, anorexia, weakness, dermatitis, bone marrow suppression
Other				
Laboratory Preservatives (HCl, MeOH, H_2SO_4, HNO_3)	Not applicable	Not applicable	Dermal contact, eye contact	Irritation to skin or eyes.

Abbreviations:

DOSH	Department of Safety and Health	µg/L	Micrograms per liter
HCl	Hydrochloric acid	mg/kg	Milligrams per kilogram
H_2SO_4	Sulfuric Acid	ppm	Parts per million
HNO_3	Nitric acid	STEL	Short-term exposure limit
hr	Hour	TWA	Time-weighted average
MeOH	Methanol	µg/L	Micrograms per liter

Chemical and physical properties for hazardous substances expected at the Site, including those listed above are located in the Material Safety Data Sheets notebook maintained in the field vehicle.

5.2 FIRE AND EXPLOSION HAZARDS

Flammable and combustible liquid hazards may occur from fuels and lubricants brought to the property to support heavy equipment. When on-site storage is necessary, such material will be stored in containers approved by the Washington State Department of Transportation (WSDOT) in a location not exposed to strike hazards and provided with secondary containment. A minimum 2-A:20-B fire extinguisher will be located within 25 feet of the storage location and where refueling occurs. Any subcontractors bringing flammable and combustible liquid hazards to the Site are responsible for providing appropriate material for containment and spill response, and such hazards should be addressed in their respective HASP. Transferring of flammable liquids (e.g., gasoline) will occur only after making positive metal-to-metal connection between the containers. A bonding strap may be necessary to achieve this. Storage of ignition and combustible materials will be kept away from storage and fueling operations.

5.3 PHYSICAL HAZARDS

When working in or around any hazardous or potentially hazardous substances or situations, all site personnel should plan all activities before starting any task. Site personnel shall identify health and safety hazards involved with the work planned and consult with the HSO/SS as to how the task can be performed in the safest manner. Personnel will also consult the HSO/SS if they have any concerns or uncertainties.

All field personnel will adhere to general safety rules including wearing appropriate PPE, hard hats, steel-toed boots, safety vests, and safety glasses. Eating, drinking, and/or use of tobacco or cosmetics will be restricted in all work areas. Personnel will prevent splashing of liquids containing chemicals and minimize dust emissions.

The following table summarizes a variety of physical hazards that may be encountered on the Site during work activities. For convenience, these hazards have been categorized into several general groupings with recommended preventative measures.

Hazard	Cause	Prevention
Head Strike	Falling and/or sharp objects, bumping hazards.	Hard hats will be worn by all personnel at all times when overhead hazards exist, such as during drilling activities and around large, heavy equipment.
Foot/ankle Twist, Crush, Slip/trip/fall	Sharp objects, dropped objects, uneven and/or slippery surfaces.	Steel-toed boots must be worn at all times on-site while heavy equipment is present. Pay attention to footing on uneven or wet terrain and do not run. Keep work areas organized and free from unmarked trip hazards.

Hazard	Cause	Prevention
Hand Cuts, Splinters, and Chemical Contact	Hands or fingers pinched or crushed, chemical hazards including dermal exposure to nitric acid or sulfuric acid preservative. Cut or splinters from handling sharp/rough objects and tools.	Nitrile safety gloves will be worn to protect the hands from dust and chemicals. Leather or cotton outer gloves will be used when handling sharp-edged rough materials or equipment. Refer to the preventive measures for Mechanical Hazards below.
Eye Damage from Flying Materials, or Splash Hazards	Sharp objects, poor lighting, exposure due to flying debris or splashes.	Safety glasses will be worn at all times on-site. If a pressure washer is used to decontaminate heavy equipment, a face shield will be worn over safety glasses or goggles. Care will be taken during decontamination procedures and groundwater sampling to avoid splashing or dropping equipment into decontamination water. Face shields may be worn over safety glasses if splashing is occurring during sampling, decontamination, or well slug testing.
Electrical Hazards	Underground utilities, overhead utilities, electrical cord hazards.	Utility locator service will be used prior to any investigation to locate all underground utilities. Visual inspection of work areas will be conducted prior to starting work. Whenever possible, avoid working under overhead high voltage lines. Make sure that no damage to extension cords occurs. If an extension cord is used, make sure it is the proper size for the load that is being served and inspected prior to use for defects. The plug connection on each end should be of good integrity. Insulation must be intact and extend to the plugs at either end of the cord. All portable power tools will be inspected for defects before use and must either be a double-insulated design or grounded with a ground-fault circuit interrupter (GFCI).

