

**STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY**

In the Matter of Remedial Action by:

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

v.

WEYERHAEUSER COMPANY,
a Washington Corporation

M.A.P. #2, LLC,
A Washington Corporation

AGREED ORDER

No. DE 16129

TO: Carol Wiseman
Weyerhaeuser Company
220 Occidental Avenue South
Seattle, WA 98104

Sandra L. Forman
M.A.P. #2, LLC
805 80th Street SW
Everett, WA 98203

TABLE OF CONTENTS

I.	INTRODUCTION.....	3
II.	JURISDICTION.....	3
III.	PARTIES BOUND.....	3
IV.	DEFINITIONS	4
V.	FINDINGS OF FACT	5
VI.	ECOLOGY DETERMINATIONS.....	12
VII.	WORK TO BE PERFORMED	14
VIII.	TERMS AND CONDITIONS.....	19
	A. Payment of Remedial Action Costs	19
	B. Designated Project Coordinators	20
	C. Performance	21
	D. Access	21
	E. Sampling, Data Submittal, and Availability	22
	F. Public Participation.....	23

G.	Retention of Records.....	24
H.	Resolution of Disputes.....	24
I.	Extension of Schedule.....	26
J.	Amendment of Order.....	27
K.	Endangerment.....	28
L.	Reservation of Rights.....	29
M.	Transfer of Interest in Property.....	29
N.	Compliance with Applicable Laws.....	30
O.	Indemnification.....	31
IX.	SATISFACTION OF ORDER.....	32
X.	ENFORCEMENT.....	32
	EXHIBIT A	Site Location Diagram
	EXHIBIT B	Final Supplemental Upland RI Work Plan
	EXHIBIT C	Schedule of Deliverables

I. INTRODUCTION

The mutual objective of the State of Washington, Department of Ecology (Ecology) and Weyerhaeuser Company and M.A.P. #2, LLC under this Agreed Order (Order) is to provide for remedial action at a facility where there has been a release or threatened release of hazardous substances. Weyerhaeuser Company and M.A.P. #2, LLC are Potentially Liable Persons (PLPs) under this Order. This Order requires the PLPs to assess the nature and extent of contaminated soil and ground water at the facility, consistent with the Consent Decree. In addition, this Order requires the PLPs to identify if the source of arsenic-contaminated water that discharged from a storm water outfall (Outfall LLO-07) at the facility is associated with the Mill E facility, and if so, to identify the extent and source of arsenic and mercury contaminated sediment surrounding sediment sample LLS-19. This Order further requires the PLPs to undertake additional investigations to define the nature and extent of contamination, if warranted as a result of the aforementioned assessments; to prepare a focused feasibility study of alternatives for cleaning up the contamination; and to prepare a draft focused cleanup action plan and compliance monitoring plan to implement a remedy selected by Ecology. Ecology has determined that the actions required by this Order are in the public interest.

This Order does not apply to any area within the covenant not to sue of the consent decree entered *Dep't of Ecology v. Weyerhaeuser Co.*, No. 98-2-08718-6 (Snohomish Cty. Super. Ct. Nov. 30, 1998) (1998 Consent Decree).

II. JURISDICTION

This Agreed Order is issued pursuant to the Model Toxics Control Act (MTCA), RCW 70.105D.050(1).

III. PARTIES BOUND

This Agreed Order shall apply to and be binding upon the Parties to this Order, their successors and assigns. The undersigned representative of each party hereby certifies that he or she is fully authorized to enter into this Order and to execute and legally bind such party to comply

with this Order. PLP agrees to undertake all actions required by the terms and conditions of this Order. No change in ownership or corporate status shall alter PLP's responsibility under this Order. PLP shall provide a copy of this Order to all agents, contractors, and subcontractors retained to perform work required by this Order, and shall ensure that all work undertaken by such agents, contractors, and subcontractors complies with this Order.

IV. DEFINITIONS

Unless otherwise specified herein, the definitions set forth in RCW 70.105D, WAC 173-204 and WAC 173-340 shall control the meanings of the terms in this Order.

A. Site: The Site is referred to as Weyerhaeuser Everett Mill E or Former Mill E/Koppers Facility (Mill E Site). The Site constitutes a facility under RCW 70.105D.020(8). The Site is defined by where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located. Based upon factors currently known to Ecology, the Site is generally located at 515 East Marine View Drive, Everett, Washington 98201 as shown in the Site Location Diagram (Exhibit A). The Site includes a former wood treatment facility and the former Weyerhaeuser Mill E sawmill property (Mill E Property), currently identified as Snohomish County Assessor's Parcel #29051600200500, and includes any areas beyond the Mill E Property on which releases from that property have come to be located.

B. Parties: Refers to the State of Washington, Department of Ecology, Weyerhaeuser Company and M.A.P. #2, LLC.

C. Potentially Liable Persons (PLP(s)): Refers to Weyerhaeuser Company and M.A.P. #2, LLC.

D. Agreed Order or Order: Refers to this Order and each of the exhibits to this Order. All exhibits are integral and enforceable parts of this Order.

V. FINDINGS OF FACT

Ecology makes the following findings of fact, without any express or implied admissions of such facts by PLPs:

A. The Mill E Site lies within the Everett Smelter Cleanup Site. The Everett Smelter Cleanup Site consists of the area occupied by a former lead smelter that operated from about 1894 to 1912 and the surrounding area impacted by arsenic contamination from smelter stack emissions.

B. Weyerhaeuser Company (Weyerhaeuser) began operations in the Everett area in 1902. In 1915, Weyerhaeuser built a large sawmill complex (Mill B), which was located west and north of the Mill E Property. The Mill E Property was used as a lumber storage area from 1915 until 1948, when American Lumber Treating Company (ALTC) leased the Mill E Property from Weyerhaeuser. ALTC constructed a wood-treatment facility and began wood treatment operations at the Mill E Property. Koppers Company acquired ALTC in 1954. Wood treatment at the Mill E Property continued until 1963, when the lease expired and Weyerhaeuser resumed use of the Mill E Property. Beginning in 1963, Weyerhaeuser gradually converted the former wood-treatment facility into an equipment maintenance facility. The maintenance facility operated from 1963 to 1984. Activities at the maintenance facility consisted of petroleum fueling and maintenance of vehicles and engines. The petroleum tanks and some of the petroleum contaminated soil were removed in 1988. Weyerhaeuser built Mill E, a sawmill, at the northeast end of the Mill E Property in 1971. Mill E was designed to handle small diameter logs and produce dimensional lumber. Mill E was closed in 1984 and the building was demolished in 1988, except for the foundation slab. Between 1984 and 2005, the Mill E Property was largely unused.

C. Subsequent to Mill E closure in 1984, Weyerhaeuser began investigating contamination from past activities on the Mill E Property under Ecology oversight. These investigations continued until 1998. Ecology reviewed a draft Remedial Investigation (RI) report¹

¹ *Draft Remedial Investigation Report for Former Mill E/Koppers Facility* (with Appendices A-I), September 1, 1994

(1994) and a Feasibility Study (FS) report² (1997), and accepted them as having met the functional requirements of MTCA. In 1998 Ecology and Weyerhaeuser entered into the 1998 Consent Decree (Decree)³, which specified cleanup actions to be taken at the Mill E Site as defined by the Decree. Exhibit C of the 1998 Consent Decree is the *Cleanup Action Plan*, and Exhibit E is the *Performance and Compliance Monitoring Plan*, which describe the remedial actions required on the Site.

D. Weyerhaeuser began the remedial actions required by the Consent Decree in 1999. The cleanup action consisted of hot spot soil removal, construction of a vertical barrier wall around a highly contaminated part of the Site, installation of a low-permeability asphalt cap to cover the barrier wall containment area, placement of a soil cap over portions of the Site outside the barrier wall, institutional controls, and long-term monitoring. The purpose of the barrier wall is to surround and laterally contain shallow contaminated groundwater inside an area of contaminated soil with elevated concentrations of arsenic and other hazardous substances.

E. The Site is underlain by fill, an upper sand aquifer, an upper silt low permeability aquitard, and a lower sand aquifer. The barrier wall is keyed into the upper silt low permeability aquitard. An asphalt cap covers the area surrounded by the barrier wall, and extends slightly beyond the barrier wall, to prevent precipitation from infiltrating into the contained area. Groundwater is not contained or controlled over the remainder of the Site.

F. The 1998 Consent Decree provides cleanup levels for soil and groundwater at the Site. The *Cleanup Action Plan* (Exhibit C) states that “The groundwater point of compliance for the Site is the property boundary adjacent to the Snohomish River.” (§4.2, p. 14). The 1998 Consent Decree (Exhibit E) provides a *Performance and Compliance Monitoring Plan (PCMP)* for the asphalt cap, soil cap, the groundwater barrier wall, and groundwater compliance inside the

² *Feasibility Study, Former Mill E/Koppers Facility*, February 25, 1997

³ *Weyerhaeuser Everett Mill E Consent Decree*, November 12, 1998

barrier wall, and the 1998 Consent Decree (and 1998 Cleanup Action Plan) provides for groundwater cleanup standards outside of the barrier wall for TPH and PCP.

G. Arsenic is a hazardous substance of interest for this Agreed Order.

H. The 1998 Consent Decree explicitly excludes arsenic in ground water and soil outside the barrier wall from the Decree's Covenant Not to Sue. Section XXVII - Covenant Not to Sue, states (p.24), "This covenant is strictly limited in its application to the Site specifically defined in Exhibit A [of 1998 Consent Decree] and to contamination which Ecology knows to be located at the Site as of the entry of this Decree, except that this covenant is not applicable to the arsenic contamination in soil and ground water located outside the vertical barrier wall to be constructed pursuant to Section VI.C.7. The state retains all of its authority relative to such arsenic contamination."

I. In August 2005 Weyerhaeuser sold the Mill E Property to M.A.P. #2, LLC. At the time M.A.P. #2, LLC was a wholly-owned subsidiary of Pacific Topsoils, Inc. Pacific Topsoils has used the Mill E Property for storage since its purchase in 2005.

J. Performance of the barrier wall is assessed by groundwater monitoring (see 1998 Consent Decree, Exhibit C, *Cleanup Action Plan*, §6.3, p. 23 and Exhibit E, *Performance and Compliance Monitoring Plan*). The *Cleanup Action Plan* and the *Performance and Compliance Monitoring Plan* (PCMP) indicate that water levels are to be measured at three piezometers installed inside the barrier wall and in three piezometers installed outside the barrier wall. All six are screened in the upper sand aquifer. If water levels inside the barrier wall are stable or decrease, the system is judged to be functioning normally. If water levels increase within the contained portion of the upper sand aquifer, the cap performance is to be evaluated and corrective actions implemented and the frequency of water level monitoring is to be increased. Concentrations in ground water outside the wall are not required to be measured in the *Cleanup Action Plan* or the *PCMP*.

K. The *Performance and Compliance Monitoring Plan* (1998 Consent Decree, Exhibit E) also has requirements for monitoring the performance of the barrier wall. It notes that the water elevations within the contained portion of the upper sand aquifer are expected to reach a new equilibrium at approximately the average elevation of the hydraulic head in the lower aquifer, and that this would significantly decrease the contaminant flux from the upper sand aquifer down into the lower sand aquifer (see p. 2 of the *PCMP*). If water levels inside the wall decline and reach a new equilibrium at approximately the average elevation of the hydraulic head in the lower aquifer, it can be presumed that the containment system (barrier wall and asphalt cap) is functioning as designed. The *PCMP* monitoring program utilized monitoring of the upper aquifer water levels to assess the barrier wall performance metric of reduced hydraulic gradients between shallow and deep aquifer, based on whether upper aquifer water levels were stable or decreasing, or increasing (see Tables 2-1 and 2-2 of *PCMP*). On August 23, 2017 Ecology approved the *PCMP Addendum* to Exhibit E [*PCMP* of 1998 Consent Decree], to implement work that would allow for a comparison of hydraulic heads between the Upper and Lower Sand Aquifers. Following the initial quarterly measurements of water elevations, water elevation measuring will continue annually in September thereafter. The *2018 Annual Performance and Compliance Monitoring Report* (Table 3, November, 2018) for the quarterly monitoring shows there is a vertical hydraulic head difference between groundwater in the Upper and the Lower Sand Aquifers. The results show that the water head elevations for the Lower Sand Aquifer are consistently less than for the Upper Sand Aquifer. Groundwater quality results for arsenic from PZ-3A (Upper Sand Aquifer; inside the barrier wall) in September, 2018 was 551 µg/L, in excess of the cleanup level of 5 µg/L, which is expected inside the barrier wall and in compliance with the Consent Decree. The contaminant flux to the Lower Sand Aquifer from the Upper Sand Aquifer has not been determined since the barrier wall was constructed. The groundwater quality of the Lower Sand Aquifer, inside the barrier wall area or immediately downgradient from the barrier wall, was not part of the *PCMP* monitoring program.

L. Additional information became available to Ecology regarding arsenic in ground water and outfall discharges, and arsenic and mercury in sediment adjacent to the Site. The *Final Supplemental Remedial Investigation Report for the Everett Smelter Lowland Area*⁴ (ES SRI 2016 Report) reports arsenic contamination in ground water outside the barrier wall in concentrations exceeding the Mill E Site arsenic cleanup level (*Cleanup Action Plan*, p. 14, of 1998 Consent Decree) and the Everett Smelter preliminary cleanup level for protection of surface water in the Snohomish River (ES SRI 2016 Report Table 5-4), both of which are 5 µg/L. It has not been determined whether this contamination is related to Everett Smelter contamination.

M. Arsenic concentrations in ground water in piezometer PZ-3B (Upper Sand Aquifer), outside the barrier wall and adjacent to the Snohomish River were measured for four quarters in 2013. Concentrations ranged from 5.8 µg/L to 31 µg/L (see ES SRI 2016 Report Figures 6-8 through 6-11). Arsenic concentrations in well LLMW-20D, adjacent to PZ-3B and screened in the Lower Sand Aquifer, ranged from 8.7 µg/L to 34.2 µg/L in the four quarters measured in 2013 (see ES SRI 2016 Report Figures 6-13 to 6-16).

N. In addition, arsenic concentrations are elevated in the Upper Sand Aquifer groundwater in PZ-1B (166 µg/L; Aug/Sept, 2013) in relation to arsenic concentrations in upgradient wells LLMW-18S and LLMW-21S, farther upgradient from the barrier wall (see ES SRI 2016 Report Figure 6-8 through 6-11). Lower Sand Aquifer well LLMW-19D, near to the upgradient side of the barrier wall [outside the wall and off the Mill E Property] has groundwater with elevated arsenic concentrations in relation to other deep aquifer wells LLMW-18D and LLMW-21D, which are farther upgradient from the barrier wall (See ES SRI 2016 Report Figures 6-13 to 6-16).

⁴ *Final Supplemental Remedial Investigation Report, Everett Smelter Lowland Area*, February 8, 2016.

O. The ES SRI 2016 Report also reports data obtained from outfalls, seeps, storm water solids and sediment along the Snohomish River adjacent to the Everett Smelter Site. Outfall LLO-07 is on the Site south of the asphalt-covered/barrier wall containment area (See ES SRI 2016 Report Figure 6-24). The dissolved arsenic concentration in water discharging from the outfall was 542 µg/L in spring 2013. This is in excess of federal water quality standards (CFR Title 40, Chapter I, Subchapter D, Part 131) for protection of aquatic life for marine waters of 39 µg/L (Criterion Continuous Concentration) and 69 µg/L (Criterion Maximum Concentration), or for protection of human health for marine waters of 0.14 µg/L (consumption of organisms only). It is in excess of the ground water cleanup level set in the *Cleanup Action Plan* (1998 Consent Decree) of 5 µg/L. Adjacent outfalls have concentrations of 39.9 µg/L for LLO-06 (south of LLO-07) and 0.8 µg/L for LLO-05 (north of LLO-07).

P. Sediment sample LLSD-19, collected below outfall LLO-07 had an arsenic concentration of 837 mg/kg (ES SRI 2016 Report Figure 6-22). This is in excess of both the Sediment Cleanup Objective (SCO) of 57 mg/kg and the Cleanup Screening Level (CSL) of 93 mg/kg (See WAC 173-204-562, Table III). Other sediment samples collected north and south of the Site during that investigation had arsenic concentrations in the range of 10 to 19 mg/kg. A cleanup level for arsenic contaminated sediment has not been established for the Mill E Site as sediment was not identified as a media of concern as part of the RI.

Q. Sediment sample LLSD-19 also had a mercury concentration higher than adjacent samples. The LLSD-19 mercury concentration was 0.16 mg/kg. Adjacent samples had mercury concentrations of 0.04 and 0.07 mg/kg. This compares to the SCO of 0.41 mg/kg and the CSL of 0.59 mg/kg (WAC 173-204-562, Table III). The SCO and CSL are for protection of the benthic community. A cleanup level for mercury contaminated sediment has not been established for the Mill E Site as mercury was not identified as a constituent of concern and sediment was not identified as a media of concern as part of the RI.

R. Both the arsenic concentrations in water discharging from outfall LLO-07 and the arsenic and mercury concentrations in sediment at LLSD-19 are new information.

S. In response to the new information on arsenic contaminated water discharging from outfall LLO-07, the PLP's conducted work in 2017-2018 on the storm water pipe within the Mill E Property, including delineating the pipe location, condition, connections and abandonment^{5,6,7}. The pipe extends westward approximately 290' from the outfall, where the pipe enters a wooden junction box structure that had no cover and was filled with soil and debris. The contaminated soil in this area is required to be capped by a thin, permeable layer of uncontaminated soil to protect occupants from direct exposure per the *Cleanup Action Plan* [of 1998 Consent Decree]. Beneath the protective soil cap, outside of the barrier wall, arsenic contamination in soil was reported in the 1994 RI report to be 121 mg/kg near the storm water pipe (SB-3 @ 7.2') and 125 mg/kg adjacent to the shoreline (MW-32 @ 6'), less than the Mill E Site CUL of 200 mg/kg.

T. The greatest arsenic concentration in groundwater at the Site is reported in the 1994 RI at approximately 17,000 µg/L (well MW-23; 1992), before 1999 when some contaminated soil was removed to the water table and the barrier wall was built around that well location. There were other groundwater samples taken in 1992 and 1993 at locations outside the current barrier wall location, and closer to the storm water pipe beneath the soil cap, i.e., HC-3 (1250 µg/L), MW-32 (818 µg/L), HC-14 (417 µg/L). Because the PCMP does not require sampling outside of the barrier wall, no groundwater quality samples have been taken by the PLPs within the soil cap area of the Site since 1996, prior to remedy implementation. Per the PCMP, groundwater sampling inside the barrier wall has been performed since 1999. Current groundwater water quality in the soil cap area is unknown.

⁵ *Pipe Exploration Summary for Storm Drain Associated with Outfall LLO-07*, October 20, 2017

⁶ *Revised Pipe Exploration Summary for Storm Drain Associated with Outfall LLO-07*, December 13, 2017

⁷ *Storm Drain Pipe Abandonment Associated with Outfall LLO-07 at the Former Mill E/Koppers Facility*, May 30, 2018

U. Weyerhaeuser collected sediment data in three phases, obtaining over 40 samples in 1992 and 1995 prior to completion of remedial actions at the Site. Sediment data collected in 1992 from SR-04, immediately adjacent to LLO-07, contained arsenic at a concentration of 45.5 mg/kg. Sediment data collected adjacent to the barrier wall, as part of the Mill E 1992 RI, showed arsenic concentrations ranging from 10.2 – 21.2 ppm. In 1992, arsenic was found in surface and subsurface sediment at 253 mg/kg @ 3 cm, 426 mg/kg @ 30 cm and at 239 mg/kg @ 58 cm in sample SR-05. This sample was located near Outfall LLO-07. Subsequent surface (0-10 cm) sediment sampling in 1995⁸, around the location of SR-05, resulted in one sample (SR-05B) exceeding the marine chemical and biological benthic criteria (SCO of 57 mg/kg) for arsenic at 84.5 mg/kg (See WAC 173-204-562, Table III), with 2 other samples passing this criteria (<57 mg/kg) but showing elevated concentrations. The arsenic concentrations protective of human health by exposure to sediment contact or ingestion (WAC 173-204-561) or the higher trophic level risk (WAC 173-204-564) from sediments has not been determined for this Site, as sediment was not determined to be a media of concern as part of the RI.

