Remedial Investigation and Interim Action Work Plan

1215 E Fir Street
Seattle, Washington
King County Assessor's Parcel 8061000045

Prepared for:
Big Village, LLLP
C/O: Seattle Chinatown International District Preservation and Development Authority (SCIDpda)
PO Box 3302
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PBS Project No. 41593.005

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1.0 INTRODUCTION

PBS Engineering and Environmental, Inc. (PBS) is pleased to submit this Remedial Investigation and Interim Action Work Plan (work plan) to Big Village, LLLP (Big Village) and the Seattle Chinatown International District Preservation and Development Authority (SCIDpda). This work plan describes environmental subsurface investigation activities related to the planned redevelopment of King County Assessor's Parcel 8061000045 located at 1215 E Fir Street in Seattle, Washington (the Site/Property).

PBS understands that SCIDpda intends to enter a land lease of the parcel with property owner Seattle Housing Authority (SHA) for redevelopment of the property as an affordable housing complex. It is understood that the single-story warehouse structure totaling approximately 40,000 square feet will be razed to give way to redevelopment.

1.1 Site Description and Topography

The site is located in the Yesler Terrace neighborhood of Seattle, Washington in the northeast quarter of Section 5, Township 24 North, Range 4 East of the Willamette Base and Meridian (W.M.) (Figure 1). The site is bound on the north by East Fir Street, on the south by East Yesler Way, and on the east by 13th Avenue. The site is currently developed with a single-story warehouse used for public records storage by King County Archives and Records Center. The site slopes to the southeast (Refer to Figure 2 for site layout).

2.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

The Property is located in the Puget Lowland physiographic province of Washington. This province is a basin which is bordered to the east by the Cascade Mountains and to the west by the Olympic Mountains. The Puget Sound Basin was partially filled with thick accumulations of sand, gravel, and till by at least four separate periods of glaciation within the past two million years. Periods of glaciation were followed by lacustrine, alluvial, and marine deposition of clay, silt, sand, gravel, and peat.

According to the Geologic Map of Washington – Northwest Quadrant (Washington Division of Geology and Earth Resources, 2002), 1:250,000 scale, the site is underlain by Pleistocene-aged glacial drift deposited as an end or recessional moraine.

The closest surface water to the site is Elliott Bay, an inlet of the greater Puget Sound, located approximately 1.1-miles to the west. Lake Washington is located 1.5-miles to the east of the Property.

3.0 BACKGROUND

3.1 Phase I ESA

In May 2017, SoundEarth Strategies, Inc. performed a Phase I Environmental Site Assessment (ESA) for the Property. The Phase I ESA report has not been provided to PBS for review. A Phase II report summarizing the Phase I noted that no recognized environmental conditions were reported in the Phase I ESA. However, a former gas station, three former dry cleaners, and an existing car maintenance facility were located within 250 feet of the Property in the upgradient direction with respect to groundwater flow.

3.2 Phase II ESA

A Phase II ESA was performed for the Property by Amec Foster Wheeler (Amec) in July 2017[1]. The Phase II included advancement of six soil borings along the western property boundary. One soil sample was collected from each boring at depths ranging from 10 to 16 feet below ground surface (bgs). Additionally, grab groundwater samples were collected from three of the six borings. The Amec Phase II ESA report presented the following findings:

- Total Petroleum Hydrocarbons (TPH) in the heavy oil range (TPH-HO) were detected in soil near the western property boundary at a concentration in exceedance of the Washington State Department of Ecology's (Ecology's) Method A Cleanup Levels for unrestricted land use. The soil sample in which TPH-HO was detected was collected from within the capillary fringe. Thus, there is a possibility that the TPH-HO may be attributable to an offsite source.
- Metals (arsenic, chromium, and lead) concentrations were reported in exceedance of cleanup levels in groundwater in the northwest corner of the Property. Additionally, arsenic was detected in groundwater in exceedance of cleanup levels in various locations along the western property boundary.
- A combined sewer is located within the vacated Mosler Avenue, which is now the alley between the Property and west adjacent properties. The combined sewer drains properties to the northwest, including several current and former auto body shops and dry cleaners. Leakage from the sewer in combination with releases at nearby properties may have contributed to groundwater contamination at the Property.