Hazard	Cause	Prevention
Mechanical Hazards	Heavy equipment such as drill rigs, service trucks, mowing equipment, saws, drills, etc. Conducting work in road right of ways (on the road shoulder).	Ensure the use of competent operators, backup alarms, regular maintenance, daily mechanical checks, and proper guards. Subcontractors will supply their own HASP. All project personnel will make eye contact with operator and obtain a clear OK before approaching or working within swing radius of heavy equipment, staying clear of swing radius. Obey on-site speed limits. Personnel will stand clear of machinery at all times unless specific instructions are given by the operator or other person in authority. Safety toe rubber or leather boots will be worn at all times when working around machinery and hardhats will be worn when overhead hazards are present. When possible, appropriate guards will be in place during equipment use.
Traffic Hazards	Vehicle traffic and hazards when working near public right-of-ways and around site.	When working around active Site operations, orange cones and/or flagging will be placed around the work area. Multiple field staff will work together (buddy system) and spot traffic for each other if necessary. Avoid working with your back to traffic whenever possible. **Further details on traffic hazards are provided in Section 5.3.4.**
Hearing Damage due to Noise	Machinery creating more than 85 decibels TWA, less than 115 decibels continuous noise, or peak at less than 140 decibels.	Wear earplugs or protective ear muffs when a conversational level of speech is difficult to hear at a distance of 3 feet; when in doubt, a sound level meter may be used on-site to document noise exposure.

Hazard	Cause	Prevention
Strains from Improper Lifting	Injury due to improper lifting techniques, overreaching/ overextending, or lifting overly heavy objects.	Use proper lifting techniques and mechanical devices where appropriate. The proper lifting procedure first involves testing the weight of the load by tipping it. If in doubt, ask for help. Do not attempt to lift a heavy load alone. Take a good stance and plant your feet firmly with legs apart, one foot farther back than the other. Make sure you stand on a level area with no slick spots or loose gravel. Use as much of your hands as possible, not just your fingers. Keep your back straight, almost vertical. Bend at the hips, holding load close to your body. Keep the weight of your body over your feet for good balance. Use large leg muscles to lift. Push up with one foot positioned in the rear as you start to lift. Avoid quick, jerky movements and twisting motions. Turn the forward foot and point it in the direction of the eventual movement. Never try to lift more than you are accustomed to.
Cold Stress	Cold temperatures and related exposure on and offshore.	Workers will wear appropriate clothing, stay dry, and take breaks in a heated environment when working in freezing temperatures. **Further details on cold stress are provided in Section 5.3.1.**
Heat Exposure	High temperatures exacerbated by PPE and/or dehydration.	Workers will ensure adequate hydration, shade, and breaks when temperatures are elevated. **Further details on heat stress are provided in Section 5.3.2.**
Accidents due to Inadequate Lighting	Improper illumination.	Work will proceed during daylight hours only or under sufficient artificial light.

5.3.1 Cold Stress

Field work will be completed in the winter of 2017/2018 and exposure to cold temperature is likely to occur. Exposure to moderate levels of cold can cause the body's internal temperature to drop to a dangerously low level, causing hypothermia. Symptoms of hypothermia include slow, slurred speech; mental confusion; forgetfulness; memory lapses; lack of coordination; and drowsiness.

To prevent hypothermia, site personnel will stay dry and avoid exposure. Site personnel will have access to a warm, dry area, such as a vehicle, to take breaks from the cold weather and warm up.

Site personnel will be encouraged to wear sufficient clothing in layers such that outer clothing is wind- and waterproof and inner layers retain warmth (wool or polypropylene), if applicable. Site personnel will keep hands and feet well protected at all times. The signs and symptoms and treatment for hypothermia are summarized below:

Signs and Symptoms

- Mild hypothermia (body temperature of 98–90 degrees Fahrenheit [°F])
  - Shivering.
  - Lack of coordination, stumbling, fumbling hands.
  - Slurred speech.
  - Memory loss.
  - Pale, cold skin.
- Moderate hypothermia (body temperature of 90–86 °F)
  - Shivering stops.
  - Unable to walk or stand.
  - Confused and irrational.
- Severe hypothermia (body temperature of 86–78 °F)
  - Severe muscle stiffness.
  - Very sleepy or unconscious.
  - Ice-cold skin.
  - Death.

Treatment of Hypothermia (Proper treatment depends on the severity of the hypothermia.)

- Mild hypothermia
  - Move to warm area.
  - Stay active.
  - Remove wet clothes, replace with dry clothes or blankets, and cover the head.
  - Drink warm (not hot) sugary drinks.
- Moderate hypothermia
  - All of the above, plus:
    - Call 911 for an ambulance,
    - Cover all extremities completely, and
    - Place very warm objects such as hot packs or water bottles on the victim's head, neck, chest, and groin.
- Severe hypothermia
  - Call 911 for an ambulance.