VI. ECOLOGY DETERMINATIONS

Ecology makes the following determinations, without any express or implied admissions of such determinations (and underlying facts) by PLPs.

A. Weyerhaeuser Company is an “owner or operator” as defined in RCW 70.105D.020(22) of a “facility” as defined in RCW 70.105D.020(8). Weyerhaeuser Company owned the Mill E Property from 1912 to 2005 and operated it during that time except from 1948 to 1963 when American Lumber Treating Co. constructed and operated a wood-treatment facility at the Site pursuant to a lease with Weyerhaeuser as documented in the 1998 Consent Decree.

⁸ *Results of Phase III Sediment Sampling*, April 5, 1996

B. M.A.P. #2, LLC is an “owner or operator” as defined in RCW 70.105D.020(22) of a “facility” as defined in RCW 70.105D.020(8). M.A.P. #2, LLC purchased the property from Weyerhaeuser Company as documented in a Purchase Agreement dated February 28th, 2005, between Pacific Topsoils, Inc. and Weyerhaeuser Company. At the time M.A.P. #2, LLC was a wholly owned subsidiary of Pacific Topsoils, Inc. M.A.P. #2, LLC is the current owner of the Mill E Property.

C. Based upon all factors known to Ecology, a “release” or “threatened release” of “hazardous substance(s)” as defined in RCW 70.105D.020(32) and (13), respectively, has occurred at the Site.

D. Based upon credible evidence, Ecology issued a PLP status letter to Weyerhaeuser Company dated September 6, 1989, pursuant to RCW 70.105D.040, .020(26), and WAC 173-340-500. After providing for notice and opportunity for comment, reviewing any comments submitted, and concluding that credible evidence supported a finding of potential liability, Ecology issued a determination that Weyerhaeuser Company is a PLP under RCW 70.105D.040 and notified Weyerhaeuser Company of this determination by letter dated September 6, 1989. In 1998 Ecology and Weyerhaeuser entered into the 1998 Consent Decree to address specific releases.

E. Pursuant to RCW 70.105D.030(1) and .050(1), Ecology may require PLPs to investigate or conduct other remedial actions with respect to any release or threatened release of hazardous substances, whenever it believes such action to be in the public interest. Based on the foregoing facts, Ecology believes the remedial actions required by this Order are in the public interest.

F. Based upon credible evidence, Ecology issued an additional PLP status letter to Weyerhaeuser Company dated January 27, 2017, pursuant to RCW 70.105D.040, .020(26), and WAC 173-340-500. After providing for notice and opportunity for comment, reviewing any comments submitted, and concluding that credible evidence supported a finding of potential liability, Ecology issued a determination that Weyerhaeuser Company is a PLP under RCW

70.105D.040 and notified Weyerhaeuser Company of this determination by letter dated November 19, 2018.

G. Based upon credible evidence, Ecology issued a PLP status letter to M.A.P. #2, LLC dated January 27, 2017, pursuant to RCW 70.105D.040, .020(26), and WAC 173-340-500. After providing for notice and opportunity for comment, reviewing any comments submitted, and concluding that credible evidence supported a finding of potential liability, Ecology issued a determination that M.A.P. #2, LLC is a PLP under RCW 70.105D.040 and notified M.A.P. #2, LLC of this determination by letter dated November 19, 2018.

H. Under WAC 173-340-430, an interim action is a remedial action that is technically necessary to reduce a threat to human health or the environment by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance, that corrects a problem that may become substantially worse or cost substantially more to address if the remedial action is delayed, or that is needed to provide for completion of a site hazard assessment, remedial investigation/feasibility study, or design of a cleanup action plan. Either party may propose an interim action under this Order. If the Parties are in agreement concerning the interim action, the Parties will follow the process in Section VII.D. If the Parties are not in agreement, Ecology reserves its authority to require interim action(s) under a separate order or other enforcement action under RCW 70.105D, or to undertake the interim action itself.

VII. WORK TO BE PERFORMED

Based on the Findings of Fact and Ecology Determinations, it is hereby ordered that the PLPs take the following remedial actions at the Site. The area where remedial action is necessary under RCW 70.105D is generally described as within the Site Diagram (Exhibit A). Except as specifically noted (limited sampling within a barrier wall to inform remedial investigation under the scope of this Order), the remedial actions ordered do not apply to any area within the covenant

not to sue of the 1998 Consent Decree. These remedial actions must be conducted in accordance with WAC 173-340 and 173-204:

A. Implement Exhibit B, Supplemental RI investigative work per Ecology approved Supplemental Upland RI Work Plan (Exhibit B), which includes a Sampling and Analysis Plan (SAP), meeting the requirements of WAC 173-340-820, and Quality Assurance Project Plan (QAPP), meeting the requirements of WAC 173-340-830. The Supplemental Upland RI Work Plan will: (1) Assess arsenic concentrations in the Upper and Lower Sand Aquifers, inside and outside the barrier wall, and whether they would be projected to flow past the ground water point of compliance at the Mill E Property boundary adjacent to the Snohomish River (See 1998 Consent Decree, Exhibit C, Cleanup Action Plan, p. 14) in either the Upper or Lower Sand Aquifers; (2) Assess the arsenic concentrations in groundwater over time and determine the source of arsenic contamination in groundwater outside the barrier wall on the Site, including performing enough soil sampling to define the nature and extent of current or potential groundwater contamination sources. Present the soil and groundwater investigation findings in a Supplemental Upland RI (SRI) Data Summary Report, submitted for Ecology approval according to Exhibit C, Schedule.

Following the completion of the SRI Data Summary Report, perform any necessary additional investigations (Phase 2 SRI), as directed by Ecology, to define the nature and extent of contamination based upon the findings of the assessments in paragraph VII.A, above, and develop a plan to evaluate feasible cleanup alternatives. If warranted, this additional investigation work would include assessing the extent of arsenic and mercury contaminated sediment, determine if the source of the sediment contamination is associated with the Mill E facility and, if necessary, develop a plan to evaluate feasible cleanup alternatives for sediment. This additional work, if warranted, would be described in an approved SRI/Focused Feasibility Study (SRI/FFS) Work Plan, provided to Ecology on a schedule specified in Exhibit C, Schedule.

B. Provide the information obtained from supplemental remedial investigations in a SRI Report for the Mill E Site. Present the findings in an Agency Review Draft Report, a Public Review Draft Report, and a Final SRI Report meeting the applicable requirements of WAC 173-

340-350, submitted to Ecology for approval as determined by the schedule specified in Exhibit C, Schedule.

C. Identify feasible alternatives for cleaning up contamination identified during supplemental remedial investigations. Present the findings in an Agency Review Draft Report, a Public Review Draft Report, and a Final FFS Report meeting the applicable requirements of WAC 173-340-350, submitted to Ecology for approval by the schedule specified in Exhibit C Schedule.

D. Prepare a preliminary Draft Focused Cleanup Action Plan (FCAP) meeting the applicable requirements of WAC 173-340-380, submitted to Ecology for review by the schedule specified in Exhibit C, Schedule.

E. The following naming conventions shall be used for documents: Agency Review Draft (designation for the first time Ecology receives a document); Public Review Draft (designates a document ready for public comment); Final (designation for a document after public comment and Ecology approval); and the preliminary Draft FCAP (designation for the PLP's version of the FCAP).

F. All submittals to Ecology shall meet the General Submittal Requirements of WAC 173-340-840. This includes showing a survey grid on all planimetric views based on monuments established in the field and referenced to state plan coordinates. Reports are to be legible. Main text is to have a font no smaller than 12 points on the printed page. No font shall be smaller than 8 points. Maps plotting data shall show the data at the location of collection. Maps showing sample locations with tables and leaders pointing to the location shall not be used. Maps using colored dots shall also show the numeric value of the data at the collection location. Maps using color shall be developed with consideration that many people are colorblind.

G. All data used in reports shall be submitted to Ecology's Environmental Information Management System (EIM), including data from historic reports. Reports shall include the EIM Study Name and Study Number corresponding to the data presented therein.

H. All documents referenced in reports shall be submitted to Ecology as Adobe Acrobat (.pdf) files upon request, except for documents generally available and documents that are copyrighted.

I. Agency Review Draft reports shall be submitted in Adobe Acrobat (.pdf) format. The main text will be submitted in Microsoft Word so that Word's Review feature can be used. Appendices will be submitted in Word upon Ecology request. All supporting electronic files (Excel, AutoCAD, ArcGIS, etc.) shall also be submitted. Paper copies shall not be submitted unless requested by Ecology. Public Review Draft and Final reports will be submitted in both paper and electronic format as specified by Ecology. Paper copies shall include a CD with the report in Adobe Acrobat (.pdf) format bound into the document.

J. Exhibit C, Schedule, gives the schedule for submitting the Agency Review Draft, Public Review Draft, and Final SRI and FFS Reports.

K. PLPs shall submit quarterly progress reports that include: (1) a list of activities that have taken place during the reporting period, including summaries of contacts with representatives of the local community, public interest groups, press, and federal, state, or tribal governments; (2) summaries of sampling and testing reports and other data reports received by the PLPs; (3) summaries of problems or anticipated problems in meeting the schedule or objectives set forth in the SRI Work Plan and other follow-on documents; (4) summaries of solutions developed and implemented or planned to address any actual or anticipated problems or delays; (5) a detailed description of any deviations from required tasks and where those deviations will be documented in project plans or amendment requests; (6) a description of all deviations from the Schedule, and any planned deviations in the upcoming month; (7) for any deviations in schedule, a plan for recovering lost time and maintaining compliance with the schedule; (8) all raw data (including laboratory analyses) received by PLPs during the reporting period, including upload of this data to Ecology's Environmental Information Management System (EIM); (9) a list of deliverables, if any, for the upcoming reporting period; (9) changes in key personnel; (10) a description of work

planned for the next reporting period; and (11) any other information relevant to the timely execution of the work. Progress reports shall be submitted to Ecology until PLPs have received notice of satisfaction of this Order in accordance with Section IX of the Order. Progress Reports shall be submitted to the Ecology project coordinator by the 15th of the month following the end of the quarter and due in April, July, October, and January of each year. If this day is a weekend or holiday, deliverables will be submitted to Ecology on the next business day. Quarterly reports shall be submitted to Ecology via email in Adobe Acrobat format. The Adobe Acrobat file will contain the complete quarterly report. Chemical and other appropriate data shall be submitted by upload to EIM. If requested by Ecology, figures, drawings, and tables will be submitted in AutoCAD, Excel, Word, Access, ArcGIS or other format as approved by Ecology.

L. All plans or other deliverables submitted by PLPs for Ecology's review and approval under the Scope of Work and Schedule (Exhibit C) shall, upon Ecology's approval, become integral and enforceable parts of this Order.

M. If the Parties agree on an interim action under Section VI.E, PLPs shall prepare and submit to Ecology an Interim Action Work Plan, including a scope of work and schedule, by the date determined by Ecology. Ecology will provide public notice and opportunity to comment on the Interim Action Work Plan in accordance with WAC 173-340-600(16). The PLPs shall not conduct the interim action until Ecology approves the Interim Action Work Plan. Upon approval by Ecology, the Interim Action Work Plan becomes an integral and enforceable part of this Order, and PLPs are required to conduct the interim action in accordance with the approved Interim Action Work Plan.

N. If Ecology determines that PLPs have failed to make sufficient progress or failed to implement the remedial action, in whole or in part, Ecology may, after notice to PLPs, perform any or all portions of the remedial action or at Ecology's discretion allow the PLPs opportunity to correct. In an emergency, Ecology is not required to provide notice to PLPs, or an opportunity for dispute resolution. PLPs shall reimburse Ecology for the costs of doing such work in accordance

with Section VIII.A (Remedial Action Costs). Ecology reserves the right to enforce requirements of this Order under Section X (Enforcement).

O. Except where necessary to abate an emergency situation or where required by law, the PLPs shall not perform any remedial actions at the Site outside those remedial actions required by this Order to address the contamination that is the subject of this Order, unless Ecology concurs, in writing, with such additional remedial actions pursuant to Section VIII.J. (Amendment of Order). In the event of an emergency, or where actions are taken as required by law, PLPs must notify Ecology in writing of the event and remedial action(s) planned or taken as soon as practical but no later than within twenty-four (24) hours of the discovery of the event.

VIII. TERMS AND CONDITIONS

A. Payment of Remedial Action Costs

PLPs shall pay to Ecology costs incurred by Ecology pursuant to this Order and consistent with WAC 173-340-550(2). These costs shall include work performed by Ecology or its contractors for, or on, the Site under RCW 70.105D, including remedial actions and Order preparation, negotiation, oversight, and administration. These costs shall include work performed both prior to and subsequent to the issuance of this Order. Ecology's costs shall include costs of direct activities and support costs of direct activities as defined in WAC 173-340-550(2). Ecology has not accumulated remedial action costs related to this Site as of May 1, 2020. For all Ecology costs incurred, PLPs shall pay the required amount within thirty (30) days of receiving from Ecology an itemized statement of costs that includes a summary of costs incurred, an identification of involved staff, and the amount of time spent by involved staff members on the project. A general statement of work performed will be provided upon request. Itemized statements shall be prepared quarterly. Pursuant to WAC 173-340-550(4), failure to pay Ecology's costs within ninety (90) days of receipt of the itemized statement of costs will result in interest charges at the rate of twelve percent (12%) per annum, compounded monthly.

In addition to other available relief, pursuant to RCW 19.16.500, Ecology may utilize a collection agency and/or, pursuant to RCW 70.105D.055, file a lien against real property subject to the remedial actions to recover unreimbursed remedial action costs.

B. Designated Project Coordinators

The project coordinator for Ecology is:

Ronald W. Timm
Washington State Department of Ecology
Northwest Regional Office
Toxics Cleanup Program
3190 160th Ave SE
Bellevue, WA 98008

The project coordinators for PLP is:

Carol Wiseman
Weyerhaeuser Company
220 Occidental Avenue South
Seattle, WA 98104

Sandra L. Forman
M.A.P. #2, LLC
805 80th Street SW
Everett, WA 98203

Each project coordinator shall be responsible for overseeing the implementation of this Order. Ecology's project coordinator will be Ecology's designated representative for the Site. To the maximum extent possible, communications between Ecology and PLPs, and all documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Order shall be directed through the project coordinators. The project coordinators may designate, in writing, working level staff contacts for all or portions of the implementation of the work to be performed required by this Order.

Any party may change its respective project coordinator. Written notification shall be given to the other party at least ten (10) calendar days prior to the change.

C. Performance

All geologic and hydrogeologic work performed pursuant to this Order shall be under the supervision and direction of a geologist or hydrogeologist licensed by the State of Washington or under the direct supervision of an engineer registered by the State of Washington, except as otherwise provided for by RCW 18.43 and 18.220.

All engineering work performed pursuant to this Order shall be under the direct supervision of a professional engineer registered by the State of Washington, except as otherwise provided for by RCW 18.43.130.

All construction work performed pursuant to this Order shall be under the direct supervision of a professional engineer or a qualified technician under the direct supervision of a professional engineer. The professional engineer must be registered by the State of Washington, except as otherwise provided for by RCW 18.43.130.

Any documents submitted containing geologic, hydrogeologic, or engineering work shall be under the seal of an appropriately licensed professional as required by RCW 18.43 and 18.220.

PLPs shall notify Ecology in writing of the identity of any engineer(s) and geologist(s), contractor(s) and subcontractor(s), and others to be used in carrying out the terms of this Order, in advance of their involvement at the Site.

D. Access

Ecology or any Ecology authorized representative shall have access to enter and freely move about all property at the Site that PLPs either owns, controls, or has access rights to at all reasonable times for the purposes of, *inter alia*: inspecting records, operation logs, and contracts related to the work being performed pursuant to this Order; reviewing PLP's progress in carrying out the terms of this Order; conducting such tests or collecting such samples as Ecology may deem necessary; using a camera, sound recording, or other documentary type equipment to record work done pursuant to this Order; and verifying the data submitted to Ecology by PLPs. PLPs shall make all reasonable efforts to secure access rights for those properties within the Site not owned or

controlled by PLPs where remedial activities or investigations will be performed pursuant to this Order. Ecology or any Ecology authorized representative shall give reasonable notice before entering any Site property owned or controlled by PLPs unless an emergency prevents such notice. All persons who access the Site pursuant to this section shall comply with any applicable health and safety plan(s). Ecology employees and their representatives shall not be required to sign any liability release or waiver as a condition of Site property access.

E. Sampling, Data Submittal, and Availability

With respect to the implementation of this Order, PLPs shall make the results of all sampling, laboratory reports, and/or test results generated by it or on its behalf available to Ecology. Pursuant to WAC 173-340-840(5), all sampling data shall be submitted to Ecology in both printed and electronic formats in accordance with Section VII (Work to be Performed), Ecology's Toxics Cleanup Program Policy 840 (Data Submittal Requirements), and/or any subsequent procedures specified by Ecology for data submittal.

If requested by Ecology, PLPs shall allow Ecology and/or its authorized representative to take split or duplicate samples of any samples collected by PLPs pursuant to implementation of this Order. PLPs shall notify Ecology seven (7) days in advance of any sample collection or work activity at the Site. Ecology shall, upon request, allow PLPs and/or its authorized representative to take split or duplicate samples of any samples collected by Ecology pursuant to the implementation of this Order, provided that doing so does not interfere with Ecology's sampling. Without limitation on Ecology's rights under Section VIII.E (Access), Ecology shall notify PLPs prior to any sample collection activity unless an emergency prevents such notice.

In accordance with WAC 173-340-830(2)(a), all hazardous substance analyses shall be conducted by a laboratory accredited under WAC 173-50 for the specific analyses to be conducted, unless otherwise approved by Ecology.

F. Public Participation

A Public Participation Plan is required for this Site. Ecology shall review any existing Public Participation Plan to determine its continued appropriateness and whether it requires amendment, or if no plan exists, Ecology shall develop a Public Participation Plan alone or in conjunction with PLPs.

Ecology shall maintain the responsibility for public participation at the Site. However, PLPs shall cooperate with Ecology, and shall:

1. If agreed to by Ecology, develop appropriate mailing lists and prepare drafts of public notices and fact sheets at important stages of the remedial action, such as the submission of work plans, remedial investigation/feasibility study reports, cleanup action plans, and engineering design reports. As appropriate, Ecology will edit, finalize, and distribute such fact sheets and prepare and distribute public notices of Ecology's presentations and meetings.
2. Notify Ecology's project coordinator prior to the preparation of all press releases and fact sheets, and before meetings related to remedial action work to be performed at the Site with the interested public and/or local governments. Likewise, Ecology shall notify PLPs prior to the issuance of all press releases and fact sheets related to the Site, and before meetings related to the Site with the interested public and local governments. For all press releases, fact sheets, meetings, and other outreach efforts by PLP that do not receive prior Ecology approval, PLPs shall clearly indicate to its audience that the press release, fact sheet, meeting, or other outreach effort was not sponsored or endorsed by Ecology.
3. When requested by Ecology, participate in public presentations on the progress of the remedial action at the Site. Participation may be through attendance at public meetings to assist in answering questions or as a presenter.

4. When requested by Ecology, arrange and/or continue information repositories to be located at the following locations:

- a. Everett Public Library
2702 Hoyt Ave.
Everett, WA
- b. Ecology's Northwest Regional Office
3190 160th Ave SE
Bellevue, WA

At a minimum, copies of all public notices, fact sheets, and documents relating to public comment periods shall be promptly placed in these repositories. A copy of all documents related to this Site shall be maintained in the repository at Ecology's Northwest Regional Office in Bellevue, Washington.