3.3 Follow-up Subsurface Investigation

In July 2019, PBS performed a limited subsurface investigation at the Property to further delineate contamination identified in the 2017 Amec Phase II ESA[2]. The subsurface investigation involved advancement of seven soil borings, which were also completed as temporary wells to facilitate collection of grab groundwater samples. Soil samples were collected from the soil borings at depths ranging from 2 to 15 feet bgs. Grab groundwater samples were collected from five of the seven borings. Drilling refusal at depths shallower than the groundwater table prevented collection of grab groundwater samples from the other two borings. The limited subsurface investigation report presented the following findings:

- TPH in the gasoline (TPH-G), diesel (TPH-D) and heavy oil (TPH-HO) ranges and benzene, toluene, ethylbenzene and xylenes (BTEX) were not detected above laboratory reporting limits in site soil samples.
- Groundwater across the property contains levels of metals, namely arsenic, chromium, and lead, at concentrations in exceedance of Cleanup Levels. It is noted that the groundwater samples collected from the property were grab samples collected from temporary wells, and that analytical results may be biased high based on the influence of sediment contained in the sample.
- Volatile organic compounds (VOCs) in groundwater do not appear to be migrating onto the Property from the west adjacent properties at the time of the investigation.

[1] *Phase II Environmental Site Assessment – 1215 E Fir Street, Seattle, Washington*. Amec Foster Wheeler Environment & Infrastructure, Inc., July, 2017.

[2] *Subsurface Investigation Report – 1215 E Fir Street, Seattle, Washington.* PBS Engineering and Environmental, September 24, 2019.

3.4 Vapor Intrusion Evaluation

Concentrations of VOCs in groundwater and sub-slab soil gas at the west adjacent properties have been confirmed to be above cleanup levels and MTCA Method B screening levels for sub-slab soil gas (screening levels), respectively. As such, PBS performed a vapor intrusion (VI) evaluation at the property in October 2019[3]. The VI evaluation was performed to evaluate sub-slab soil gas concentrations beneath the existing building slab. Sub-slab soil gas samples were collected from beneath the building slab via vapor pins in four locations. VOCs including 1,1,1-trichloroethane, TCE, ethylbenzene and xylenes were detected in various locations. Detected concentrations were below screening levels.

3.5 West Adjacent Properties

Extensive environmental investigation has been conducted since 1991 at the TD Auto Body & Repair and Seattle Curtain sites (collectively referred to as the west adjacent properties). The following findings at the west adjacent properties relate to environmental investigation and cleanup of the Site:

- Arsenic was detected in exceedance of cleanup levels (CULs) in groundwater samples collected in 2020 from monitoring wells along the southeast property boundary. These wells are considered upgradient from the Site.
- TPH-HO was detected in groundwater below CULs but in exceedance of concentrations detected on-site groundwater at locations throughout the west adjacent properties.
- The west adjacent properties were reported to contain substantial artificial fill material near the ground surface, apparently deposited from the original regrading of 12th Avenue.

4.0 CURRENT UNDERSTANDING OF NATURE AND EXTENT OF CONTAMINATION

The following section presents the current understanding of the nature and extent of contamination in soil and groundwater at the Property.

4.1 Contaminants of Concern

contaminants of concern (COCs) are defined as contaminants that have been detected at the property above their respective cleanup level in a given media. Based on investigation at the property to date, COCs at the property by media are as follows.

<u>Soil</u>

- TPH-HO

<u>Groundwater</u>

- Arsenic
- Chromium
- Lead

4.2 Extent of Contamination

<u>Soil</u>

Based on investigation conducted at the property to date, contamination of soil by TPH-HO is limited to a relatively small area in the southwestern portion of the property bound by borings BH-03 to the south, BH-04 to the north, BH-06 to the east, and the property boundary to the west. However, TPH-HO was not detected in at soil sample collected from boring BH-03 or surrounding borings, adjacent to the former TPH-HO exceedance in boring FIR-02. The soil samples were collected at similar depths. Field readings with a photoionization detector (PID) taken continuously from ground surface to total boring depth did not indicate the presence of volatile

[3] *Vapor Intrusion Evaluation – 1215 E Fir Street, Seattle, Washington,* PBS Engineering and Environmental, November 6, 2019.

contaminants in any of the borings advanced in the 2019 follow-up investigation. Based on the lack of observed TPH-HO in shallower soils in the vicinity of FIR-02, it is suspected that the detected concentration of TPH-HO in boring FIR-02 was due to the influence of groundwater containing TPH-HO saturating the soil sample. The lateral and vertical extents of soil contamination will be confirmed via soil sampling both during well installation and following demolition of the existing site structure.

Groundwater

Based on investigation conducted at the property to date, contamination of groundwater by metals is defined as site wide. Groundwater contamination by metals begins at the depth of the static water table. The vertical extent of groundwater contamination by metals will be confirmed via well installation and groundwater sampling.