- Treat the victim very gently.
- Do not attempt to re-warm—the victim should receive treatment in a hospital.

Frostbite

Frostbite occurs when the skin actually freezes and loses water. In severe cases, amputation of the frostbitten area may be required. While frostbite usually occurs when the temperatures are 30 °F or lower, wind chill factors can allow frostbite to occur in above-freezing temperatures. Frostbite typically affects the extremities, particularly the feet and hands. Frostbite symptoms include cold, tingling, stinging, or aching feelings in the frostbitten area followed by numbness and skin discoloration from red to purple, then to white or very pale skin. Should any of these symptoms be observed, wrap the area in soft cloth—do not rub the affected area—and seek medical assistance. Call 911 if the condition is severe.

Protective Clothing

Wearing the right clothing is the most important way to avoid cold stress. The type of fabric also makes a difference. Cotton loses its insulation value when it becomes wet. Wool, on the other hand, retains its insulation even when wet. The following are recommendations for working in cold environments:

- Wear *at least three layers* of clothing:
  - An outer layer to break the wind and allow some ventilation (like Gortex or nylon).
  - A middle layer of down or wool to absorb sweat and provide insulation even when wet.
  - An inner layer of cotton or synthetic weave to allow ventilation.
- Wear a hat—up to 40 percent of body heat can be lost when the head is left exposed.
- Wear insulated boots or other footwear.
- Keep a change of dry clothing available in case work clothes become wet.
- Do not wear tight clothing—loose clothing allows better ventilation.

Work Practices

- Drinking: Drink plenty of liquids, avoiding caffeine and alcohol. It is easy to become dehydrated in cold weather.
- Work Schedule: If possible, heavy work should be scheduled during the warmer parts of the day. Take breaks out of the cold in heated vehicles.
- Buddy System: Try to work in pairs to keep an eye on each other and watch for signs of cold stress.

5.3.2 Heat Stress

Because fieldwork is likely to occur during the winter season, heat stress is unlikely to occur. However, in the case that field work is postponed or extended, to avoid heat-related illness, current regulations in WAC 296-62-095 through 296-62-09570 will be followed during all outdoor work activities. These regulations apply to any outdoor work environment from May 1 through September 30, annually when workers are exposed to temperatures above 89 °F when wearing breathable clothing, above 77 °F when wearing double-layered woven clothing such as jackets or coveralls, or above 52 °F when wearing non-breathing clothing such as chemical resistant suits or Tyvek. Floyd|Snider will identify and evaluate temperature, humidity, and other environmental factors associated with heat-related illness including but not limited to the provision of rest breaks that are adjusted for environmental factors, and encourage frequent consumption of drinking water. Drinking water will be provided and made readily accessible in sufficient quantity to provide at least 1 quart per employee per hour. All Floyd|Snider personnel will be informed and trained for responding to signs or symptoms of possible heat-related illness and accessing medical aid.

Employees showing signs or demonstrating symptoms of heat-related illness must be relieved from duty and provided with a sufficient means to reduce body temperature, including rest areas or temperature controlled environments (i.e., air conditioned vehicle). Any employee showing signs or demonstrating symptoms of heat-related illness must be carefully evaluated to determine whether it is appropriate to return to work or if medical attention is necessary.

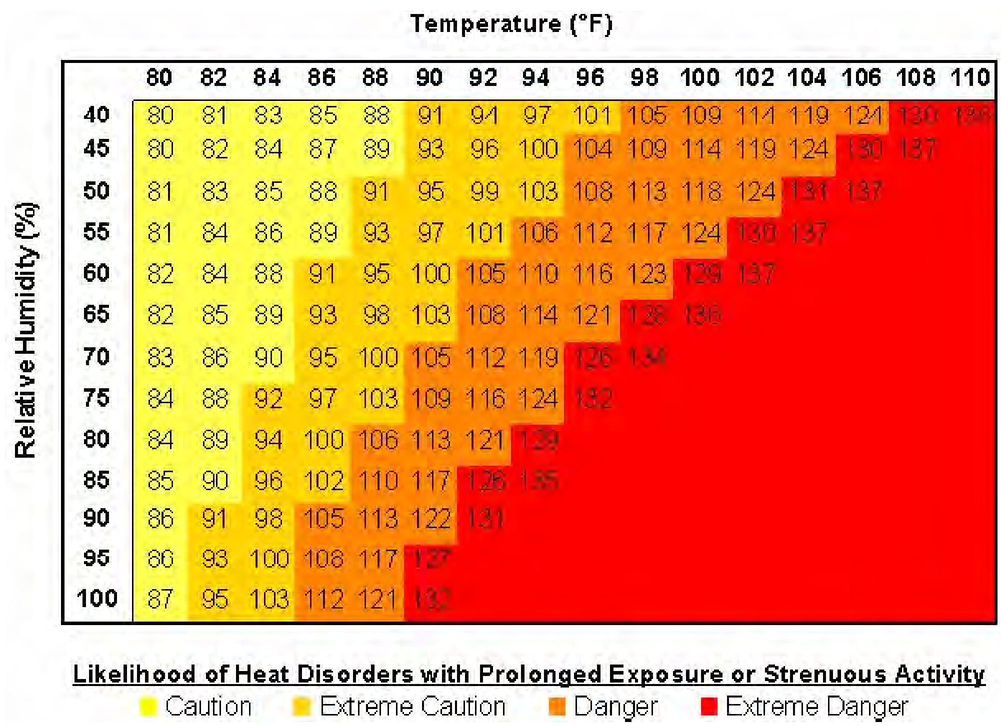
Any incidence of heat-related illness must be immediately reported to the employer directly through the HSO/SS.