G. Retention of Records

During the pendency of this Order, and for ten (10) years from the date of completion of work performed pursuant to this Order, PLPs shall preserve all records, reports, documents, and underlying data in its possession relevant to the implementation of this Order and shall insert a similar record retention requirement into all contracts with project contractors and subcontractors. Upon request of Ecology, PLPs shall make all records available to Ecology and allow access for review within a reasonable time.

Nothing in this Order is intended to waive any right PLPs may have under applicable law to limit disclosure of documents protected by the attorney work-product privilege and/or the attorney-client privilege. If PLPs withhold any requested records based on an assertion of privilege, PLPs shall provide Ecology with a privilege log specifying the records withheld and the applicable privilege. No Site-related data collected pursuant to this Order shall be considered privileged.

H. Resolution of Disputes

1. In the event that PLPs elects to invoke dispute resolution PLPs must utilize the procedure set forth below.

a. Upon the triggering event (receipt of Ecology's project coordinator's written decision or an itemized billing statement), PLPs have fourteen (14) calendar days within which to notify Ecology's project coordinator in writing of its dispute (Informal Dispute Notice).

b. The Parties' project coordinators shall then confer in an effort to resolve the dispute informally. The parties shall informally confer for up to fourteen (14) calendar days from receipt of the Informal Dispute Notice. If the project coordinators cannot resolve the dispute within those 14 calendar days, then within seven (7) calendar days Ecology's project coordinator shall issue a written decision (Informal Dispute Decision) stating: the nature of the dispute; the PLPs position with regards to the dispute; Ecology's position with regards to the dispute; and the extent of resolution reached by informal discussion.

c. PLPs may then request regional management review of the dispute. This request (Formal Dispute Notice) must be submitted in writing to the Northwest Region Toxics Cleanup Section Manager within seven (7) calendar days of receipt of Ecology's Informal Dispute Decision. The Formal Dispute Notice shall include a written statement of dispute setting forth: the nature of the dispute; the disputing Party's position with respect to the dispute; and the information relied upon to support its position.

d. The Section Manager shall conduct a review of the dispute and shall issue a written decision regarding the dispute (Decision on Dispute) within thirty (30) calendar days of receipt of the Formal Dispute Notice. The Decision on Dispute shall be Ecology's final decision on the disputed matter.

2. The Parties agree to only utilize the dispute resolution process in good faith and agree to expedite, to the extent possible, the dispute resolution process whenever it is used.

3. Implementation of these dispute resolution procedures shall not provide a basis for delay of any activities required in this Order, unless Ecology agrees in writing to a schedule extension.

4. In case of a dispute, failure to either proceed with the work required by this Order or timely invoke dispute resolution may result in Ecology's determination that insufficient progress is being made in preparation of a deliverable, and may result in Ecology undertaking the work under Section VII.E (Work to be Performed) or initiating enforcement under Section X (Enforcement).

I. Extension of Schedule

1. PLPs request for an extension of schedule shall be granted only when a request for an extension is submitted in a timely fashion, generally at least thirty (30) days prior to expiration of the deadline for which the extension is requested, and good cause exists for granting the extension. All extensions shall be requested in writing. The request shall specify:

- a. The deadline that is sought to be extended.
- b. The length of the extension sought.
- c. The reason(s) for the extension.
- d. Any related deadline or schedule that would be affected if the extension were granted.

2. The burden shall be on PLPs to demonstrate to the satisfaction of Ecology that the request for such extension has been submitted in a timely fashion and that good cause exists for granting the extension. Good cause may include, but may not be limited to:

- a. Circumstances beyond the reasonable control and despite the due diligence of PLPs including delays caused by unrelated third parties or Ecology, such as (but not limited to) delays by Ecology in reviewing, approving, or modifying documents submitted by PLPs.
- b. Acts of God, including fire, flood, blizzard, extreme temperatures, storm, or other unavoidable casualty.
- c. Endangerment as described in Section VIII.K (Endangerment).

However, neither increased costs of performance of the terms of this Order nor changed economic circumstances shall be considered circumstances beyond the reasonable control of PLPs.

3. Ecology shall act upon any PLPs written request for extension in a timely fashion. Ecology shall give PLPs written notification of any extensions granted pursuant to this Order. A requested extension shall not be effective until approved by Ecology. Unless the extension is a substantial change, it shall not be necessary to amend this Order pursuant to Section VIII.J (Amendment of Order) when a schedule extension is granted.

4. At PLPs request, an extension shall only be granted for such period of time as Ecology determines is reasonable under the circumstances. Ecology may grant schedule extensions exceeding ninety (90) days only as a result of one of the following:

- a. Delays in the issuance of a necessary permit which was applied for in a timely manner.
- b. Other circumstances deemed exceptional or extraordinary by Ecology.
- c. Endangerment as described in Section VIII.K (Endangerment).

J. Amendment of Order

The project coordinators may verbally agree to minor changes to the work to be performed without formally amending this Order. Minor changes will be documented in writing by Ecology within seven (7) days of verbal agreement.

Except as provided in Section VIII.L (Reservation of Rights), substantial changes to the work to be performed shall require formal amendment of this Order. This Order may only be formally amended by the written consent of both Ecology and PLPs. Ecology will provide its written consent to a formal amendment only after public notice and opportunity to comment on the formal amendment.

When requesting a change to the Order, PLPs shall submit a written request to Ecology for approval. Ecology shall indicate its approval or disapproval in writing and in a timely manner after the written request is received. If Ecology determines that the change is substantial, then the Order

must be formally amended. Reasons for the disapproval of a proposed change to this Order shall be stated in writing. If Ecology does not agree to a proposed change, the disagreement may be addressed through the dispute resolution procedures described in Section VIII.H (Resolution of Disputes).

K. Endangerment

In the event Ecology determines that any activity being performed at the Site under this Order is creating or has the potential to create a danger to human health or the environment on or surrounding the Site, Ecology may direct PLPs to cease such activities for such period of time as it deems necessary to abate the danger. PLPs shall immediately comply with such direction.

In the event PLPs determine that any activity being performed at the Site under this Order is creating or has the potential to create a danger to human health or the environment, PLPs may cease such activities. PLPs shall notify Ecology's project coordinator as soon as possible, but no later than twenty-four (24) hours after making such determination or ceasing such activities. Upon Ecology's direction, PLPs shall provide Ecology with documentation of the basis for the determination or cessation of such activities. If Ecology disagrees with PLP's cessation of activities, it may direct PLPs to resume such activities.

If Ecology concurs with or orders a work stoppage pursuant to this section, PLP's obligations with respect to the ceased activities shall be suspended until Ecology determines the danger is abated, and the time for performance of such activities, as well as the time for any other work dependent upon such activities, shall be extended in accordance with Section VIII.I (Extension of Schedule) for such period of time as Ecology determines is reasonable under the circumstances.

Nothing in this Order shall limit the authority of Ecology, its employees, agents, or contractors to take or require appropriate action in the event of an emergency.

L. Reservation of Rights

This Order is not a settlement under RCW 70.105D. Ecology's signature on this Order in no way constitutes a covenant not to sue or a compromise of any of Ecology's rights or authority. Ecology will not, however, bring an action against PLPs to recover remedial action costs paid to and received by Ecology under this Order. In addition, Ecology will not take additional enforcement actions against PLP regarding remedial actions required by this Order, provided PLPs comply with this Order.

Ecology nevertheless reserves its rights under RCW 70.105D, including the right to require additional or different remedial actions at the Site should it deem such actions necessary to protect human health or the environment, and to issue orders requiring such remedial actions. Ecology also reserves all rights regarding the injury to, destruction of, or loss of natural resources resulting from the release or threatened release of hazardous substances at the Site.

By entering into this Order, PLPs does not admit to any liability for the Site. Although PLPs are committing to conducting the work required by this Order under the terms of this Order, PLPs expressly reserves all rights available under law, including but not limited to the right to seek cost recovery or contribution against third parties, and the right to assert any defenses to liability in the event of enforcement.

M. Transfer of Interest in Property

No voluntary conveyance or relinquishment of title, easement, leasehold, or other interest in any portion of the Site shall be consummated by PLPs without provision for continued implementation of all requirements of this Order and implementation of any remedial actions found to be necessary as a result of this Order.

Prior to PLP's transfer of any interest in all or any portion of the Site, and during the effective period of this Order, PLPs shall provide a copy of this Order to any prospective purchaser, lessee, transferee, assignee, or other successor in said interest; and, at least thirty (30) days prior to any transfer, PLPs shall notify Ecology of said transfer. Upon transfer of any interest, PLPs shall

notify all transferees of the restrictions on the activities and uses of the property under this Order and incorporate any such use restrictions into the transfer documents.

N. Compliance with Applicable Laws

1. *Applicable Laws.* All actions carried out by PLPs pursuant to this Order shall be done in accordance with all applicable federal, state, and local requirements, including requirements to obtain necessary permits or approvals, except as provided in RCW 70.105D.090. At this time, no federal, state, or local requirements have been identified as being applicable to the actions required by this Order. PLPs have a continuing obligation to identify additional applicable federal, state, and local requirements which apply to actions carried out pursuant to this Order, and to comply with those requirements. As additional federal, state, and local requirements are identified by Ecology or PLPs, Ecology will document in writing if they are applicable to actions carried out pursuant to this Order, and PLPs must implement those requirements.

2. *Relevant and Appropriate Requirements.* All actions carried out by PLPs pursuant to this Order shall be done in accordance with relevant and appropriate requirements identified by Ecology. At this time, no relevant and appropriate requirements have been identified as being applicable to the actions required by this Order. If additional relevant and appropriate requirements are identified by Ecology or PLPs, Ecology will document in writing if they are applicable to actions carried out pursuant to this Order and PLPs must implement those requirements.

3. Pursuant to RCW 70.105D.090(1), PLPs may be exempt from the procedural requirements of RCW 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 and of any laws requiring or authorizing local government permits or approvals. However, PLPs shall comply with the substantive requirements of such permits or approvals. For permits and approvals covered under RCW 70.105D.090(1) that have been issued by local government, the Parties agree that Ecology has the non-exclusive ability under this Order to enforce those local government permits and/or approvals. At this time, no state or local permits or approvals have been identified as being applicable but procedurally exempt under this section.

4. PLPs have a continuing obligation to determine whether additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under this Order. In the event either Ecology or PLPs determine that additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under this Order, it shall promptly notify the other party of its determination. Ecology shall determine whether Ecology or PLPs shall be responsible to contact the appropriate state and/or local agencies. If Ecology so requires, PLPs shall promptly consult with the appropriate state and/or local agencies and provide Ecology with written documentation from those agencies of the substantive requirements those agencies believe are applicable to the remedial action. Ecology shall make the final determination on the additional substantive requirements that must be met by PLPs and on how PLPs must meet those requirements. Ecology shall inform PLPs in writing of these requirements. Once established by Ecology, the additional requirements shall be enforceable requirements of this Order. PLPs shall not begin or continue the remedial action potentially subject to the additional requirements until Ecology makes its final determination.

Pursuant to RCW 70.105D.090(2), in the event Ecology determines that the exemption from complying with the procedural requirements of the laws referenced in RCW 70.105D.090(1) would result in the loss of approval from a federal agency that is necessary for the state to administer any federal law, the exemption shall not apply and PLPs shall comply with both the procedural and substantive requirements of the laws referenced in RCW 70.105D.090(1), including any requirements to obtain permits or approvals

O. Indemnification

PLPs agrees to indemnify and save and hold the State of Washington, its employees, and agents harmless from any and all claims or causes of action (1) for death or injuries to persons, or (2) for loss or damage to property, to the extent arising from or on account of acts or omissions of PLPs, its officers, employees, agents, or contractors in entering into and implementing this Order. However, PLPs shall not indemnify the State of Washington nor save nor hold its employees and

agents harmless from any claims or causes of action to the extent arising out of the negligent acts or omissions of the State of Washington, or the employees or agents of the State, in entering into or implementing this Order.

IX. SATISFACTION OF ORDER

The provisions of this Order shall be deemed satisfied upon PLP's receipt of written notification from Ecology that PLPs have completed the remedial activity required by this Order, as amended by any modifications, and that PLPs have complied with all other provisions of this Agreed Order.

X. ENFORCEMENT

Pursuant to RCW 70.105D.050, this Order may be enforced as follows:

A. The Attorney General may bring an action to enforce this Order in a state or federal court.

B. The Attorney General may seek, by filing an action, if necessary, to recover amounts spent by Ecology for investigative and remedial actions and orders related to the Site.

C. A liable party who refuses, without sufficient cause, to comply with any term of this Order will be liable for:

1. Up to three (3) times the amount of any costs incurred by the State of Washington as a result of its refusal to comply.

2. Civil penalties of up to twenty-five thousand dollars (\$25,000) per day for each day it refuses to comply.

D. This Order is not appealable to the Washington Pollution Control Hearings Board.

This Order may be reviewed only as provided under RCW 70.105D.060.

Effective date of this Order: _____

WEYERHAEUSER COMPANY



Kristen Sawin
VP Corporate and Government Affairs
220 Occidental Ave South
Seattle, WA 98104
(206) 539-4416

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY



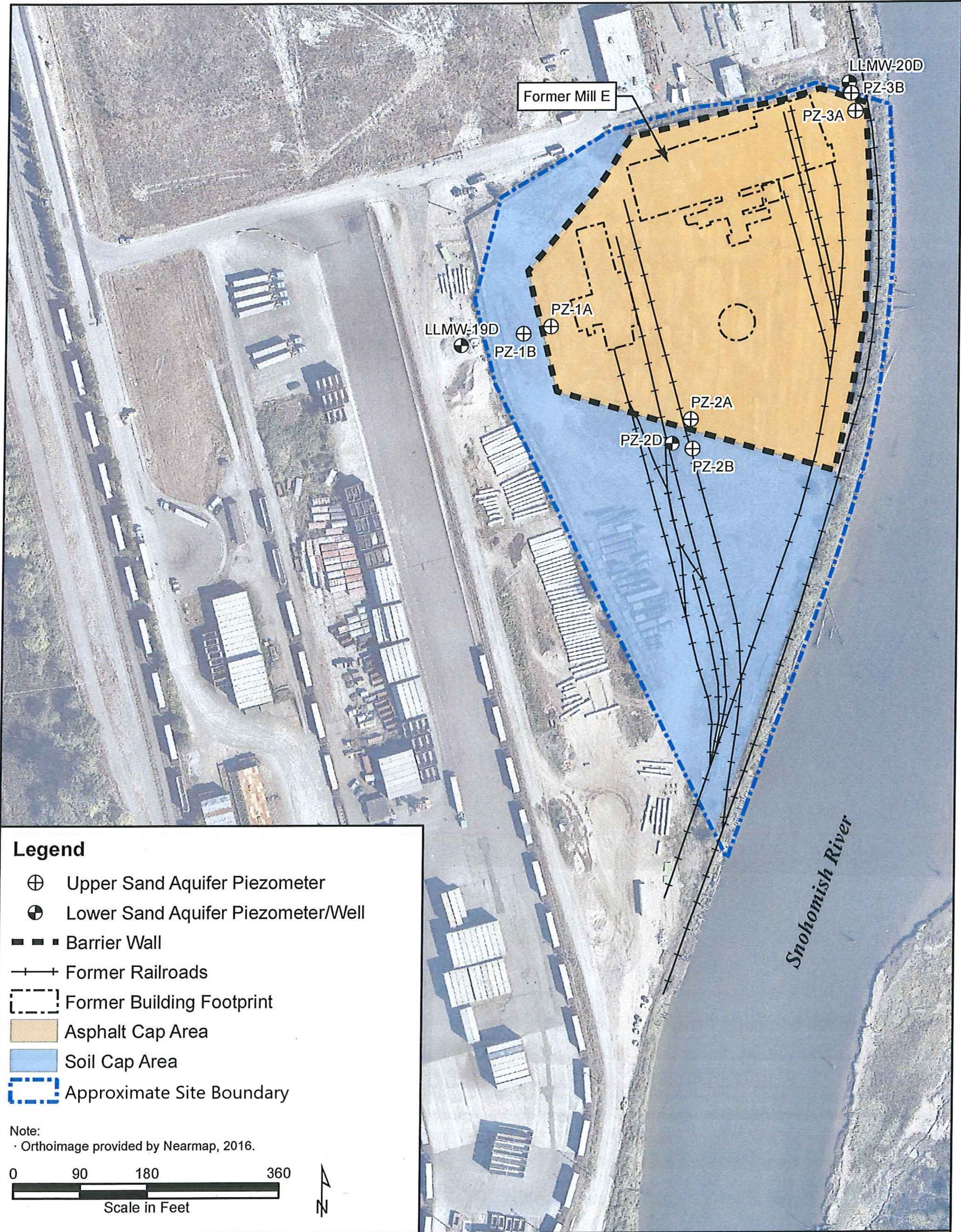
Robert Warren
Section Manager
Toxics Cleanup Program
Northwest Regional Office
425-649-7054

M.A.P. #2, LLC

DATE: August 12, 2020



Sandra L. Forman
805 80th Street SW
Everett, WA 98203
425-337-2700



Legend

- ⊕ Upper Sand Aquifer Piezometer
- ⊗ Lower Sand Aquifer Piezometer/Well
- ■ ■ Barrier Wall
- +— Former Railroads
- ⋯ Former Building Footprint
- Asphalt Cap Area
- Soil Cap Area
- ⋯ Approximate Site Boundary

Note:
· Orthoimage provided by Nearmap, 2016.

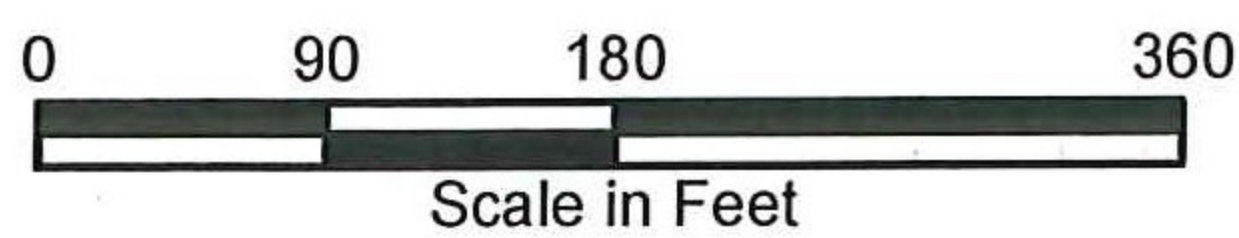


Exhibit B
Former Mill E/Koppers Facility
Supplemental Upland Remedial Investigation Work Plan

This Supplemental Upland Remedial Investigation Work Plan (Work Plan) for the Former Mill E/Koppers Facility in Everett, Washington (Site) will support the requirements of the Agreed Order (AO) under the Model Toxics Control Act (MTCA; Chapter 70.105D RCW), which is executed between the Washington State Department of Ecology (Ecology), Weyerhaeuser, and MAP #2. Figure 1 shows the geographic location of the Site, which is within the boundaries of the Everett Smelter Lowland Area. The surrounding properties are shown on Figure 2, and pertinent Site features, including Site piezometers and monitoring wells, are shown on Figure 3.

BACKGROUND

Weyerhaeuser is a former owner and operator of the Site. In 1946, Weyerhaeuser leased a 6.6-acre portion along the west bank of the Snohomish River to American Lumber and Treating Company (and then Koppers Company), who used the Site for wood treatment until 1963. In 1971, Weyerhaeuser constructed Mill E, a small lumber mill, which operated on the Mill E property until 1984; it was dismantled in 1988. Cleanup actions were completed by Weyerhaeuser in 1999, in accordance with the 1998 Cleanup Action Plan (CAP) and Consent Decree No. 98-2-08718-6 (Consent Decree). Weyerhaeuser sold the property to MAP #2 in 2005 and MAP #2 remains the current owner and operator. The Site is currently vacant and is used for light storage.