5.0 REMEDIAL INVESTIGATION FIELD APPROACH

This section presents the field approach to achieve the objectives of the remedial investigation as follows:

- Confirm the presence of TPH-HO in soil in the southwestern portion of the property
- If present, define the extent of TPH-HO in soil in the southwestern portion of the property
- Confirm the presence and concentrations of metals in groundwater site-wide via analysis of groundwater samples collected from permanent, properly developed groundwater monitoring wells.

5.1 Drilling and Monitoring Well Installation

PBS will advance four soil borings using a hollow-stem auger drill rig to depths of up to 20 feet bgs. Prior to beginning the drilling investigation, PBS will file a public utility notification request, obtain street use permits from the Seattle Department of Transportation for wells to be installed within the city sidewalk. PBS will also contract a private utility locating firm to conduct borehole clearance prior to advancement of borings onsite.

Soil samples will be retained at five-foot drilling intervals for the purpose of lithologic logging and description. Samples will be field screened for volatile contaminants using a PID. Additionally, one soil sample from each boring will be submitted for laboratory analysis as described in section 7. Upon reaching total depth, the borings will be completed as 2-inch PVC flush mount groundwater monitoring wells with ten-foot screen intervals. Depth to water measurements will be collected periodically throughout boring advancement. Well screen intervals will be selected such that they intersect the static groundwater table at the time of well installation.

Proposed well locations have been selected to characterize groundwater contamination on-site and to preserve monitoring wells through site redevelopment as possible. Wells MW-1 and MW-4 are located within the city sidewalk to increase probability of well preservation during construction. Well MW-3 is located within a parking lot area in the proposed site concept design, and is will be preserved through site redevelopment if possible. Well MW-2 is located within the existing and proposed building footprint and is expected to be decommissioned prior to site redevelopment. Proposed monitoring well locations are presented in Figure 2.

Following completion of monitoring well construction, wells will be developed using typical surge, bail and pump techniques. A maximum of 50 gallons of groundwater will be removed from each well during well development.

Drilling spoils including soil cuttings and purge water generated during well development will be containerized in labeled, sealed drums and stored on site pending waste profiling and disposal.

5.2 Soil Sampling

One soil sample from each soil boring will be retained for laboratory analysis. Samples for analysis will be collected at depths corresponding to evidence of contamination as observed in the field. If no evidence of contamination is observed in a given boring, the soil sample for analysis will be collected from a depth of one to two feet bgs. Additional soil samples for laboratory analysis of TPH-HO only will be collected from the boring advanced in location MW-3 at depths of five and ten feet bgs.

In addition to soil samples collected during boring advancement, confirmation soil samples will be collected from beneath the existing building slab following slab removal and site excavation for construction purposes. It is anticipated that approximately 750 cubic yards of soil will be removed from beneath the existing building slab to facilitate placement of crushed rock for construction purposes. Following removal of surface soil for construction purposes, up to 30 soil samples will be collected from final grade prior to placement of crushed rock. A 50 by 50-foot grid will be overlain on the former building footprint and soil sample locations will correspond to grid centers.

Laboratory analyses for soil samples is presented in section 7.

5.3 Groundwater Sampling

Groundwater samples will be collected from the four on-site monitoring wells on a quarterly basis for one year, or until wells are destroyed to facilitate site redevelopment. A minimum of 72 hours will be required following well development prior to collection of groundwater samples. Groundwater samples will be collected using a peristaltic pump following low flow groundwater sampling techniques as specified in PBS' Standard Operating Procedure for Sampling Groundwater Monitoring Wells, a copy of which is provided in Appendix A.

Samples will be collected in laboratory supplied containers and stored on ice under chain-of-custody documentation pending transport to an Ecology accredited laboratory for analysis. Samples for analysis of metals will be both collected directly into an acid preserved container, as well as field filtered using a 0.45-micron field filter into an unpreserved container for analysis of total and dissolved metals, respectively.

Purge water generated during groundwater sampling will be containerized in labeled, sealed drums and stored on-site pending waste profiling and disposal.

6.0 POTENTIAL INTERIM REMEDIAL ACTION

If contaminants are detected in exceedance of cleanup levels in soil samples collected from soil borings or in confirmation soil samples collected from the building footprint following site excavation and grading, it is likely that interim remedial action by soil removal will be performed. Lateral extent of soil removal by excavation will be based on results of grid sampling. Vertical extent of soil sampling will be based on results of soil samples collected from borings advanced for well installation.

Excavation spoils generated from interim action by soil removal will be stockpiled on plastic sheeting on-site and sampled for waste disposal. Following completion of interim action by soil removal, additional confirmation soil samples will be collected from areas of soil removal to confirm the effectiveness of interim action. Confirmation soil samples will be collected on grid centers. An appropriate grid spacing will be determined following interim action based on the size of the area(s) of soil removal.