The signs, symptoms, and treatment of heat stress are given in the following table.

Condition	**Signs/Symptoms**	**Treatment**
Heat Cramps	Painful muscle spasms and heavy sweating.	Increase water intake, rest in shade/cool environment.
Heat Syncope	Brief fainting and blurred vision.	Increase water intake, rest in shade/cool environment.
Dehydration	Fatigue, reduced movement, headaches.	Increase water intake, rest in shade/cool environment.
Heat Exhaustion	Pale and clammy skin, possible fainting, weakness, fatigue, nausea, dizziness, heaving, sweating, blurred vision, body temperature slightly elevated.	Lie down in cool environment, increase water intake, and loosen clothing; call 911 for ambulance transport if symptoms continue once in cool environment.

Condition	Signs/Symptoms	Treatment
Heat Stroke	Cessation of sweating, skin hot and dry, red face, high body temperature, unconsciousness, collapse, convulsions, confusion or erratic behavior, life threatening condition.	**Medical Emergency! Call 911** for ambulance transport. Move victim to shade and immerse in water.

If site temperatures are forecast to exceed 85 °F and physically demanding site work will occur in impermeable clothing, the HSO/SS will promptly consult with a certified industrial hygienist (CIH) and a radial pulse monitoring method will be implemented to ensure that heat stress is properly managed among the affected workers. The following heat index chart indicates the relative risk of heat stress:



5.3.3 Biohazards

Bees and other insects may be encountered during the field work tasks. Persons with allergies to bees will make the HSO/SS aware of their allergies and will avoid areas where bees are identified. Controls such as repellents, hoods, nettings, masks, or other personal protection may be used. Report any insect bites or stings to the HSO/SS and seek first aid if necessary.

Site personnel will maintain a safe distance from any urban wildlife encountered, including raccoons and rodents, to preclude a bite from a sick or injured animal. Personnel will be gloved and will use tools to lift covers from catch basins and monitoring wells.

5.3.4 Traffic Hazards

While work is being performed at the active Site, barricades should be utilized. Spotters will be used to ensure traffic is monitored during work activities because signs, signals, and barricades do not always provide appropriate protection. All workers will wear reflective high visibility neon/orange vests.

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6.0 Site Monitoring

The following sections describe site monitoring techniques and equipment that will be used during site field activities. The HSO/SS, or a designated alternate, is responsible for site control and monitoring activities.

6.1 SITE MONITORING

Since the Site is currently active, and noise generating activities will be conducted within the site boundary, noise levels are expected to be below the allowable levels.

Air monitoring will not be conducted as previous investigations have generally characterized the type and concentrations of volatile chemicals present at the Site. Visual monitoring for dust will be conducted by the HSO/SS to ensure inhalation of contaminated soil particles does not occur. It is not anticipated that dust will be generated given that the Site is primarily concrete and asphalt. However, if visible dust is present in the work area, work will cease and the area will be cleared until the dust settles.

Concentrations of VOCs in soil and groundwater at the Site are present at concentrations that are not expected to result in vapor concentrations that exceed allowable OSHA levels. All work will be conducted outdoors in an open-air ventilated environment. A photoionization detector (PID) will be used on-site for screening of soil samples collected. This PID will also be used to monitor vapor concentrations in breathing air of total volatile chemicals in parts per million that can be detected using this method. Should the PID read a sustained concentration of total volatile chemicals above the lowest action level sustained for 15 minutes, the HSO/SS will stop work and evacuate the area until vapor concentrations return to background levels. As needed, actions may be taken to reduce exposure to vapor concentrations in the work area by covering exposed soil or drilling cuttings, and leaving the work area until odor dissipates.