In its recent correspondence identified above, Ecology identified both Weyerhaeuser and MAP #2 as potentially liable parties (PLPs) for liability outside of the scope of the Consent Decree. In correspondence dated March 28, 2017, Weyerhaeuser accepted status as a PLP for groundwater at the Site outside the barrier wall and outside of the scope of the Consent Decree, with certain reservations as described in that correspondence.¹ This Work Plan provides a summary of activities completed by Weyerhaeuser and MAP #2 at the Site between 2017 and 2018 to address Ecology's concerns regarding barrier wall performance and the origin of discharges from an unknown outfall, designated as LLO-07, which discharges to the Snohomish River from a location on the southern portion of the Site. This Work Plan also provides proposed additional investigation activities at the Site to evaluate elevated concentrations of arsenic in soil and groundwater in the area of the Site outside the barrier wall and outside of the scope of the Consent Decree.

¹ See also Weyerhaeuser correspondence dated October 20, 2017, May 30, 2018, and August 20, 2018, that further discussed its reservations regarding PLP status.

BARRIER WALL EVALUATION

As part of the remedy selected by Ecology in the Consent Decree and CAP, Weyerhaeuser installed a barrier wall at the Site in 1999. The barrier wall surrounds the contained area of contamination in shallow fill material and an Upper Sand Aquifer, which extend to depths of approximately 6 to 10 feet below ground surface (bgs). The barrier wall is embedded in a low permeability Upper Silt Aquitard below this unit. A Lower Sand Aquifer is present beneath the Upper Silt Aquitard. The containment system, which consists of both a subsurface containment barrier wall and an asphalt cap, is shown on Figure 3.

Two cross-sections (A-A' and B-B') were prepared based on historical documentation for the Site to show the subsurface geology and hydrogeology relative to the barrier wall construction. Cross-section A-A' is oriented west to east across the barrier wall, as shown on Figure 4, and cross-section B-B' is oriented northeast to southeast across the barrier wall, as shown on Figure 5. The locations of the two cross-sections are shown on Figure 3.

Since 1999, Site monitoring has been conducted in accordance with the Performance Compliance Monitoring Plan (PCMP; EMCON 1998) to confirm that the barrier wall is functioning as intended. The purpose of the barrier wall, as outlined in the PCMP, is to hydraulically isolate the major sources of contamination (arsenic, petroleum hydrocarbons, and pentachlorophenol [penta]) in the Upper Sand Aquifer and minimize contaminant migration out of the containment area. The barrier wall was also intended to decrease potential contaminant flux from the Upper Sand Aquifer into the Lower Sand Aquifer and ultimately into the Snohomish River, which is hydraulically connected to the Lower Sand Aquifer.

Weyerhaeuser conducted the PCMP monitoring prior to August 2005, and MAP #2 conducted the monitoring after August 2005. As part of the third 5-year review for the Site (June 2016) and in light of recent data provided in the Everett Smelter Lowland Area *Final Supplemental Remedial Investigation Report* (SRI; GeoEngineers 2016), Ecology indicated that additional data were necessary to confirm that the barrier wall was functioning as intended. In its December 8, 2016, letter, Ecology described additional actions that it believed were necessary to address these concerns; specifically, monitoring of water levels in the Lower Sand Aquifer. Weyerhaeuser developed a PCMP Addendum (Floyd|Snider 2017a) to address Ecology's concerns regarding the performance of the containment system.

In accordance with the PCMP Addendum, Floyd|Snider completed water level monitoring on a quarterly basis to confirm that vertical hydraulic head differences meet performance criteria throughout the seasons. Water level measurements were collected in September 2017, December 2017, March 2018, June 2018, and September 2018, as reported in the 2017 and 2018 Annual Performance and Monitoring Compliance Reports (Floyd|Snider 2017b, 2018a). These additional data confirmed that the containment system is functioning as designed, consistent with remedial goals and performance standards described in the CAP and PCMP; water levels in the Upper Sand Aquifer inside the barrier wall are stable at a decreased level relative to those in the Upper Sand Aquifer outside the barrier wall, as described below.

The horizontal head differences across the barrier wall and vertical head differences inside and outside the barrier wall are used as the primary indicators of the barrier wall's performance to control the hydraulic movement of contaminants. The groundwater elevation of the Upper Sand Aquifer inside the barrier wall was consistently lower than outside the barrier wall for all three piezometer pair locations (PZ-1A/B, PZ-2A/B, and PZ-3A/B). This indicates a positive horizontal head difference that drives potential groundwater flow inward through the barrier wall, to the extent flow occurs through the barrier. In addition, using water elevation measurements for the Lower Sand Aquifer,² the vertical head difference inside the barrier wall was substantially lower (approximately 1 foot) than the vertical head difference outside the barrier wall at all three piezometer pair monitoring locations. These results show that the hydraulic head inside the barrier wall was consistently lower than outside the barrier wall, indicating the barrier wall and asphalt cap are functioning as intended by isolating groundwater horizontally and reducing the downward flux of groundwater and potentially contaminants inside the barrier wall through the Upper Silt Aquitard.

OUTFALL LLO-07 PIPE INVESTIGATION

In its December 8, 2016, and January 27, 2017, letters, Ecology also stated that data collected in 2013 as part of the SRI (GeoEngineers 2016) indicated elevated arsenic concentrations in water discharging from Outfall LLO-07 and elevated concentrations of arsenic and mercury in sediment directly below Outfall LLO-07. The integrity and source of piping discharging at Outfall LLO-07 was not known. As a result, while stating that they were not liable for discharges from Outfall LLO-07, Weyerhaeuser and MAP #2 nevertheless agreed to investigate the unknown source of the outfall.³

Weyerhaeuser and Floyd|Snider researched and reviewed available background documents that could provide information about the outfall and its conveyance pipe. Weyerhaeuser reviewed its own property records, and Floyd|Snider reviewed documents from the City of Everett, Snohomish County, Washington state archives, and Sanborn maps. No record of the outfall or its conveyance pipe were found. Visual inspections of the outfall indicated that it was 12 inches in diameter and it was not screened, which allowed river water and debris to enter the pipe during high tides. The stormwater conveyance pipe is located in an area of the Site that is not currently or historically paved and where stormwater currently and historically infiltrates.

Floyd|Snider performed fieldwork at the Site, at the request of Weyerhaeuser, to investigate Outfall LLO-07 and its associated conveyance piping between February and September 2017. Floyd|Snider, along with its subcontractors and MAP #2, investigated the pipe from Outfall LLO-07 using a combination of technologies (refer to Figure 6). The pipe was initially able to be traced 290 feet from where it discharges at Outfall LLO-07, at which point there was an

² Using data collected outside the barrier wall is an accurate way to determine the potentiometric surface for the Lower Sand Aquifer inside the wall.

³ This section provides a summary of Weyerhaeuser and MAP #2's investigation of outfall LLO-07. Please refer to Weyerhaeuser's March 28, 2017, October 20, 2017, May 30, 2018, and August 20, 2018, correspondence for additional information regarding the LLO-07 investigation.

obstruction in the pipe that could not be bypassed. This obstruction was later determined to be a wooden junction box, which was approximately 40 feet from the western property line. Stormwater was observed flowing into the junction box from the upstream conveyance pipe. A stormwater sample was collected for analysis, and the results indicated that arsenic was present at a concentration of 154 micrograms per liter ($\mu\text{g/L}$). The conveyance pipe was subsequently traced in a westerly direction from inside the junction box to just before the property line. The pipe was exposed via potholing at this location (at the western property boundary) and was confirmed to be intact with no visible signs of damage or obstruction. This was the farthest this pipe could be exposed without crossing the property line or undermining the property line fence. Based upon the visual observation of the pipe, Floyd|Snider concluded there is sufficient evidence to reasonably infer that this pipe crosses the property line intact and drains, or previously drained, an unknown area away from and off of the property. The origin of the pipe remains unknown. Additional details regarding this pipe investigation are provided in a December 2017 technical memorandum, *Revised Pipe Exploration Summary for Storm Drain Associated with Outfall LLO-07* (Floyd|Snider 2017c).

MAP #2 subsequently abandoned the pipe on its property in coordination with Ecology and the adjacent property owner, the Port of Everett, in order to eliminate the inflow of stormwater into the storm drain pipe from an unknown, off-property upland source and to prevent further discharge of stormwater from Outfall LLO-07. In addition, the junction box that was identified on the Site as part of pipe investigation activities was also abandoned at the same time. Three locations along the storm drain pipe alignment were selected to be plugged: (1) at the western property boundary to eliminate inflow of stormwater onto the Site property, (2) at the junction box, and (3) near Outfall LLO-07 to eliminate discharge. Additional details regarding the pipe abandonment are included in a May 2018 technical memorandum, *Storm Drain Pipe Abandonment Associated with Outfall LLO-07 at the Former Mill E/Koppers Facility* (Floyd|Snider 2018b).

EXISTING SITE SOIL AND GROUNDWATER DATA

Remedial investigation activities for the Site were completed in the early 1990s, as summarized in the *Draft Remedial Investigation Report* (EMCON 1994). The barrier wall was installed in 1999 in accordance with the CAP and Consent Decree and is functioning as intended, based on routine PCMP data collection, to provide containment of contaminated soil and groundwater within the wall. More recent data were collected in 2013 in the vicinity of the Site (and on the Site) as part of the SRI for the Everett Smelter Lowland Area (GeoEngineers 2016). The locations of soil and groundwater investigation locations at the Site and in the immediate vicinity of the Site are shown on Figure 7.

Available data show that arsenic concentrations in soil and groundwater outside the barrier wall at the Site exceed MTCA Method A cleanup levels (CULs) in soil for Unrestricted Land Use (WAC 173-340-900, Table 740-1) and MTCA Method A CULs in groundwater (WAC 173-340-900, Table 720-1). Exceedances in some cases are greater than the Site CUL established in the

Consent Decree for inside the barrier wall.⁴ Arsenic concentrations in soil are shown on Figure 8, and arsenic concentrations in groundwater are shown on Figure 9 (Upper Sand Aquifer) and Figure 10 (Lower Sand Aquifer).

PROPOSED CURRENT CONDITIONS EVALUATION SAMPLING AND ANALYSIS PLAN

Additional soil and groundwater data collection is proposed to evaluate current conditions outside the barrier wall at the Site, as summarized in Table 1 and described in the sections below. The primary objectives of the proposed investigation are as follows:

- Assess current arsenic concentrations in soil and groundwater in both the Upper and Lower Sand Aquifers outside the barrier wall. This will be accomplished by installing additional Upper and Lower Sand Aquifer monitoring wells and collecting groundwater data from existing and new Site monitoring wells and piezometers and from Everett Smelter Lowland Area monitoring wells in the immediate vicinity of the Site. Additional soil data will be collected as described in the Proposed Soil Quality Evaluation section below to evaluate arsenic concentrations that may be impacting groundwater concentrations or exceeding Mill E Site CULs for soil as defined in the Consent Decree.
- Evaluate current conditions for groundwater in the Upper Sand Aquifer inside the barrier wall, including groundwater sample collection from existing piezometers for arsenic, total petroleum hydrocarbons (TPH), and penta.
- Evaluate current conditions for soil and groundwater in the vicinity of Outfall LLO-07 pipe alignment south of the barrier wall, including groundwater near former monitoring well HC-3.
- Assess Site groundwater flow directions and horizontal gradients for both the Upper and Lower Sand Aquifers, and vertical gradients between the aquifers.
- Collect geochemical parameters from soil and groundwater samples to evaluate arsenic fate and transport and to better understand natural geochemical conditions and determine if naturally reducing conditions are present.

Proposed Monitoring Well Installation

Ecology's December 2016 letter indicated that the 5 µg/L CUL for arsenic in groundwater does not appear to be met at the point of compliance (POC) at the Snohomish River. In order to evaluate arsenic concentrations at the conditional POC (CPOC; where groundwater discharges to

⁴ It is important to note that the barrier wall was designed to contain the most significant source of soil contamination (arsenic, petroleum hydrocarbons, and penta) and did not contain all source soil with contamination present at concentrations greater than Site CULs. Arsenic contamination in soil and groundwater greater than the Site CUL remains present outside the barrier wall and is not a new condition. The Site CUL for arsenic defined in the CAP applies only to "within the area of the containment wall."

surface water), a series of shoreline monitoring wells in both the Upper and Lower Sand Aquifers are proposed. Refer to Figure 11 for proposed monitoring well locations.

A total of nine Upper Sand Aquifer monitoring wells are proposed as follows:

- Six monitoring wells (MW-01S through MW-06S) will be installed along the shoreline at the CPOC to evaluate groundwater quality in the Upper Sand Aquifer where groundwater discharges to surface water. Two of these proposed locations (MW-02S and MW-03S) were requested by Ecology and are located between the barrier wall and the bulkhead wall in a possible stagnation zone that may not be representative of Upper Sand Aquifer groundwater discharging through the bulkhead to the Snohomish River. Groundwater in this area may be both isolated from the rest of the Upper Sand Aquifer at the Site and not appreciably discharging to the river, because groundwater flow paths are disrupted by the barrier wall, hydraulic gradients are flat, and flushing from upgradient groundwater flow and precipitation infiltration are significantly reduced.⁵
- Three monitoring wells (MW-05S, MW-07S, and MW-08S) will be installed south of the barrier wall to evaluate groundwater quality in the Upper Sand Aquifer south of the containment system and along the alignment of the LLO-07 conveyance pipe, including along the western property boundary (one of the three, MW-05S, is also a shoreline well as described in the bullet above).
- One monitoring well (MW-09S) will be installed in the northwest portion of the Site, to evaluate groundwater quality in the Upper Sand Aquifer upgradient of piezometer PZ-3B, which had arsenic concentrations ranging from 5.8 to 31 µg/L in 2013.

A total of 10 Lower Sand Aquifer monitoring wells are proposed as follows:

- Six monitoring wells (MW-01D through MW-06D) will be installed along the shoreline at the CPOC to evaluate groundwater quality in the Lower Sand Aquifer where groundwater discharges to surface water.
- One monitoring well (MW-07D) will be installed along the central alignment of the LLO-07 stormwater pipe to evaluate Lower Sand Aquifer groundwater quality and to evaluate vertical and horizontal gradients.
- One monitoring well (MW-08D) will be installed south of the barrier wall along the western property boundary, to evaluate groundwater quality in the Lower Sand Aquifer on the upgradient portion of the Site in this area.
- One monitoring well (MW-09D) will be installed in the northwest portion of the Site, to evaluate groundwater quality in the Lower Sand Aquifer upgradient of

⁵ The Upper Sand Aquifer, because of its elevation, occurrence in fill material above the native tideflat, and the shoreline bulkhead, is not strongly connected hydraulically with the Snohomish River, based on limited tidal influence, although it may discharge to seeps that drain to the Snohomish River during low tides. The area between the barrier wall and bulkhead is expected to be a stagnation zone.

Everett Smelter Lowland Site monitoring well LLMW-20D, which had arsenic concentrations ranging from 8.7 to 34 µg/L in 2013.

- One monitoring well (MW-10D) will be installed adjacent to existing Upper Sand Aquifer piezometer PZ-1B in order to provide a closer and onsite compliance monitoring point in the Lower Sand Aquifer for routine PCMP water level monitoring. Everett Smelter Lowland Site monitoring well LLMW-19D, which is approximately 90 feet west of PZ-1B is currently monitored. This monitoring well will also provide groundwater quality data immediately outside the barrier wall and downgradient of LLMW-19D, which had elevated arsenic concentrations (approximately 40 µg/L) in 2013.

Monitoring well construction and development will be performed in accordance with the Floyd|Snider monitoring well construction and development standard guidelines included in Attachment 1. A 2-inch-diameter polyvinyl chloride well with a 5- or 10-foot-long screen will be installed at each proposed location using sonic drilling methods. Soil core will be collected continuously during monitoring well installation and logged to identify the location and thickness of the Upper Silt Aquitard. Soil samples that will be collected for analysis are described in the soil quality evaluation section below.

For Upper Sand Aquifer monitoring well installation, the field geologist will direct the drill rig to be advanced to collect soil core in short (approximately 1 foot) increments as the approximate depth of the contact with the Upper Silt Aquitard, until the aquitard is identified, to minimize penetration of the aquitard. For Lower Sand Aquifer monitoring well installation, appropriate drilling methods will be used to prevent cross-contamination of the Lower Sand Aquifer. If necessary, casing will be advanced into the aquitard to create a seal, and the remainder of the borehole will be drilled through the casing. Upper Sand Aquifer monitoring wells will be constructed with screens set to be consistent with existing Upper Sand Aquifer monitoring wells and extending to approximately at the upper contact of the Upper Sand Aquifer and Upper Silt Aquitard (approximately 5 to 10 feet bgs). Lower Sand Aquifer monitoring wells will be set consistent with existing Lower Sand Aquifer monitoring wells and immediately below the aquitard (approximately 15 to 25 feet bgs). The screened interval will be determined in the field based on field observations (i.e., depth and thickness of the Upper Silt Aquitard) and will be designed to be representative of the targeted aquifer. Wells will be completed with either flush-mounted monuments or standpipes based on their location.

Following installation, monitoring wells will be developed to remove fine-grained material by purging with a submersible pump and surging with the pump or a surge block in order to move water through the sand pack and surrounding soil formation. Wells will be developed until the purge water achieves visual clarity. Existing wells will also be evaluated for the presence of excessive sedimentation (i.e., greater than 0.05 feet of accumulated material) and may be redeveloped if necessary, to remove accumulated fine-grained material prior to groundwater sample collection. Excess soil and purge water will be collected in 55-gallon drums as

investigation derived waste (IDW) and will be temporarily stored on site pending waste characterization and offsite disposal.

All new monitoring wells will subsequently be surveyed and tied into the existing network to facilitate evaluation of groundwater elevation and preparation of contour maps.

Proposed Soil Boring Locations

In addition to soil data collection as part of monitoring well installation described above, additional shallow soil borings are proposed to evaluate current soil quality outside the barrier wall and to evaluate if current soil quality may be adversely impacting groundwater quality at the Site. Refer to Figure 11 for proposed soil boring locations.

A total of five soil borings are proposed as follows:

- Four soil borings will be advanced in the soil cap area south of the barrier wall; three north of LLO-07 pipe (SB-101, SB-102, and SB-103) and one south of the pipe (SB-104) to evaluate current soil conditions.
- One soil boring (SB-100) will be advanced northwest of and adjacent to the barrier wall to evaluate current soil conditions immediately outside the barrier wall and in an area where elevated arsenic in the Upper Sand Aquifer has been detected (at location PZ-1B).

Soil borings will be advanced using sonic or direct-push drilling methods, and soil core will be collected continuously until the Upper Silt Aquitard is observed. The field geologist will direct the drill or direct-push rig to be advanced to collect soil core in short (approximately 1 foot) increments as the approximate depth of the contact with the Upper Silt Aquitard, until the aquitard is identified, to minimize penetration of the aquitard. Soil samples will be logged and collected in accordance with Floyd|Snider's standard guidelines included in Attachment 1. Excess soil will be collected in 55-gallon drums as IDW and will be temporarily stored on site pending waste characterization and offsite disposal. All soil boring locations will subsequently be surveyed to document their location.

Proposed Soil Quality Evaluation

Existing data indicate that the majority of arsenic detected in soil outside the barrier wall is less than the Site CUL for arsenic of 200 milligrams per kilogram specified in the CAP (refer to Figure 8).

Additional soil arsenic data will be collected during the installation of Upper Sand Aquifer monitoring wells and soil borings south of the barrier wall and along the Outfall LLO-07 pipe alignment and northwest of the barrier wall to evaluate arsenic levels in soil around the containment system and in the vicinity of the pipe. Field investigation activities indicated that the conveyance pipe is located between 5.5 and 8 feet bgs as it traverses the Site west to east (it is deepest just before the outfall). There was also a minimum of 1 foot of clean soil placed outside

the barrier wall during remedial construction activities in 1999 (refer to soil cap area on Figure 3). Many previous test pits and soil borings that were sampled for arsenic were generally very shallow (i.e., less than 3 feet bgs), and additional data are necessary to evaluate the vertical extent of arsenic in soil outside the barrier wall. Therefore, additional soil data will be collected between 2 and 10 feet bgs to evaluate arsenic concentrations in shallow soils.