The HSO/SS will visually inspect the work site at least daily to identify any new potential hazards. If new potential hazards are identified, immediate measures will be taken to eliminate or reduce the risks associated with these hazards.

Ambient air background PID readings should be measured prior to the start and during drilling activities to factor in other sources of volatiles, from upwind of the work area. Air monitoring levels from the work area should be adjusted to account for the background concentration.

Monitoring Equipment	Readings[1]	Action[2]
PID	<1 ppmv (8-hour TWA for benzene); <5 ppm for 15 mins (STEL for benzene)	Continue operations in Level D PPE
	>5 and <10 ppmv; intermittent	Identify source of concentrations if possible (vehicle emissions, exposed contaminated material, etc.) Implement engineering controls to reduce concentrations for continued operations (move work area upwind of operating equipment, cover exposed contaminated material, etc.); resume work only if PID indicates VOC is less than the OSHA PEL of 5 ppmv in breathing zone.
	>10 ppmv; sustained	Stop operations and evacuate area, identify source of concentrations if possible (vehicle emissions, exposed contaminated material, etc.) Implement engineering controls to reduce concentrations for continued operations (move work area upwind of operating equipment, cover exposed contaminated material, etc.); resume work only if PID indicates VOC is less than the OSHA PEL of 5 ppmv in breathing zone.

Notes:

1 Action levels prior to and during drilling activities.

2 OSHA STEL is a 15-minute TWA exposure that should not be exceeded at any time during a workday.

Abbreviations:

PEL Permissible Exposure Limit

ppmv Parts per million volatile

7.0 Hazard Analysis by Task

The following section identifies potential hazards associated with each task listed in Section 3.2 of this HASP. Tasks have been grouped according to the types of potential hazard associated with them.

Task	Potential Hazard
Installation of Soil Borings and Wells, Soil Sampling	Exposure to loud noise; overhead hazards; head, foot, ankle, hand, and eye hazards; electrical and mechanical hazards; lifting hazards; dust inhalation hazards; potential dermal or eye exposure to site contaminants in groundwater and soil; fall hazards; traffic hazards; and heat and cold exposure hazards.
Groundwater Sampling from Monitoring Wells, Well Development, and Decontamination	Chemical hazards include potential dermal or eye exposure to site contaminants in groundwater. Physical hazards include slip, trip, or fall hazards; heat and cold exposure hazards; and biological hazards (less common during the winter months).

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8.0 Personal Protective Equipment

All work involving heavy equipment, drilling, and well installation will proceed in Level D PPE, which shall include hard hat, steel-toed boots, hearing protection, eye protection, and protective gloves.

All personnel will be properly fitted and trained in the use of PPE. The level of protection will be upgraded by the HSO/SS whenever warranted by conditions present in the work area. The HSO/SS will periodically inspect equipment such as gloves and hard hats for defects.

For all work involving potential exposure to soil or groundwater, workers will wear nitrile gloves and Level D PPE. Safety vests will be worn when working around heavy equipment and in the active Site areas. Personnel will wear rain suits on windy, rainy days to prevent hypothermia.

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9.0 Site Control and Communication

9.1 SITE CONTROL

Pedestrians and other unauthorized personnel will not be allowed in the work area; however the site is an active business. Access to the work site will be restricted to designated personnel. The purpose of site control is to minimize the public's potential exposure to site hazards, to prevent vandalism in the work area and access by children and other unauthorized persons, and to provide adequate facilities for workers. Work area controls and decontamination areas will be provided to limit the potential for chemical exposure associated with site activities, and transfer of contaminated media from one area of the Site to another. Staff will decontaminate all equipment and gear as necessary prior to exiting the work area.

9.2 COMMUNICATION

All site work will occur in teams and the primary means of communication on-site and with off-site contacts will be via cell phones. An agreed-upon system of alerting via air horns and/or vehicle horns may be used around heavy equipment to signal an emergency if shouting is ineffective.

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10.0 Decontamination

Decontamination procedures will be strictly followed to prevent off-site spread of contaminated soil or water. Decontamination effectiveness will be assessed by visual inspection by the HSO/SS. Refer to the Sampling and Analysis Plan/Quality Assurance Project Plan (Appendix B) for additional details.

Before eating, drinking, and use of tobacco, hands must be thoroughly washed.

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11.0 Emergency Response and Contingency Plan

This section defines the emergency action plan for the Site. It will be rehearsed with all site personnel and reviewed whenever the plan is modified or the HSO/SS believes that site personnel are unclear about the appropriate emergency actions.