Soil samples will be collected from the continuously collected soil core in 2-foot intervals from the ground surface to the upper contact with the Upper Silt Aquitard or 10 feet bgs, whichever comes first. Soil samples will initially be selected for arsenic analysis from selected intervals of the Upper Sand Aquifer based on the location and surrounding data density and depths to fill in data gaps. Soil samples that are not selected for initial laboratory analysis of arsenic will be archived at the laboratory in the event that additional data are needed to define the vertical extent of arsenic in soil. Additional analyses will be performed as needed based on the initial results.

Soil samples will also be collected for analyses of iron, manganese, sulfide, and total organic carbon to evaluate the variability in aquifer minerals that affect fate and transport of arsenic.

Proposed Groundwater Quality Evaluation

The proposed groundwater quality evaluation will consist of the collection and laboratory analyses of groundwater samples as follows:

- Existing Site Upper Sand Aquifer piezometers located inside the barrier wall (PZ-1A, PZ-2A, and PZ-3A) for arsenic (total and dissolved), TPH by NWTPH-Gx and NWTPH-Dx, and penta by USEPA Method 8270.
- Existing Site Upper Sand Aquifer piezometers located outside the barrier wall (PZ-1B, PZ-2B, and PZ-3B) for arsenic (total and dissolved).
- Existing Site Lower Sand Aquifer piezometer located outside the barrier wall (PZ-2D) for arsenic (total and dissolved).
- Existing Everett Smelter Lowland Site Upper Sand Aquifer monitoring wells (LLMW-18S and LLMW-21S) for arsenic (total and dissolved).
- Existing Everett Smelter Lowland Site Lower Sand Aquifer monitoring wells (LLMW-18D, LLMW-19D, LLMW-20D, and LLMW-21D) for arsenic (total and dissolved).
- New proposed Upper and Lower Sand Aquifer monitoring wells for arsenic (total and dissolved).

Groundwater samples will be collected using standard low-flow sampling methods in accordance with the Floyd|Snider standard guidelines (included in Attachment 1), and field measurements for pH, temperature, dissolved oxygen, oxygen reduction potential, and specific conductivity will be collected.

The depth to groundwater will be recorded at each location prior to groundwater sample collection. Two comprehensive groundwater monitoring events are proposed to evaluate seasonal data variability and flow patterns, one during the wet season (October through April) and one during the dry season (May through September). Groundwater samples will be collected from the Lower Sand Aquifer monitoring wells during a low tide to minimize tidal interference⁶ and collect samples representative of groundwater discharging to surface water. Refer to Figure 11 for proposed soil and groundwater investigation locations.

Groundwater samples will also be collected for analyses of major cations (calcium, magnesium, potassium, and sodium), major anions (bromide, chloride, fluoride, and sulfate), alkalinity (dissolved), major ions (ortho-phosphate), nitrate, nitrite, iron (dissolved), manganese (dissolved), sulfide (dissolved), and organic carbon (total and dissolved) to evaluate potential natural variability of geochemical conditions that affect fate and transport of arsenic.

Quality Assurance Project Plan

The Quality Assurance Project Plan included in Attachment 2 describes the analytical program to be conducted for each sample selected for chemical analysis, as well as the laboratory quality assurance objectives and quality control procedures required to be met to achieve technically sound and useable data.

Contingency Discussion

Weyerhaeuser has proposed the installation of 19 additional monitoring wells (9 in the Upper Sand Aquifer and 10 in the Lower Sand Aquifer) as part of this Work Plan and believes the additional data collection will provide sufficient information to evaluate groundwater quality at the Site.

The Lower Sand Aquifer groundwater flow is not restricted by the barrier wall (the barrier wall is keyed into the Upper Silt Aquitard above the Lower Sand Aquifer), and, therefore, collection of groundwater data immediately adjacent to and outside the wall can provide adequate information regarding the nature and extent of arsenic in the Lower Sand Aquifer. In particular, the proposed data collection program includes several locations along the shoreline to assess groundwater prior to the point of discharge to the Snohomish River (the groundwater POC). If data gaps remain after the completion of additional investigation activities described in this Work Plan, then they would be addressed in a Supplemental Remedial Investigation/Focused Feasibility Study Work Plan (SRI/FFS Work Plan) that would be developed to address these data gaps, after consultation with Ecology.

⁶ Floyd|Snider conducted a baseline groundwater level evaluation in 2017 to determine the tidal influence in the vicinity of the barrier wall. All accessible locations were measured for a full tide cycle. Tidal influence was noted in all measured Lower Sand Aquifer monitoring wells and was not noted in Upper Sand Aquifer piezometers. Transducers will be used in selected wells as part of this proposed investigation to supplement existing data to determine which wells will require sample collection at low tide.

Lastly, analyses of geochemical parameters in soil and groundwater are proposed as part of this Work Plan to provide a better understanding of site-specific subsurface geochemical conditions and will be used to evaluate fate and transport of arsenic at the Site. If the additional data collected as part of this Work Plan warrant additional geochemical analyses or arsenic speciation to better understand fate and transport, then it would be addressed as Phase 2 in the SRI/FFS Work Plan that would be submitted after consultation with Ecology.

NEXT STEPS

The proposed field investigation would be initiated within 30 days of the effective date of the AO, per Exhibit C of the AO.

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- Washington State Department of Ecology (Ecology). 2016. *Re: Weyerhaeuser Mill E – Need for additional remedial action*. Letter from David South, Ecology, to Carol Wiseman, Weyerhaeuser Company, and Sandra L. Forman, M.A.P. #2, LLC. 8 December.
- _____. 2017. *Re: Preliminary Determination of Liability for Release of Hazardous Substances at the following Contaminated Site*. Letter from David South, Ecology, to Carol Wiseman, Weyerhaeuser Company. 27 January.
- _____. 2018. *Re: Final Determination of Liability for Release of Hazardous Substances at the following Contaminated Site*. Letter from Robert Warren, Ecology, to Carol Wiseman, Weyerhaeuser Company. 19 November.

LIST OF ATTACHMENTS

Table 1	Proposed Supplemental Upland Field Investigation
Figure 1	Site Location
Figure 2	Site and Surrounding Properties
Figure 3	Site Features and Site Monitoring Network
Figure 4	Cross-Section A-A'
Figure 5	Cross-Section B-B'
Figure 6	Stormwater Features and LLO-07 Pipe Investigation Details
Figure 7	Soil and Groundwater Investigation Locations
Figure 8	Arsenic in Soil
Figure 9	Arsenic in Groundwater—Upper Sand Aquifer
Figure 10	Arsenic in Groundwater—Lower Sand Aquifer
Figure 11	Proposed Soil and Groundwater Investigation Locations
Attachment 1	Floyd Snider Standard Guidelines
Attachment 2	Quality Assurance Project Plan

Table

**Table 1
Proposed Supplemental Upland Field Investigation**

Location ID ⁽¹⁾	Purpose/Objectives	Sample Collection ⁽²⁾	Laboratory Analysis ^(3,4,5,6)
Proposed Groundwater Monitoring Wells			
MW-01S through MW-06S	<ul style="list-style-type: none"> Evaluate groundwater quality in the Upper Sand Aquifer along the shoreline 	<ul style="list-style-type: none"> Groundwater (wet and dry season) Soil 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-05S, MW-07S, MW-08S	<ul style="list-style-type: none"> Evaluate groundwater quality in the Upper Sand Aquifer south of the containment system and along the alignment of the LLO-07 conveyance pipe, including along the western property boundary 	<ul style="list-style-type: none"> Groundwater (wet and dry season) Soil 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-09S	<ul style="list-style-type: none"> Evaluate groundwater quality in the Upper Sand Aquifer upgradient of piezometer PZ-3B 	<ul style="list-style-type: none"> Groundwater (wet and dry season) Soil 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-01D through MW-06D	<ul style="list-style-type: none"> Evaluate groundwater quality in the Lower Sand Aquifer along the shoreline 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-07D	<ul style="list-style-type: none"> Evaluate groundwater quality in the Lower Sand Aquifer and evaluate vertical and horizontal gradients 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-08D	<ul style="list-style-type: none"> Evaluate groundwater quality in the Lower Sand Aquifer on the upgradient portion of the Site along the western property boundary 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-09D	<ul style="list-style-type: none"> Evaluate groundwater quality in the Lower Sand Aquifer upgradient of Everett Smelter Lowland Site monitoring well LLMW-20D 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
MW-10D	<ul style="list-style-type: none"> Provide a closer and onsite compliance monitoring point in the Lower Sand Aquifer for routine PCMP water level monitoring 	<ul style="list-style-type: none"> Groundwater (wet and dry season) Soil 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
Existing Groundwater Monitoring Wells			
PZ-1A, PZ-2A, PZ-3A	<ul style="list-style-type: none"> Evaluate current groundwater quality in the Upper Sand Aquifer inside the barrier wall 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic TPH by NWTPH-Gx and NWTPH-Dx Penta by USEPA Method 8270 Geochemical parameters
PZ-1B, PZ-2B, PZ-3B, LLMW-18S, LLMW-21S	<ul style="list-style-type: none"> Evaluate current groundwater quality of the Upper Sand Aquifer outside the barrier wall 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
PZ-2D, LLMW-18D, LLMW-19D, LLMW-20D, LLMW-21D	<ul style="list-style-type: none"> Evaluate current quality of the Lower Sand Aquifer outside the barrier wall 	<ul style="list-style-type: none"> Groundwater (wet and dry season) 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
Proposed Soil Borings			
SB-101 through SB-104	<ul style="list-style-type: none"> Evaluate current soil conditions in the soil cap area south of the barrier wall 	<ul style="list-style-type: none"> Soil, between 2 and 10 feet bgs 	<ul style="list-style-type: none"> Arsenic Geochemical parameters
SB-100	<ul style="list-style-type: none"> Evaluate current soil conditions immediately outside the barrier wall and in an area where elevated arsenic in the Upper Sand Aquifer has been detected 	<ul style="list-style-type: none"> Soil, between 2 and 10 feet bgs 	<ul style="list-style-type: none"> Arsenic Geochemical parameters

Notes:

- 1 Refer to Figure 11 for proposed locations.
- 2 All groundwater samples will be analyzed for both total and dissolved arsenic.
- 3 Refer to the QAPP in Attachment 2 for additional information regarding sample collection.
- 4 Arsenic analysis by USEPA Method 200.8 for groundwater and USEPA Method 6020 for soil.
- 5 Geochemical parameters for groundwater include major cations (calcium, magnesium, potassium, and sodium), major anions (bromide, chloride, fluoride, and sulfate), alkalinity (dissolved), major ions (ortho-phosphate), nitrate, nitrite, iron (dissolved), manganese (dissolved), sulfide (dissolved), and organic carbon (total and dissolved).
- 6 Geochemical parameters for soil include iron, manganese, sulfide, and total organic carbon.



Abbreviations:

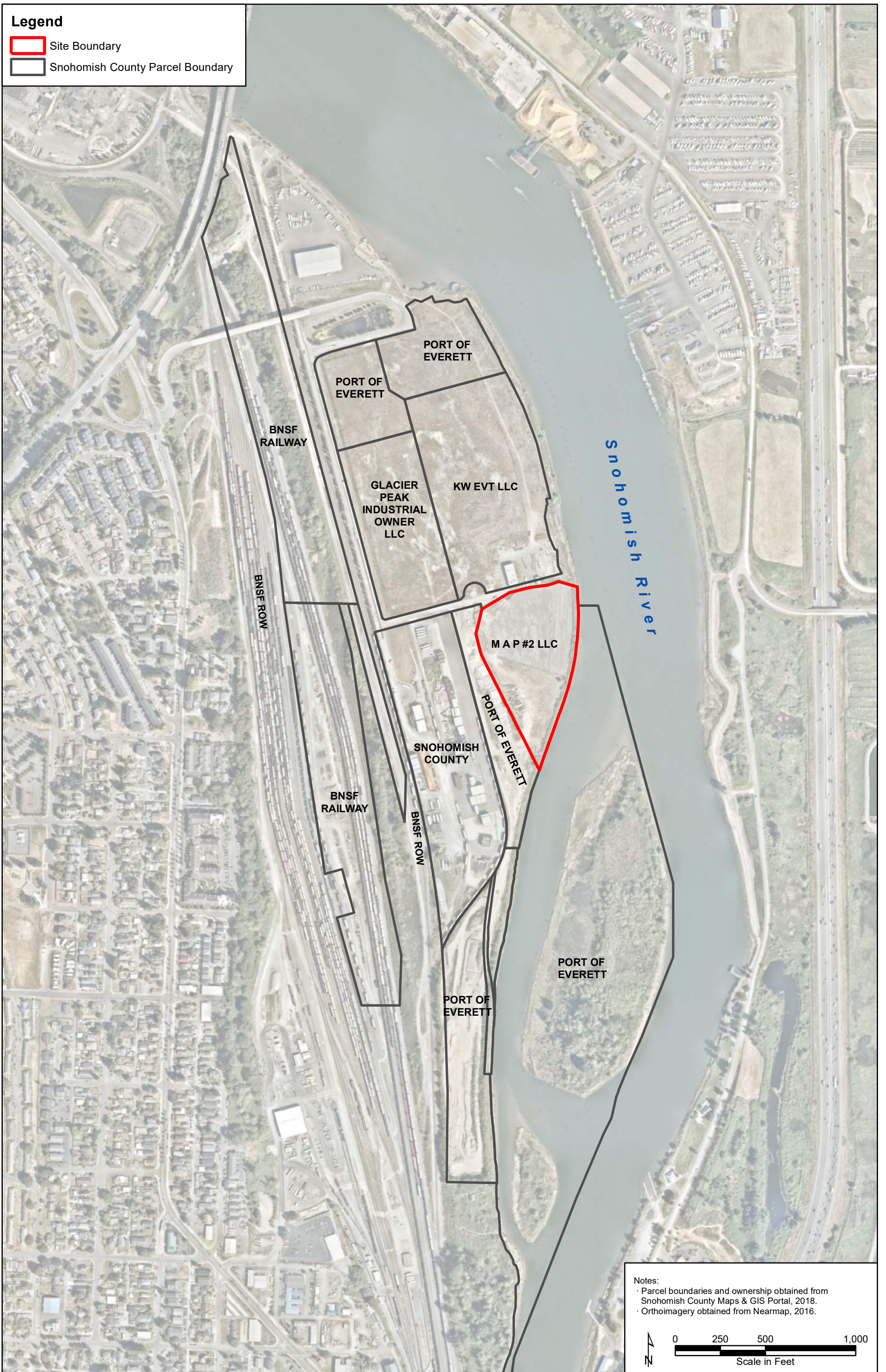
- bgs Below ground surface
- PCMP Performance Compliance Monitoring Plan
- Penta Pentachlorophenol
- QAPP Quality Assurance Project Plan
- TPH Total petroleum hydrocarbons
- USEPA U.S. Environmental Protection Agency

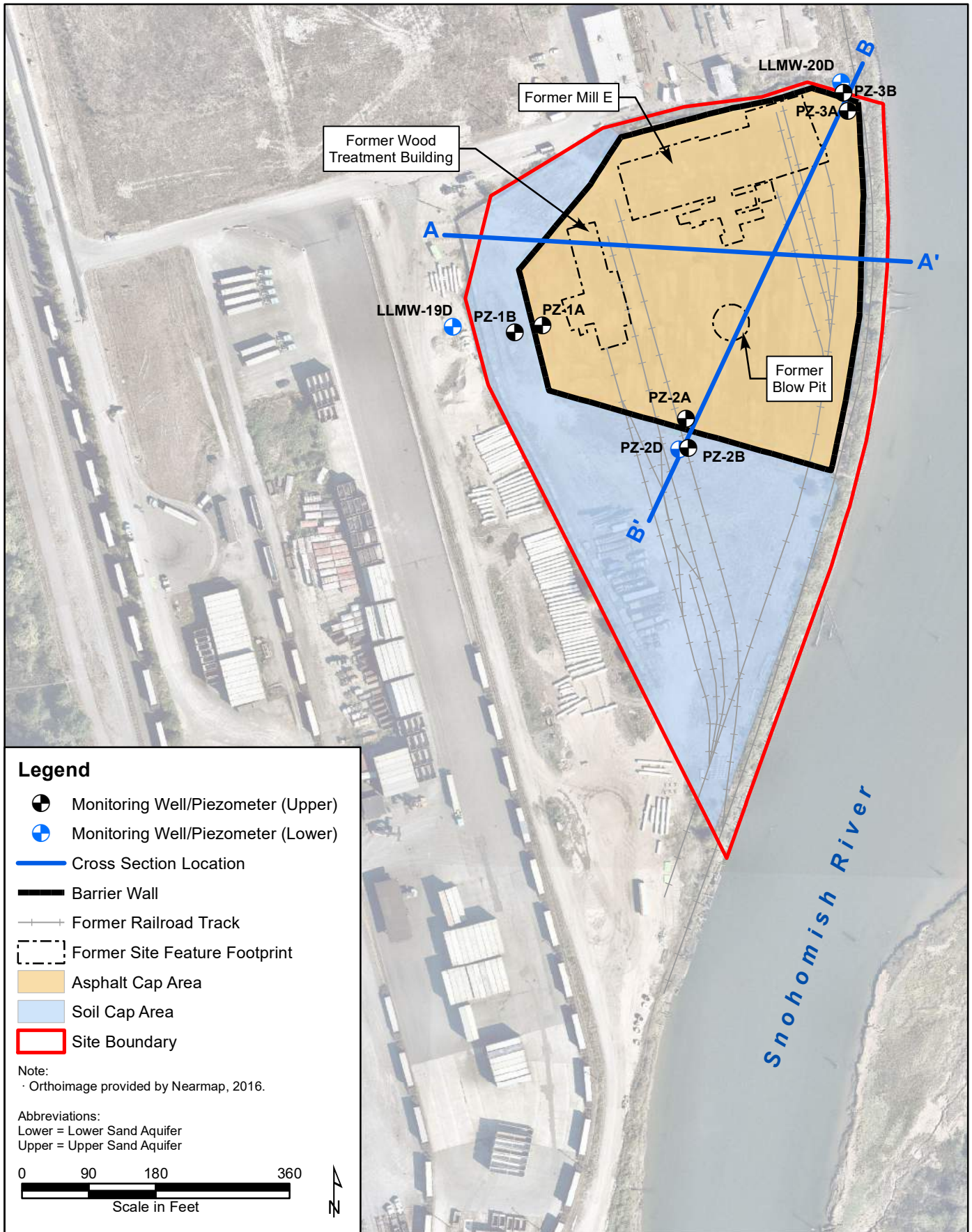
Figures












Legend

-  Site Boundary
-  Snohomish County Parcel Boundary



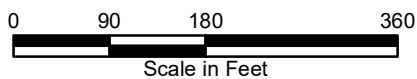


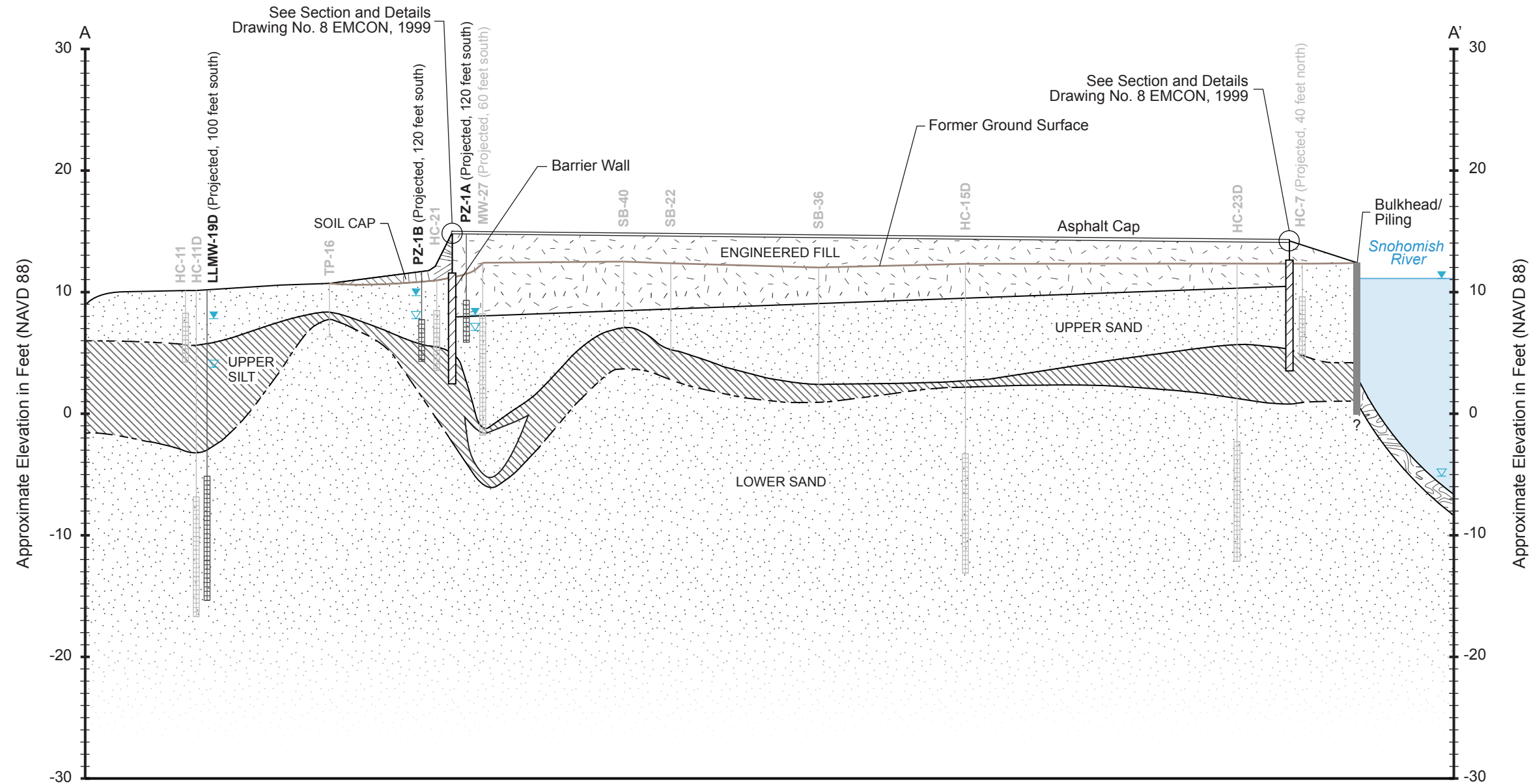
Legend

-  Monitoring Well/Piezometer (Upper)
-  Monitoring Well/Piezometer (Lower)
-  Cross Section Location
-  Barrier Wall
-  Former Railroad Track
-  Former Site Feature Footprint
-  Asphalt Cap Area
-  Soil Cap Area
-  Site Boundary

Note:
 · Orthoimage provided by Nearmap, 2016.

Abbreviations:
 Lower = Lower Sand Aquifer
 Upper = Upper Sand Aquifer





Legend

- Boring
- Highest observed water level (2015–2018)
- Lowest observed water level (2015–2018)
- Existing monitoring well
- Decommissioned monitoring well
- Contact boundary between lithologies (dashed where inferred)

Note:

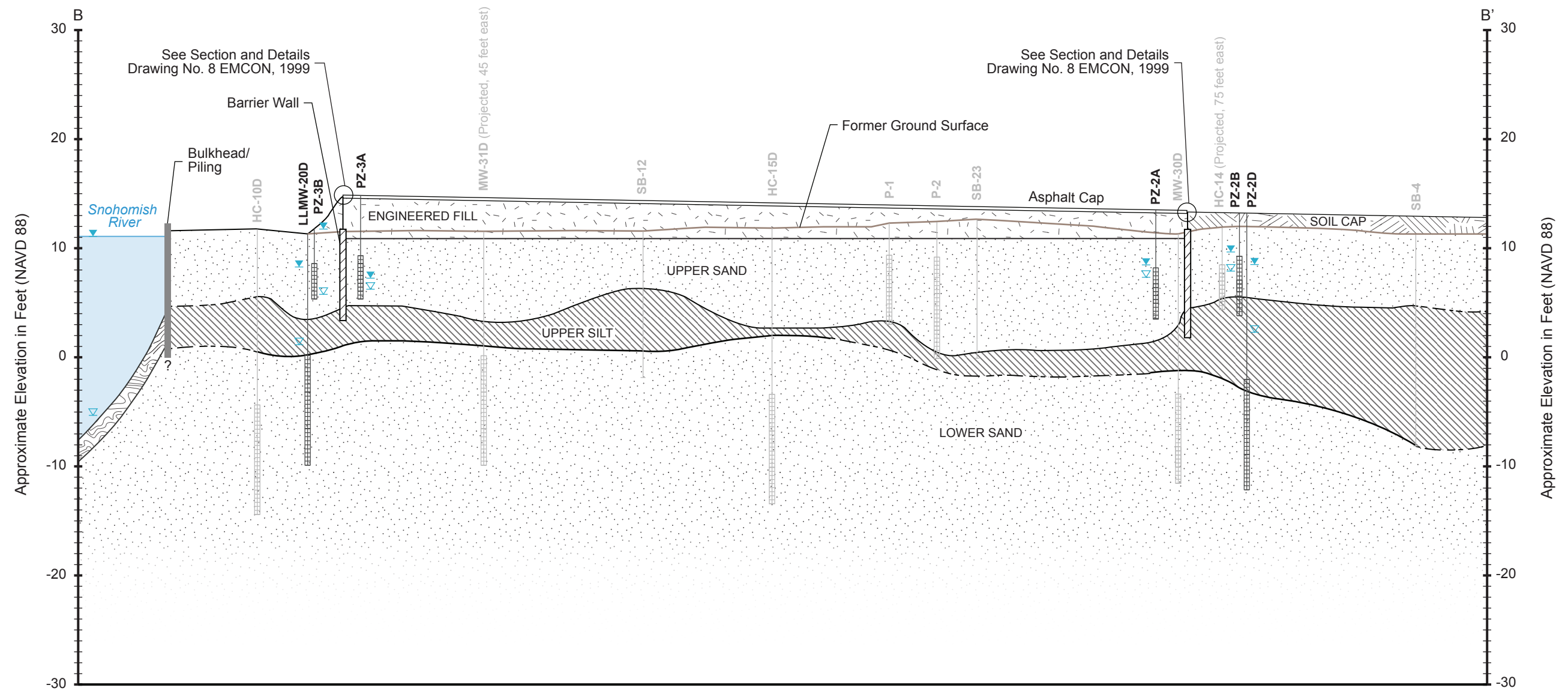
- Elevations in NAVD 88.

Abbreviation:







NAVD 88 = North American Vertical Datum of 1988

References:

- EMCON. 1999. *Former Mill "E"/Koppers Site Remediation*. Weyerhaeuser Everett Mill. Everett, Washington. September.
- Hart Crowser. 1989. *Site Characterization Report*. Weyerhaeuser Old Machine Shop. Everett Mill E Site. Everett, Washington. October.
- Hart Crowser. 1991. *Phase I Site Characterization Report*. Weyerhaeuser-Everett Mill E Site. Everett, Washington. March.
- NOAA. 2019. Station 9447659 Everett, WA. <https://tidesandcurrents.noaa.gov/noaatideannual.html?id=9447659>. Last accessed July 5, 2019.



Legend

-  Boring
-  Highest observed water level (2015–2018)
-  Lowest observed water level (2015–2018)
-  Existing monitoring well
-  Decommissioned monitoring well
-  Contact boundary between lithologies (dashed where inferred)

Note:

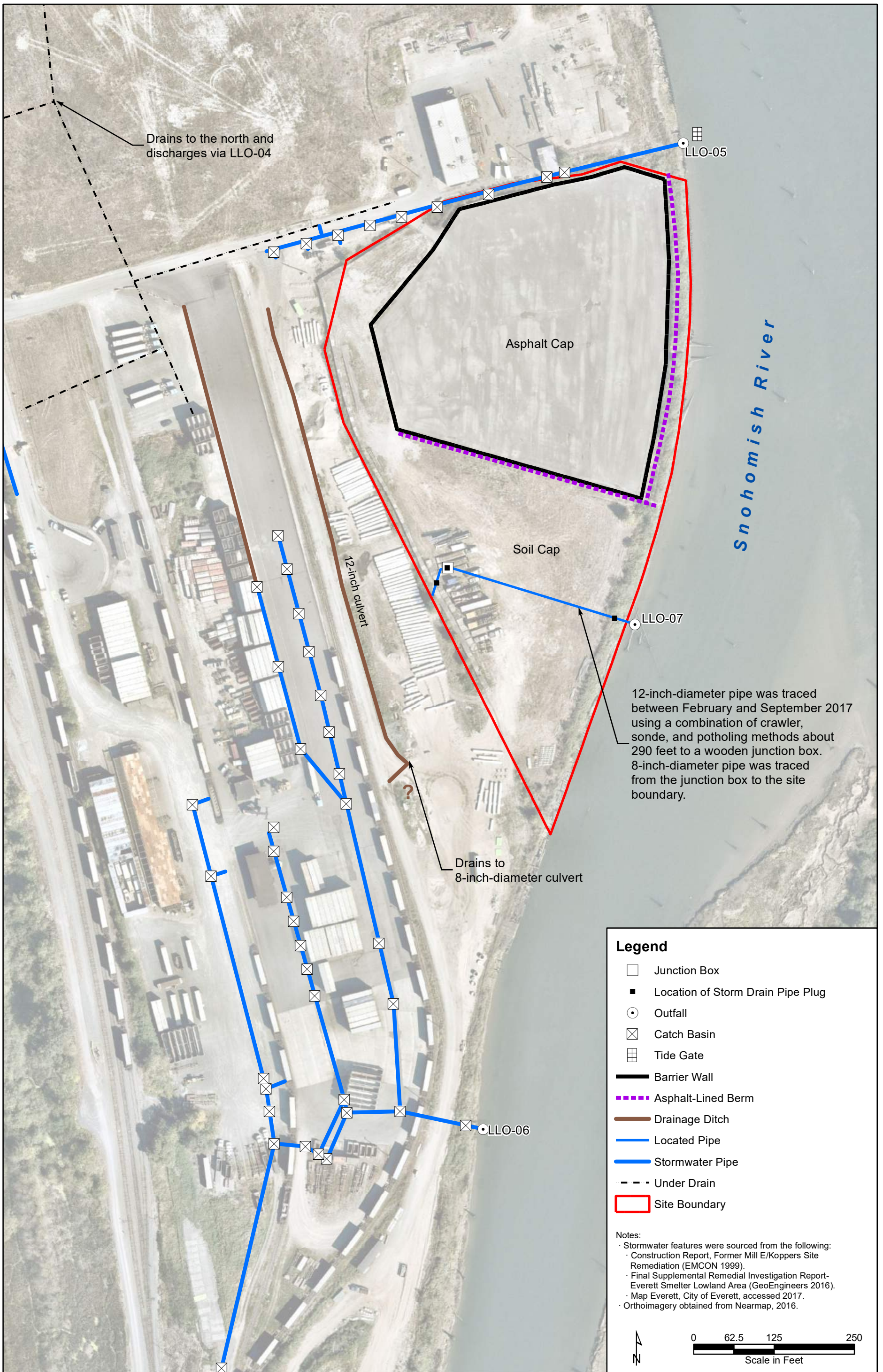
- Elevations in NAVD 88.

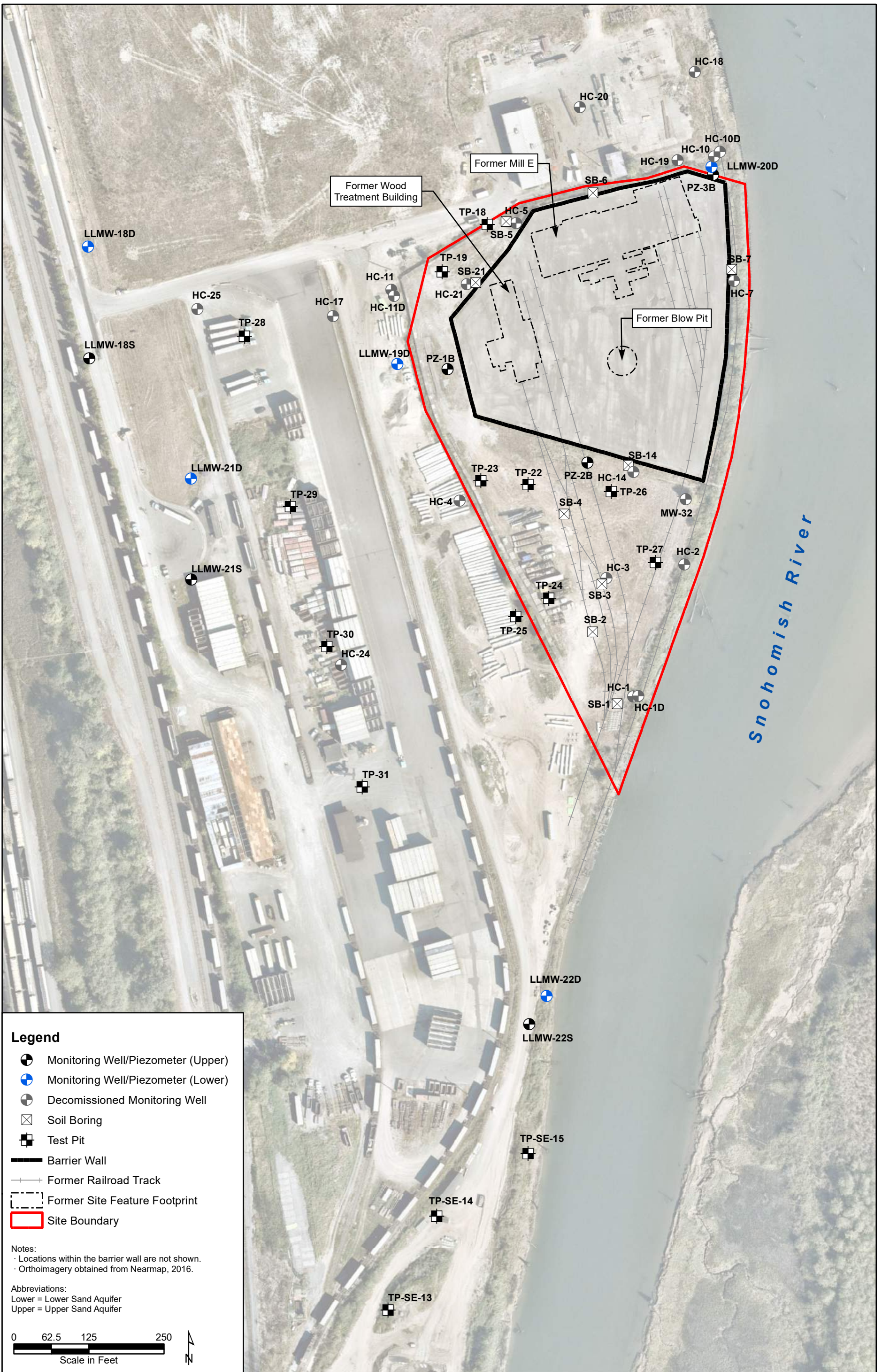
Abbreviation:

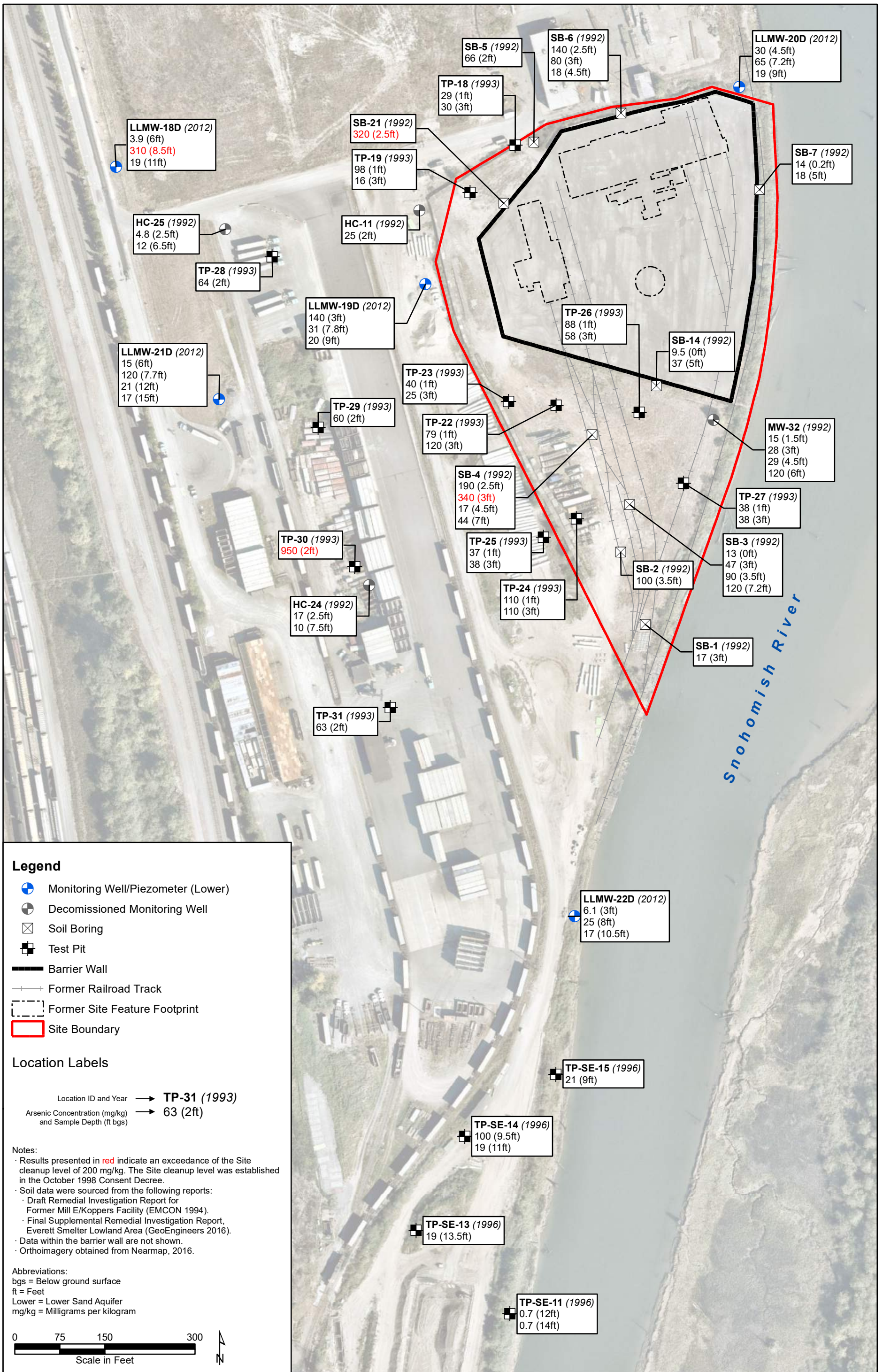
NAVD 88 = North American Vertical Datum of 1988

References:

- EMCON. 1999. *Former Mill "E"/Koppers Site Remediation*. Weyerhaeuser Everett Mill. Everett, Washington. September.
- Hart Crowser. 1989. *Site Characterization Report*. Weyerhaeuser Old Machine Shop. Everett Mill E Site. Everett, Washington. October.
- Hart Crowser. 1991. *Phase I Site Characterization Report*. Weyerhaeuser-Everett Mill E Site. Everett, Washington. March.
- NOAA. 2019. Station 9447659 Everett, WA. <https://tidesandcurrents.noaa.gov/noaatideannual.html?id=9447659>. Last accessed July 5, 2019.