A point of refuge will be identified by the HSO/SS and communicated to the field team each day. This point will be clear of adjacent hazards and preferably upwind or crosswind for the entire day. In an emergency, all site personnel and visitors will evacuate to the point of refuge for roll call. It is important that each person on-site understand their role in an emergency, and that they remain calm and act efficiently to ensure everyone’s safety.

After each emergency is resolved, the entire project team will meet and debrief on the incident—the purpose is not to fix blame, but to improve the planning and response to future emergencies. The debriefing will review the sequence of events, what was done well, and what can be improved. The debriefing will be documented in a written format and communicated to the PM. Modifications to the emergency plan will be approved by the PM.

Reasonably foreseeable emergency situations include medical emergencies, accidental release of hazardous materials (such as gasoline or diesel) or hazardous waste, and general emergencies such as vehicle accident, fire, thunderstorm, and earthquake. Expected actions for each potential incident are outlined below.

11.1 MEDICAL EMERGENCIES

In the event of a medical emergency, the following procedures should be used:

1. Stop any imminent hazard if you can safely do so.
2. Remove ill, injured, or exposed person(s) from immediate danger if moving them will clearly not cause them harm and no hazards exist to the rescuers.
3. Evacuate other on-site personnel to a safe place in an upwind or crosswind direction until it is safe for work to resume.

   If serious injury or life-threatening condition exists, call 911 for paramedics, the fire department, and police.

   Clearly describe the location, injury, and conditions to the dispatcher. Designate a person to go to the Site entrance and direct emergency equipment to the injured person(s). Provide the responders with a copy of this HASP to alert them to chemicals of potential concern.
4. Trained personnel may provide first aid/CPR if it is necessary and safe to do so. Remove contaminated clothing and PPE only if this can be done without endangering the injured person.
5. Call the HSO/SS and PM.

6. Immediately implement steps to prevent recurrence of the accident.

A map showing the nearest hospital location is attached to this HASP (refer to Section 2.0 for number and address).

11.2 ACCIDENTAL RELEASE OF HAZARDOUS MATERIALS OR WASTES

If there is an accidental release of hazardous materials or wastes at the Site, the following steps should be taken:

1. Evacuate all on-site personnel to a safe place in an upwind direction until the HSO/SS determines that it is safe for work to resume.
2. Instruct a designated person to contact the PM and confirm a response.
3. Contain the spill, if it is possible and can be done safely.
4. If the release is not stopped, call 911 to alert the fire department.
5. Contact the Washington State Emergency Response Commission at 1-800-258-5990 to report the release.
6. Initiate cleanup.
7. The PM will coordinate follow-up written reporting to Ecology in the event of a reportable release of hazardous materials or wastes.

11.3 GENERAL EMERGENCIES

In the case of fire, explosion, earthquake, or imminent hazards, work shall be halted and all on-site personnel will be immediately evacuated to a safe place. The local police/fire department shall be notified if the emergency poses a continuing hazard by calling 911.

In the event of a thunderstorm, outdoor work will be discontinued until the threat of lightning has abated. During the incipient phase of a fire, the available fire extinguisher(s) may be used by persons trained in putting out fires, if it is safe for them to do so. Contact the fire department as soon as feasible.

11.4 EMERGENCY COMMUNICATIONS

In the case of an emergency, an air horn or car horn will be used as needed to signal the emergency. One long (5-second) blast will be given as the emergency/stop work signal. If the air horn is not working, a vehicle horn and/or overhead waving of arms will be used to signal the emergency. In any emergency, all personnel will evacuate to the designated refuge area and await further instruction.

11.5 EMERGENCY EQUIPMENT

The following minimum emergency equipment will be readily available on-site and functional at all times:

- First Aid Kit—contents approved by the HSO/SS.
- Sorbent materials capable of absorbing the volume of liquids/fuels brought to the Site by Floyd|Snider personnel.
- Portable fire extinguisher (2-A:10 B/C min).
- A copy of the current HASP.

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12.0 Administrative

12.1 MEDICAL SURVEILLANCE

Floyd|Snider personnel involved with field activities must be covered under Floyd|Snider's medical surveillance program that includes biennial physical examinations. These medical monitoring programs must be in compliance with all applicable worker health and safety regulations.

12.2 RECORD KEEPING

The HSO/SS, or a designated alternate, will be responsible for keeping attendance lists of personnel present at site health and safety meetings, accident reports, and signatures of all personnel who have read this HASP.

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13.0 Approvals

Project Manager	Date
Project Health & Safety Officer	Date

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14.0 Signature Page

I have read this Health and Safety Plan and understand its contents. I agree to abide by its provisions and will immediately notify the HSO/SS if site conditions or hazards not specifically designated herein are encountered.