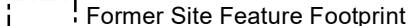



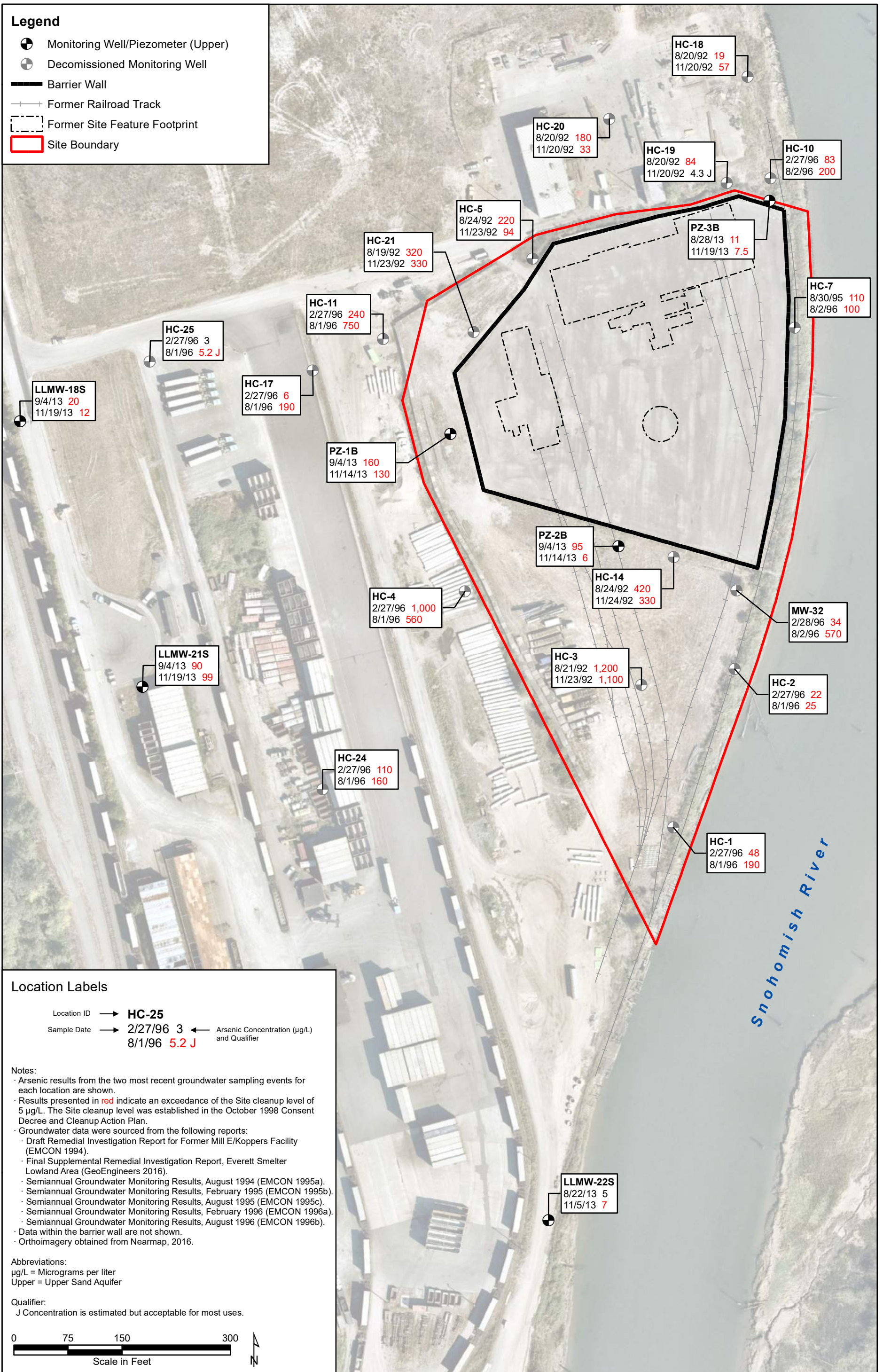


**Supplemental Upland Remedial Investigation Work Plan
Former Mill E/Koppers Facility
Everett, Washington**

Figure 8
Arsenic in Soil

Legend

-  Monitoring Well/Piezometer (Upper)
-  Decommissioned Monitoring Well
-  Barrier Wall
-  Former Railroad Track
-  Former Site Feature Footprint
-  Site Boundary



Location Labels

Location ID → **HC-25**
 Sample Date → 2/27/96 3 ← Arsenic Concentration (µg/L) and Qualifier
 8/1/96 5.2 J

Notes:

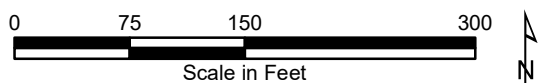
- Arsenic results from the two most recent groundwater sampling events for each location are shown.
- Results presented in red indicate an exceedance of the Site cleanup level of 5 µg/L. The Site cleanup level was established in the October 1998 Consent Decree and Cleanup Action Plan.
- Groundwater data were sourced from the following reports:
 - Draft Remedial Investigation Report for Former Mill E/Koppers Facility (EMCON 1994).
 - Final Supplemental Remedial Investigation Report, Everett Smelter Lowland Area (GeoEngineers 2016).
 - Semiannual Groundwater Monitoring Results, August 1994 (EMCON 1995a).
 - Semiannual Groundwater Monitoring Results, February 1995 (EMCON 1995b).
 - Semiannual Groundwater Monitoring Results, August 1995 (EMCON 1995c).
 - Semiannual Groundwater Monitoring Results, February 1996 (EMCON 1996a).
 - Semiannual Groundwater Monitoring Results, August 1996 (EMCON 1996b).
- Data within the barrier wall are not shown.
- Orthoimagery obtained from Nearmap, 2016.

Abbreviations:

µg/L = Micrograms per liter
 Upper = Upper Sand Aquifer

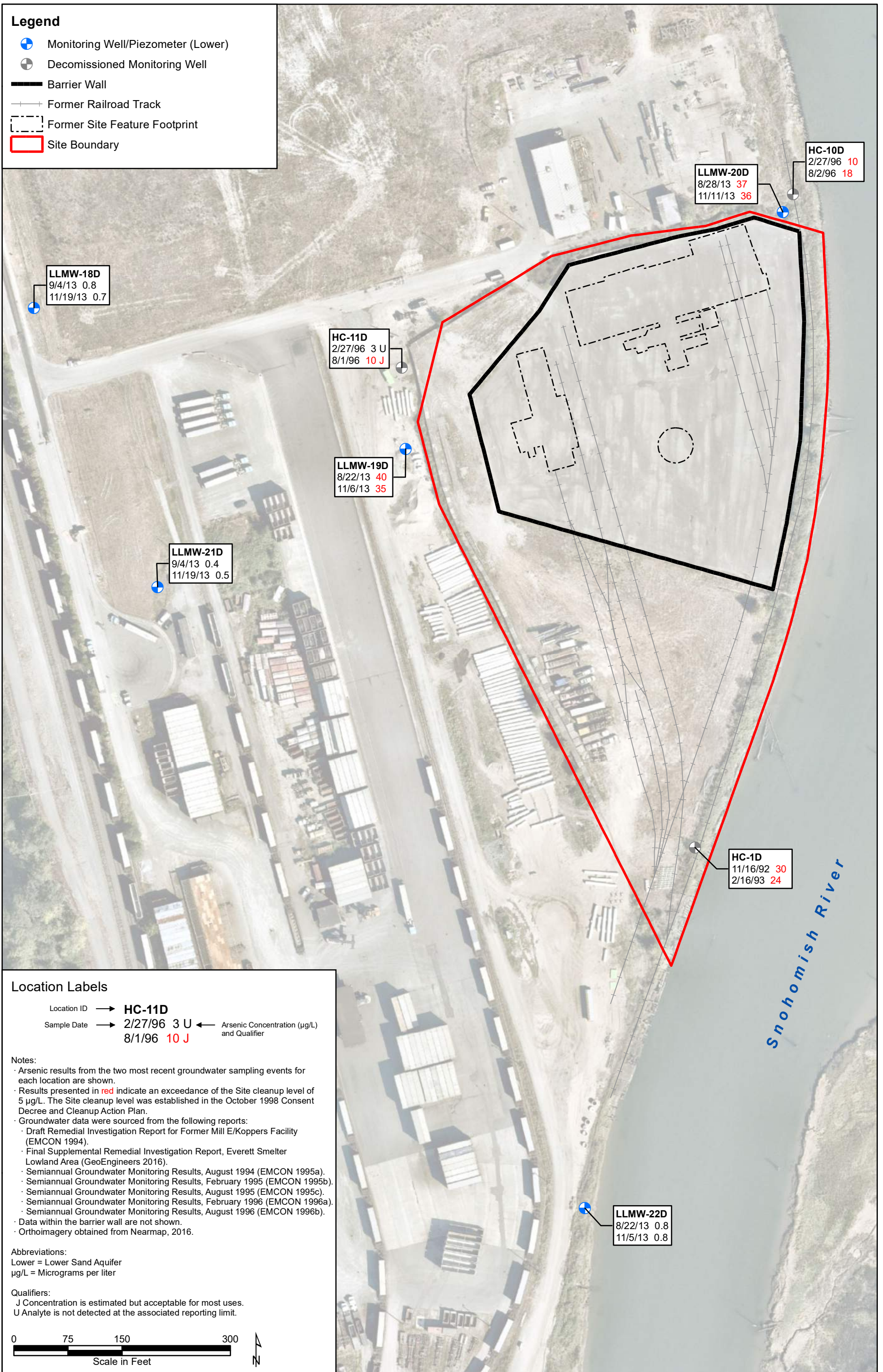
Qualifier:

J Concentration is estimated but acceptable for most uses.



Legend

- Monitoring Well/Piezometer (Lower)
- Decommissioned Monitoring Well
- Barrier Wall
- Former Railroad Track
- Former Site Feature Footprint
- Site Boundary



Location Labels

Location ID → **HC-11D**
 Sample Date → 2/27/96 3 U ← Arsenic Concentration (µg/L) and Qualifier
 8/1/96 10 J

Notes:

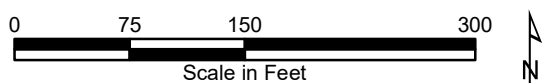
- Arsenic results from the two most recent groundwater sampling events for each location are shown.
- Results presented in **red** indicate an exceedance of the Site cleanup level of 5 µg/L. The Site cleanup level was established in the October 1998 Consent Decree and Cleanup Action Plan.
- Groundwater data were sourced from the following reports:
 - Draft Remedial Investigation Report for Former Mill E/Koppers Facility (EMCON 1994).
 - Final Supplemental Remedial Investigation Report, Everett Smelter Lowland Area (GeoEngineers 2016).
 - Semiannual Groundwater Monitoring Results, August 1994 (EMCON 1995a).
 - Semiannual Groundwater Monitoring Results, February 1995 (EMCON 1995b).
 - Semiannual Groundwater Monitoring Results, August 1995 (EMCON 1995c).
 - Semiannual Groundwater Monitoring Results, February 1996 (EMCON 1996a).
 - Semiannual Groundwater Monitoring Results, August 1996 (EMCON 1996b).
- Data within the barrier wall are not shown.
- Orthoimagery obtained from Nearmap, 2016.

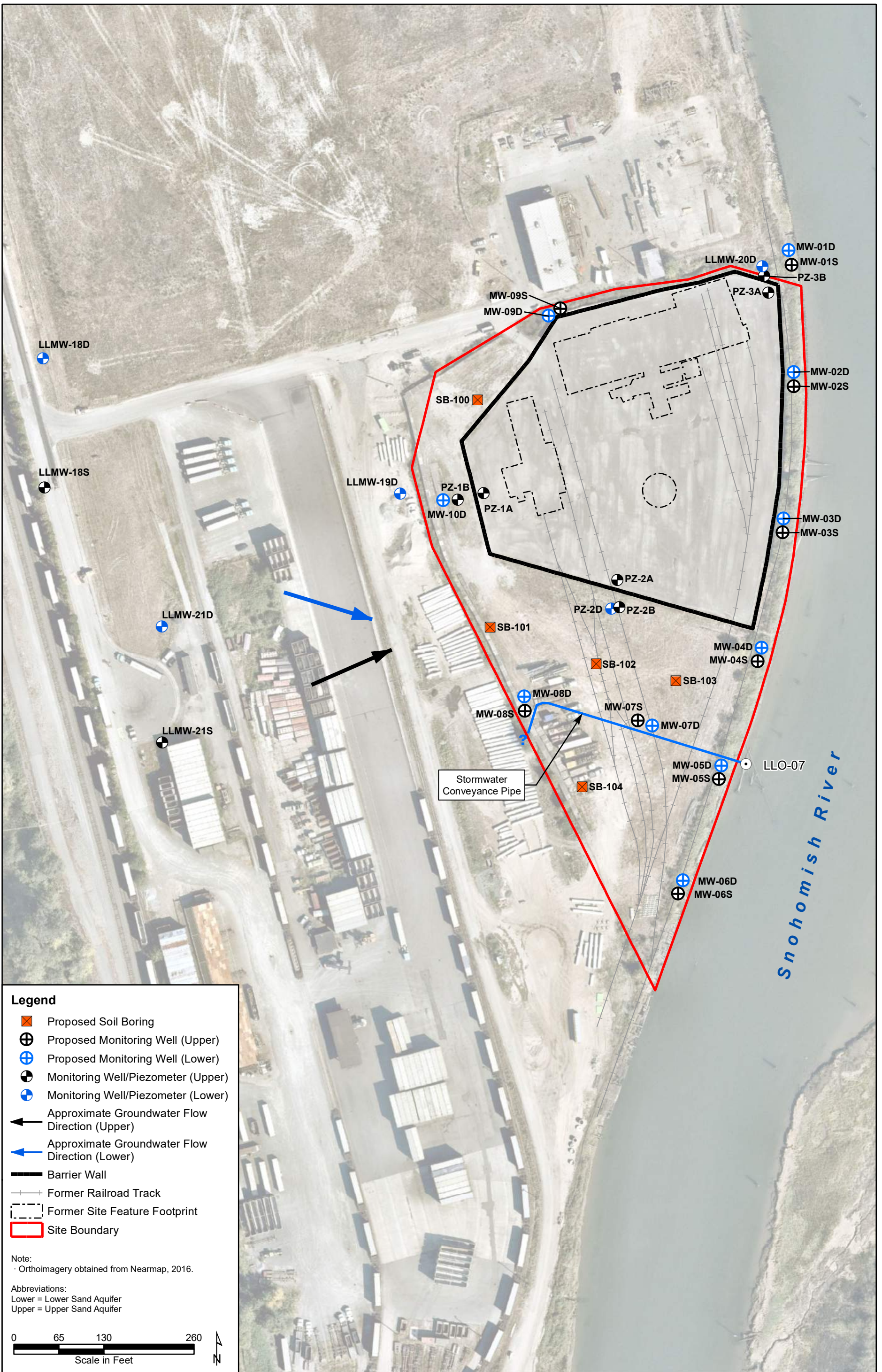
Abbreviations:

Lower = Lower Sand Aquifer
 µg/L = Micrograms per liter

Qualifiers:

J Concentration is estimated but acceptable for most uses.
 U Analyte is not detected at the associated reporting limit.





**Supplemental Upland Remedial Investigation Work Plan
Former Mill E/Koppers Facility
Everett, Washington**

Figure 11
Proposed Soil and Groundwater Investigation Locations

Attachment 1
Floyd | Snider Standard Guidelines

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 (annular 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 than 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 annular 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):	Volume of Schedule 40 PVC Pipe				
End Purge (time):	Diameter	O.D.	I.D.	Volume (Gal/Linear Ft.)	Weight of Water (Lbs/Lineal Ft.)
Gallons Purged (time):	1 1/4"	1.660"	1.380"	0.08	0.64
Purge Water Disposal Method (circle): On-site Storage Tank On-site Treatment Drum Other:	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: _____

F|S STANDARD GUIDELINE

Soil Logging

DATE/LAST UPDATE: August 2018

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. For the purposes of recording soil observations and collecting samples for analysis, assume that the recovered column of soil has been evenly compressed unless you are able to determine the interval(s) in which compression has occurred. Decompress the recovered soil when making further observations (e.g., if the recovered soil column is 80 percent of the length of the drive interval, assume 0.8 feet of recovered soil represent 1 foot of soil in situ).
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: Color, consistency, MAJOR CONSTITUENT, minor constituent, geotechnical properties, moisture content, 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. 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.
2. Determine whether organic matter influences the properties of the material. If so, record as an organic soil.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.

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

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS v.2

midwest
GEOSCIENCES
group

START HERE

DENSITY OR CONSISTENCY	<table border="0"> <tr> <td>COARSE GRAINED DEPOSITS</td> <td>N-VALUE</td> <td></td> <td>FINE GRAINED DEPOSITS</td> <td>N-VALUE</td> <td></td> <td>q_u (tsf)</td> <td></td> </tr> <tr> <td></td> <td>0-4</td> <td>▶ VERY LOOSE</td> <td></td> <td>0-2</td> <td><0.25</td> <td>▶ VERY SOFT</td> <td></td> </tr> <tr> <td></td> <td>5-10</td> <td>▶ LOOSE</td> <td></td> <td>3-4</td> <td>0.25-0.50</td> <td>▶ SOFT</td> <td></td> </tr> <tr> <td></td> <td>11-29</td> <td>▶ MEDIUM DENSE</td> <td></td> <td>5-8</td> <td>0.50-1.0</td> <td>▶ MEDIUM</td> <td></td> </tr> <tr> <td></td> <td>30-49</td> <td>▶ DENSE</td> <td></td> <td>9-15</td> <td>1.0-2.0</td> <td>▶ STIFF</td> <td></td> </tr> <tr> <td></td> <td>>50</td> <td>▶ VERY DENSE</td> <td></td> <td>16-30</td> <td>2.0-4.0</td> <td>▶ VERY STIFF</td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>>30</td> <td>>4.0</td> <td>▶ HARD</td> <td></td> </tr> </table>	COARSE GRAINED DEPOSITS	N-VALUE		FINE GRAINED DEPOSITS	N-VALUE		q_u (tsf)			0-4	▶ VERY LOOSE		0-2	<0.25	▶ VERY SOFT			5-10	▶ LOOSE		3-4	0.25-0.50	▶ SOFT			11-29	▶ MEDIUM DENSE		5-8	0.50-1.0	▶ MEDIUM			30-49	▶ DENSE		9-15	1.0-2.0	▶ STIFF			>50	▶ VERY DENSE		16-30	2.0-4.0	▶ VERY STIFF						>30	>4.0	▶ HARD		
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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 D2486

STEP 1: IS SEDIMENT COARSE GRAINED OR FINE GRAINED?
 >50% coarse-grained sediments, <50% fines → **COARSE-GRAINED DEPOSITS**
 >50% fines, <50% coarse-grained sediments → **FINE-GRAINED DEPOSITS** (organic and inorganic)

STEP 2: DETERMINE SAND VS. GRAVEL RATIO
 INCREASING GRAIN SIZE: FINE SAND (0.075 mm to 0.425 mm), MEDIUM SAND (0.425 mm to 2.0 mm), COARSE SAND (2.0 mm to 4.75 mm), SMALL GRAVEL (4.75 mm to 16.0 mm), LARGE GRAVEL (16.0 mm to 75.0 mm)

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL
 INCREASING PLASTICITY: NON PLASTIC (ML, CL), LOW PLASTICITY, MEDIUM PLASTICITY, HIGH PLASTICITY (CH)

STEP 3: CONTINUE WITH SAND OR GRAVEL ON FLOW CHART (REVERSE)
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
(See with CLASSIFICATION)
 WILL NOT SUPPORT 6mm DIAMETER ROLL IF HELD ON END
 6mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 4mm DIA. ROLL DOES NOT
 4mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 2mm DIA. ROLL DOES NOT
 2mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF
 ▶ NON-PLASTIC
 ▶ LOW PLASTICITY
 ▶ MEDIUM PLASTICITY
 ▶ HIGH PLASTICITY