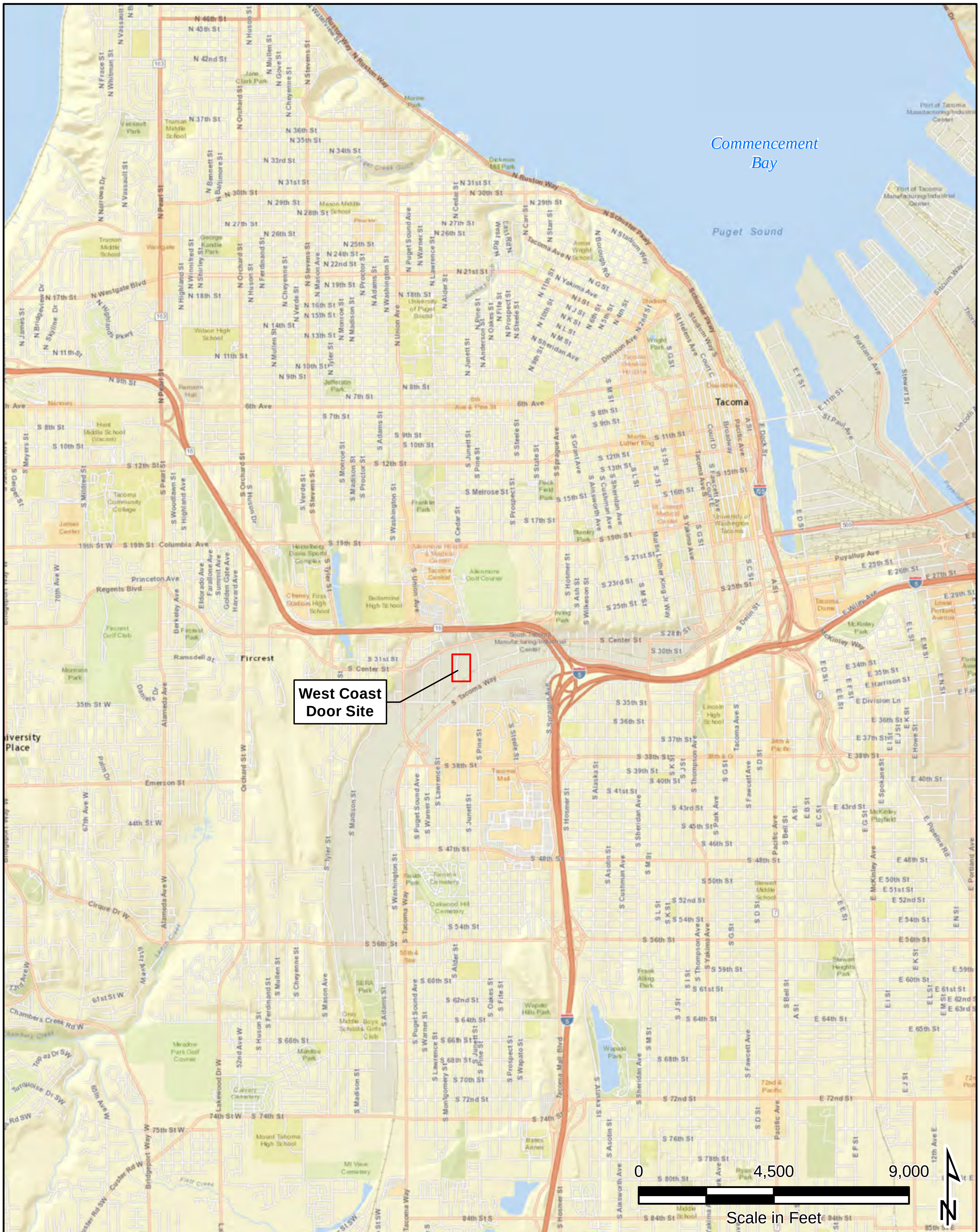
Name (Print)	Signature	Date

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix C
Health and Safety Plan

Figures



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Remedial Investigation
Data Gaps Work Plan
West Coast Door Site
Tacoma, Washington

Figure C.1
Vicinity Map

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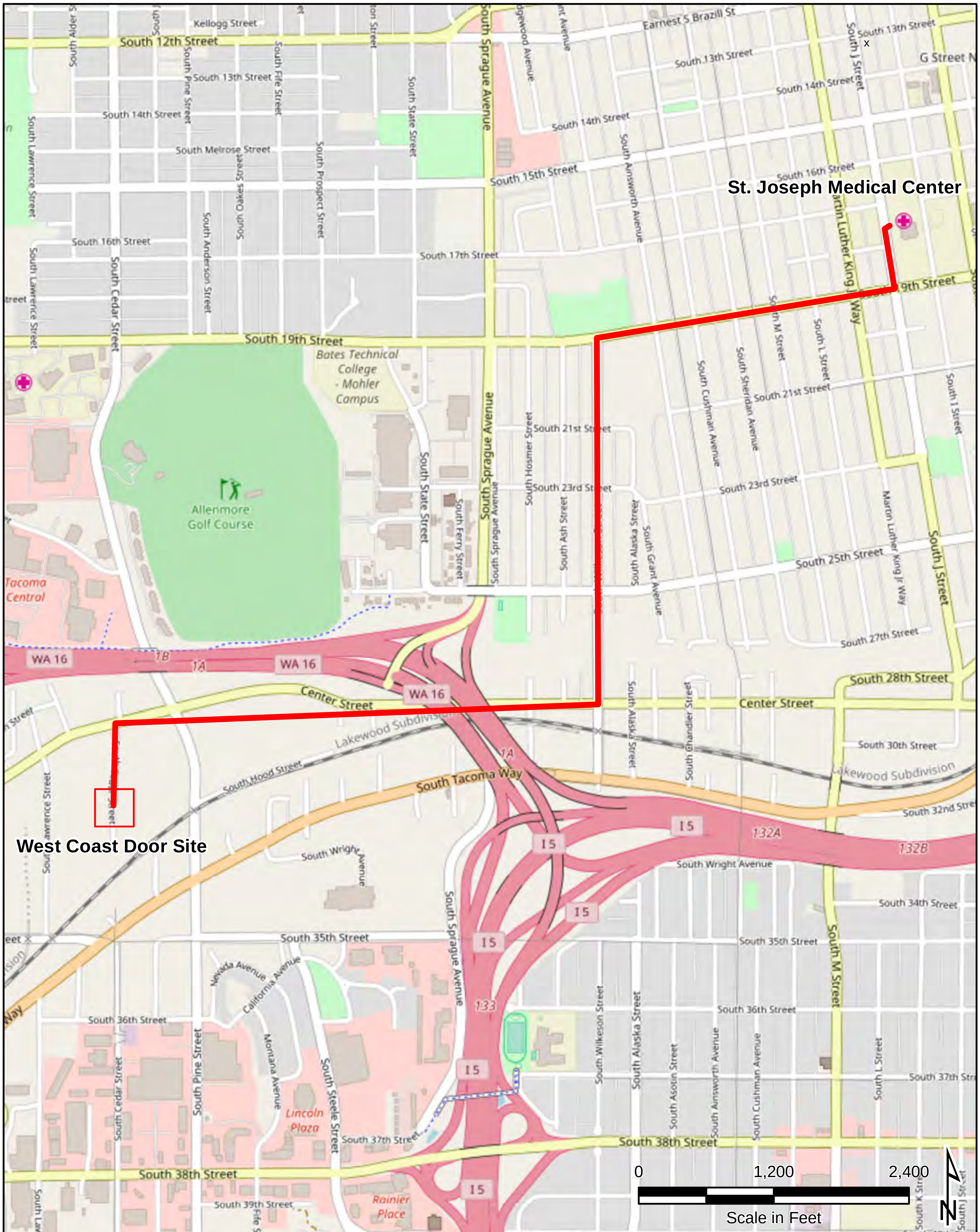
October 2017



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Remedial Investigation
Data Gaps Work Plan
West Coast Door Site
Tacoma, Washington

Figure C.2
Hospital Route

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October 2017

West Coast Door Site

Remedial Investigation
Data Gaps Work Plan

Appendix C
Health and Safety Plan

Attachment C.1
Daily Tailgate Safety Meeting Form

DAILY TAILGATE SAFETY MEETING AND DEBRIEF FORM

Instructions:
To be completed by supervisor prior to beginning of work each day, when changes in work procedures occur, or when additional hazards are present. Please maintain a copy of this form with the site-specific HASP for the record.

PROJECT NAME AND ADDRESS:	WORK COMPLETED/TOOLS USED:

TOPICS/HAZARDS DISCUSSED:

Chemicals of concern:
Slip, trip, fall:
Heat or cold stress:
Required PPE:
Other Potential Hazards:
• Environmental:
• Physical:
• Biological:
• Other :

INFORMAL TRAINING CONDUCTED (Name, topics):

NAMES OF EMPLOYEES:

ADDITIONAL HAZARDS IDENTIFIED AT END OF WORK DAY:

Near Misses/Incidents? If so proceed to Page 2 Near Miss and Incident Reporting Form

Supervisor's Signature/Date: ____

NEAR MISS AND INCIDENT REPORTING FORM

INCIDENTS:

INJURIES:

NEAR MISSES:

CORRECTIVE ACTIONS:

Supervisor's Signature/Date: ____