COHESIVENESS
 6mm DIAMETER ROLL CANNOT BE FORMED ▶ NONCOHESIVE
 6mm DIAMETER ROLL CAN BE FORMED ▶ COHESIVE

SEDIMENTARY STRUCTURE
 UNIFORM BEDS >30cm ▶ MASSIVE
 BEDS 3cm to 30cm ▶ THICKLY BEDDED
 BEDS 0.5cm to 3cm ▶ BEDDED
 BEDS <0.5cm ▶ THINLY BEDDED
 ▶ LAMINATED
SECONDARY SOIL STRUCTURE (ON SOILS ONLY)
 Spheroidal peds or granules usually pecked loosely ▶ GRANULAR
 Irregular, roughly cubelike peds with planer 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 RU RU UU

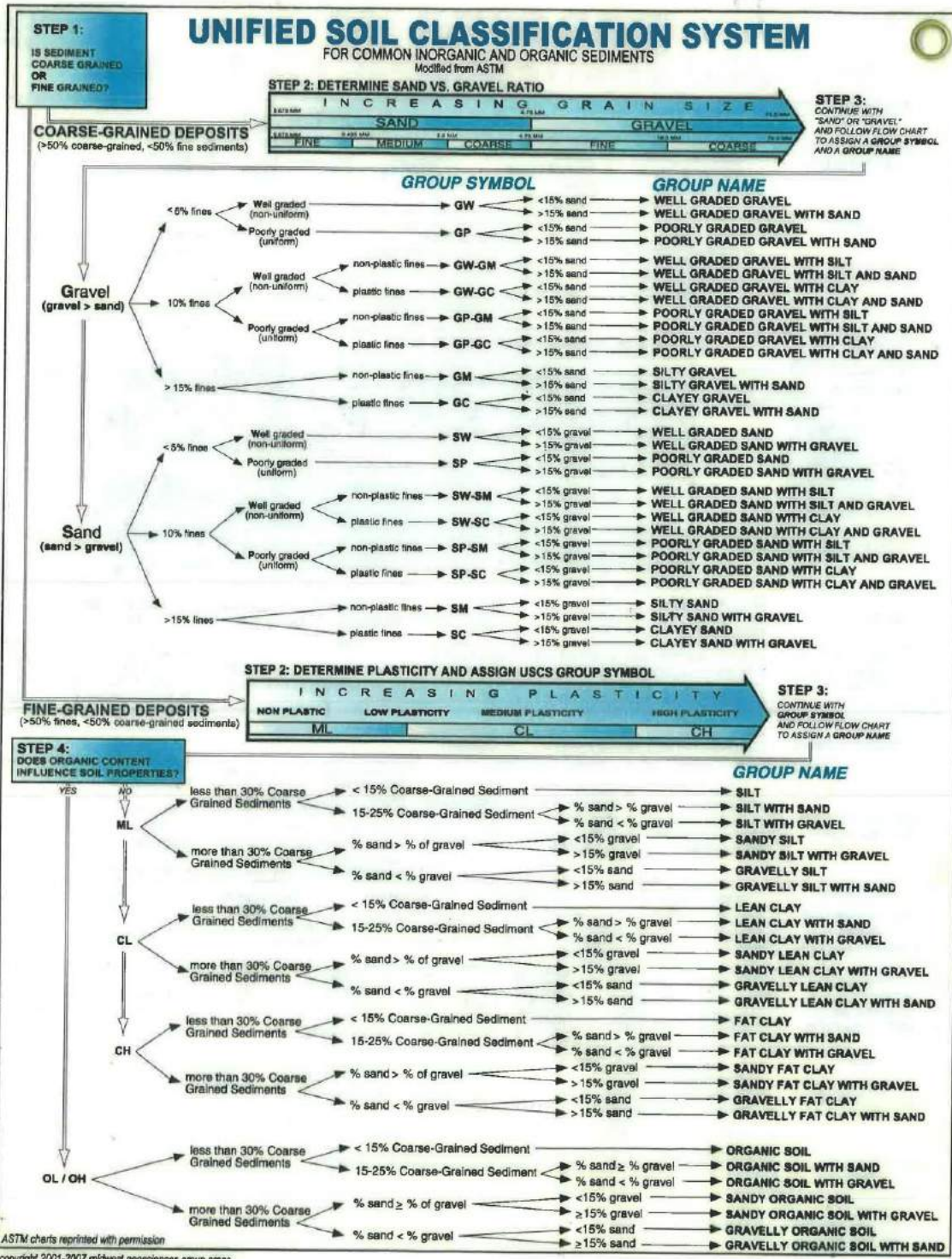
SECONDARY GRAIN SIZE INFORMATION
 < 5% ▶ TRACE
 6% to 15% ▶ LITTLE
 16% to 30% ▶ FEW
 31% to 49% ▶ SOME
 ▶ UNIFORM (poorly graded)
 ▶ NON-UNIFORM (well graded)
 ▶ FINE SAND
 ▶ MEDIUM-GRAINED SAND
 ▶ COARSE-GRAINED SAND
 ▶ FINE GRAVEL
 ▶ COARSE GRAVEL
 FOR GLACIAL DIAMICTONS ▶ CLAST FRACTION
 ▶ CLAST 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
 < 10 cm ▶ SHARP (or ABRUPT for pedogenic alternation)
 > 10 cm (Note transition interval) ▶ GRADATIONAL (or TRANSITIONAL for weathering zone change)

010106
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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 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 to 10 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.

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.

Attachment 2
Quality Assurance Project Plan

Former Mill E/Koppers Facility

Quality Assurance Project Plan

Prepared for

The Weyerhaeuser Company
220 Occidental Avenue South
Seattle, Washington 98104

April 2020

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Table of Contents

1.0 Quality Assurance Project Plan 1-1

1.1 CHEMICAL LABORATORY ANALYSES PROGRAM 1-1

 1.1.1 Reporting Limits 1-2

1.2 GEOCHEMICAL ANALYSIS 1-2

1.3 LABORATORY DATA QUALITY OBJECTIVES 1-4

 1.3.1 Precision 1-4

 1.3.2 Accuracy 1-5

 1.3.3 Representativeness 1-5

 1.3.4 Comparability 1-6

 1.3.5 Completeness 1-6

1.4 LABORATORY AND FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES 1-6

 1.4.1 Laboratory Duplicates 1-7

 1.4.2 Matrix Spikes and Matrix Spike Duplicates 1-7

 1.4.3 Laboratory Control Samples and Laboratory Control Sample Duplicates 1-7

 1.4.4 Surrogate Spike 1-7

 1.4.5 Method Blanks 1-7

1.5 DATA REDUCTION AND REPORTING 1-7

1.6 DATA VALIDATION 1-9

2.0 References 2-1

List of Tables

Table 1.1 Analytical Requirements, Methods, Preservation, Bottle Type, and Holding Times 1-1

Table 1.2 Analytical Methods, Detection Limits, and Reporting Limits 1-2

Table 1.3 Geochemical Parameters 1-3

Table 1.4 Data Quality Assurance Criteria 1-4

List of Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MDL	Method detection limit
MS	Matrix spike
MSD	Matrix spike duplicate
PQL	Practical quantitation limit
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
USEPA	U.S. Environmental Protection Agency

1.0 Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPP) describes the analytical program to be conducted for each sample, as well as the laboratory quality assurance (QA) objectives and quality control (QC) procedures required to be met to achieve technically sound and useable data. Analytical methods were selected to ensure that reporting limits are less than the applicable cleanup level criterion, where feasible.

1.1 CHEMICAL LABORATORY ANALYSES PROGRAM

Soil and groundwater samples will be submitted to Fremont Analytical in Seattle, Washington. Soil samples will be analyzed for arsenic using U.S. Environmental Protection Agency (USEPA) Method 6020. Groundwater samples will be analyzed for both total and dissolved arsenic using USEPA Method 200.8. A subset of groundwater samples will also be analyzed for total petroleum hydrocarbons (TPH) by NWTPH-Gx and NWTPH-Dx, and pentachlorophenol (penta) by USEPA Method 8270.

Sample containers and preservation requirements are presented in Table 1.1.

Table 1.1
Analytical Requirements, Methods, Preservation, Bottle Type, and Holding Times

Analyte	Analytical Method	Bottle Type	Preservative	Holding Time
Soil				
Arsenic	USEPA Method 6020	One 4-oz WMG	None, cool to <6 °C	6 months
Groundwater				
Arsenic	USEPA Method 200.8	One 250-mL HDPE ⁽¹⁾	HNO ₃ to pH<2 ⁽²⁾	6 months
Penta	USEPA Method 8270	Two 500-mL amber glass	None, cool to <6 °C	7 days to extract, then 40 days to analyze
TPH	NWTPH-Gx	Three 40-mL VOA	Cool to <6 °C, HCl to pH<2, no headspace	14 days
	NWTPH-Dx	One 500-mL amber glass	None, cool to <6 °C	7 days to extract, then 40 days to analyze

Notes:

- 1 One container is needed for total arsenic and one container is needed for dissolved arsenic.
- 2 The sample collected for dissolved arsenic should be filtered in the field using a 0.45-micrometer filter prior to preservation.

Abbreviations:

°C	Degrees Celsius	VOA	Volatile organic analysis
HDPE	High-density polyethylene	WMG	Wide-mouth glass jar

1.1.1 Reporting Limits

The analytical method identified in Table 1.1 results in method detection limits (MDLs) and practical quantitation limits (PQLs) that are less than the relevant arsenic cleanup level criteria for soil and groundwater. The target MDLs and PQLs for arsenic are summarized in Table 1.2.

**Table 1.2
Analytical Methods, Detection Limits, and Reporting Limits**

Analyte	Analytical Method	Units	Method Detection Limit	Practical Quantitation Limit
Soil				
Arsenic	USEPA Method 6020	mg/kg	0.078	0.25
Groundwater				
Arsenic	USEPA Method 200.8	µg/L	0.234/0.589 ⁽¹⁾	0.5/1.75 ⁽¹⁾
Penta	USEPA Method 8270	µg/L	0.058	2.0
TPH	NWTPH-Gx and NWTPH-Dx	µg/L	Gasoline: 11 Diesel: 5.4 Oil: 52	Gasoline: 100 Diesel: 50 Oil: 250

Note:

1 Values are for total and dissolved arsenic, respectively.

Abbreviations:

- µg/L Micrograms per liter
- mg/kg Milligrams per kilogram

These PQLs are goals only, insofar as instances may arise where high sample concentrations, heterogeneity of samples, or matrix interferences preclude achieving the desired reporting limit and associated QA/QC criteria. In such instances, the laboratory will report the reason for any deviation from these reporting limits.

1.2 GEOCHEMICAL ANALYSIS

Soil and groundwater samples will also be analyzed for geochemical parameters to evaluate fate and transport of arsenic. Soil samples will be collected for analyses of iron, manganese, sulfide, and total organic carbon. Groundwater samples will be collected for analyses of major cations (calcium, magnesium, potassium, and sodium), major anions (bromide, chloride, fluoride, and sulfate), alkalinity (dissolved), major ions (ortho-phosphate), nitrate, nitrite, iron (dissolved), manganese (dissolved), sulfide (dissolved), and organic carbon (total and dissolved). The analytical methods and target MDLs and PQLs are summarized in Table 1.3.

**Table 1.3
Geochemical Parameters**

Analyte ⁽¹⁾	Analytical Method	Units	Method Detection Limit	Practical Quantitation Limit
Soil				
Iron	USEPA Method 6020	mg/kg	1.0	5.0
Manganese	USEPA Method 6020	mg/kg	1.0	5.0
Sulfide	USEPA Method 9034	mg/kg	2.4	5.0
Total organic carbon	USEPA Method 9060	mg/kg	44.4	2,000
Groundwater				
Major Cations				
Calcium	USEPA Method 6010C	mg/L	0.0230	1.10
Magnesium		mg/L	0.133	1.10
Potassium		mg/L	0.146	3.30
Sodium		mg/L	0.550	2.0
Major Anions				
Bromide	USEPA Method 300.0	mg/L	0.060	0.50
Chloride		mg/L	0.040	0.50
Fluoride		mg/L	0.030	0.20
Sulfate		mg/L	0.260	1.20
Other Analytes				
Alkalinity (dissolved)	SM2320B	mg/L	5.00	5.0
Major ions (ortho-phosphate)	USEPA Method 365.1	mg/L	0.030	0.10
Nitrite as N	USEPA Method 300.0	mg/L	0.080	0.40
Nitrate as N	USEPA Method 300.0	mg/L	0.020	0.20
Iron (dissolved)	USEPA Method 6020A	µg/L	29.0	200.0
Manganese (dissolved)	USEPA Method 6020A	µg/L	1.8	10.0
Sulfide (dissolved)	SM4500 S2 D	mg/L	0.0	0.1
Organic carbon (total and dissolved)	SM5310B	mg/L	0.05	0.5

Notes:

- 1 Analysis is being performed to develop the geochemical conceptual site model and understand fate and transport of arsenic at the Site. Not considered a constituent of concern for the Site.

1.3 LABORATORY DATA QUALITY OBJECTIVES

Laboratory QA/QC objectives include obtaining data that are technically sound and properly documented, having been evaluated against established criteria for the principle data quality indicators (i.e., precision, accuracy, representativeness, completeness, and comparability) as defined in Ecology and USEPA guidance (Ecology 2016 and USEPA 2002). Specific data QA criteria for the method are presented in Table 1.4.

**Table 1.4
Data Quality Assurance Criteria**

Analyte	Precision ⁽¹⁾	Accuracy	Completeness	Reference
Soil				
Arsenic	±20% RPD	80–120%	95%	USEPA Method 6020
Groundwater				
Arsenic	±20% RPD	80–120%	95%	USEPA Method 6020
Penta	±30% RPD	20–137%	95%	USEPA Method 8270
TPH	±30% RPD	50–150%	95%	NWTPH-Gx and NWTPH-Dx

Note:

- 1 Precision criteria apply to analytical precision only. Field duplicate precision will be screened against an RPD of 75%.

Abbreviation:

RPD Relative percent difference

1.3.1 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 by matrix spike (MS)/matrix spike duplicate (MSD) samples for organic analyses and by laboratory duplicate samples for inorganic analyses.

Analytical precision measurements will be carried out on project-specific samples at a minimum laboratory duplicate frequency of one 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 RPD performance criteria.

Field precision will be evaluated by the collection of field duplicates at a minimum frequency of one 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 an RPD of 75 percent for all samples. However, data will not 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, where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

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

Where:

C_1 = Larger of the two observed values

C_2 = Smaller of the two observed values

1.3.2 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, laboratory control samples [LCSs], and/or MS samples) 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 MSs/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MSs/MSDs only on samples from this investigation and not from other projects. Surrogate recoveries will be determined for samples analyzed for organic compounds.

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

1.3.3 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 that 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.

1.3.4 Comparability

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

1.3.5 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:

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

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 were qualified as rejected will not be considered valid for the purpose of assessing completeness.

1.4 LABORATORY AND FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The quality of analytical data generated is assessed by both the implementation of field QC procedures, and by the frequency and type of internal laboratory QA/QC checks developed for analysis type and method. Field QC is evaluated through the analysis of trip blanks and field duplicates. Field duplicates are collected to evaluate the efficiency of field decontamination procedures, variability from sample handling, and sample heterogeneity. Laboratory results will be evaluated by reviewing analytical results of method blanks, MS/MSD, field duplicate samples, LCS, calibrations, performance evaluation samples, and interference checks as specified by the specific analytical methods.

Results of the QA/QC samples from each laboratory analysis group will be reviewed by the laboratory analyst immediately after a laboratory analysis group has been analyzed. The QA/QC sample results will then be evaluated to determine whether control limits were exceeded. If control limits are exceeded in the laboratory analysis 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 procedures that will be used to assess data quality throughout sample analysis are summarized in the following sections.

1.4.1 Laboratory Duplicates

Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. A minimum of one duplicate will be analyzed per laboratory analysis group. When there are fewer than 20 samples, a laboratory duplicate will still be analyzed.

1.4.2 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 one MS/MSD will be analyzed for every laboratory analysis group for which MS/MSD sample analysis is applicable. MS/MSD analyses will be performed on project-specific samples. When there are fewer than 20 samples, a MS/MSD will still be analyzed.

1.4.3 Laboratory Control Samples and Laboratory Control Sample Duplicates

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 LCS duplicate (LCSD) data for metals and organic compounds will be reported. The LCS/LCSD will be performed once per laboratory analysis group.

1.4.4 Surrogate Spike

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; however, no sample result will be corrected for recovery using these values.

1.4.5 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for every extraction batch.

1.5 DATA REDUCTION AND REPORTING

The laboratory will be responsible for internal checks on data reporting and will correct errors identified during the QA review. Close contact will be maintained with the laboratories to resolve any QC problems in a timely manner. The analytical laboratories will be required, where applicable, to report the following:

- **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 duplicate QA samples with laboratory sample IDs.
- **Chain-of-Custody Records.** Legible copies of the custody forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample Results.** The data package 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
- **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 previous bullet). 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.
- **Field Duplicates.** Field duplicates will be reported in the same format as any other sample. RPDs will be calculated for duplicate samples and evaluated as part of the data quality review.

1.6 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 data quality review of the analytical data will follow USEPA National Functional Guidelines in accordance with the QAPP limits (USEPA 2017a and 2017b). All chemical data will be reviewed with regard to the following:

- Chain of custody/documentation
- Sample preservation and holding times
- Instrument performance (calibration, tuning, sensitivity)
- Method blanks
- Method reporting limits
- Surrogate recoveries
- MS/MSD recoveries
- LCS recoveries
- Laboratory and field duplicate RPD

A Level II summary validation will be performed on all data.

2.0 References

- U.S. Environmental Protection Agency (USEPA). 2002. *Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8*. Publication No. EPA/240/R-02/004. Office of Environmental Information. Washington, DC. November.
- _____. 2017a. *National Functional Guidelines for Organic Superfund Methods Data Review*. EPA-540-R-2017-002/OLEM 9355.0-136. Office of Superfund Remediation and Technology Innovation. Washington, D.C. January.
- _____. 2017b. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. EPA-540-R-2017-001/OLEM 9355.0-135. Office of Superfund Remediation and Technology Innovation. Washington, D.C. January.
- Washington State Department of Ecology (Ecology). 2016. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*. Publication No. 04-03-030. Environmental Assessment Program. Manchester, Washington. December.

EXHIBIT C – Schedule of Deliverables

Deliverable/Milestone	Completion/Due Date
Progress Reports	15 th of every month, beginning after the first full respective annual quarter after the effective date of this Agreed Order and due in April, July, October, and January of each year.
Implement Supplemental Upland Remedial Investigation Work Plan	Initiate planning within 30 days of the Effective date of this Agreed Order
Agency Review Supplemental Upland RI Data Summary Report	60 calendar days after receipt of validated data from the 2 nd seasonal groundwater monitoring event of the Supplemental Upland RI Work Plan
Final Supplemental Upland Data Summary RI Report	45 calendar days after receipt of Ecology’s comments on Agency Review Supplemental Upland RI Data Summary Report
Agency Review Supplemental Remedial Investigation/ Focused Feasibility Study Work Plan	45 calendar days after receipt of Supplemental RI Data Summary Report
Draft Final SRI/FFS Work Plan	30 calendar days after receipt of Ecology comments on the Agency Review SRI/FFS Work Plan
Implement Final SRI/FFS Work Plan	30 calendar days after Ecology’s written approval of the Final SRI/FFS Work Plan
Validated Data for SRI Finalized	60 days following completion of SRI field activities
Agency Review Draft SRI Report	90 days following receipt of SRI validated data
Public Review Draft SRI Report	45 days after receipt of Ecology’s comments
Final SRI Report	30 days after receiving Ecology’s final comments on Public Review Draft SRI Report
Agency Review Draft FFS Report	90 days following Ecology request for the Public Review Draft SRI Report
Public Review Draft FFS Report	45 days following approval of Agency Review Draft FFS Report
Agency Review Preliminary Draft Focused Cleanup Action Plan (FCAP)	45 days following Ecology approval of Public Review Draft FFS Report.
Public Review Preliminary Draft FCAP	30 days following approval of Agency Review Preliminary Draft FCAP