7.0 LABORATORY ANALYSIS

The following section specifies laboratory analyses and analytical methods for soil and groundwater samples.

Soil samples collected from soil borings advanced for well installation will be analyzed for the following parameters:

- MTCA-5 metals by EPA Method 6020
- TPH-G by Method NWTPH-Gx
- TPH-D and TPH-HO by Method NWTPH-Dx

Confirmation soil samples collected from grid centers following site grading and excavation for construction purposes, as well as confirmation soil samples collected from remedial excavations for interim action will be analyzed for the following parameters:

- TPH-G, TPH-D and TPH-HO by Method NWTPH-HCID

The NWTPH-HCID method does not provide quantitative concentrations, but rather confirms the presence or absence of the contaminant in the sample. Should TPH-G, TPH-D or TPH-HO be detected in confirmation soil samples, the sample with a positive detection will be analyzed for the detected compound by Method NWTPH-Gx for TPH-G or NWTPH-Dx for TPH-D and/or TPH-HO to confirm the concentration of the detected constituent.

Groundwater samples collected from on-site monitoring wells, including one duplicate sample per monitoring event, will be analyzed for the following parameters:

- MTCA-5 metals by EPA Method 6020
- TPH-G by Method NWTPH-Gx
- TPH-D and TPH-HO by Method NWTPH-Dx

8.0 INVESTIGATION DERIVED WASTE

Investigation derived waste (IDW) including drill cuttings, decontamination water, and purge water from well development and sampling will be containerized in labeled, sealed drums and stored on-site pending waste profiling and disposal. Purge water will be characterized using the results of quarterly groundwater sampling. One composite waste sample will be collected of soil cuttings. The sample will be analyzed for the constituents specified for soil samples in Section 7 with the following deviation: RCRA-8 metals rather than MTCA-5 metals will be analyzed by EPA Method 6020.

Following waste profiling, IDW will be disposed of in accordance with applicable local, state and federal regulations.

9.0 FIELD SCHEDULE

PBS will submit street use permit applications the week of November 23, 2020. Pending receipt of an approved street use permit, PBS plans to complete drilling, well installation and development in two days between December 28, 2020 and January 8, 2021. PBS will return to the site 3 days after well development for the first quarterly groundwater monitoring event. Groundwater monitoring events will be completed in one day. The first event is tentatively scheduled for January 13, 2021. Subsequent groundwater monitoring events are tentatively scheduled for March 17, June 16, and September 15, 2021. It is noted that the second quarterly groundwater monitoring event is scheduled less than a full quarter of a year from the first event to allow sampling of all four wells prior to the potential decommissioning of well MW-2 before commencement of building demolition and site grading activities. Well installation and sampling will require site access for PBS and its subcontractors in the four well locations presented on Figure 2.

PBS understands site demolition and construction are tentatively scheduled to begin March 31, 2021. Schedule for confirmation soil sampling and interim action, if warranted based on results of soil sampling, is tentatively set for one to two weeks in March 2021. Confirmation soil sampling will require site-wide access for PBS during and in the weeks following site grading activities and interim action (if completed).

IDW will be removed from the site following completion of waste profiling. If waste soil is found to be clean, it will be stored on site until construction phase of the project and bulked with excavation spoils for removal and offsite disposal. Drums of waste water, and waste soil if found to have disposal restrictions based on sample results, will be removed from the site in February 2021. Drum removal will require access to the existing site structure by PBS and its subcontractor for approximately 1 to 2 hours.

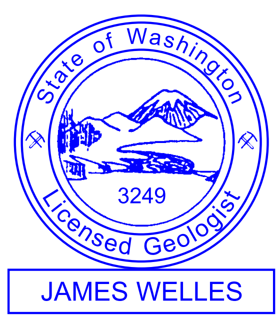
A remedial investigation report along with quarterly groundwater monitoring reports will be submitted to Ecology for formal opinion. Pending issuance of a No Further Action determination, or agreement from Ecology that additional groundwater monitoring is no longer required at the site, monitoring wells will be decommissioned in accordance with state regulations. Schedule for well decommissioning is not known at this time. Well decommissioning will require site access for PBS and its subcontractors in the four well locations presented on Figure 2.

10.0 LIMITATIONS

PBS has prepared this work plan for use by Big Village, LLLP, SCIDpda and their development partners SHA and Community Roots Housing. This document is for the exclusive use of the client and its partners and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without the expressed written consent of the client and PBS.

Sincerely,
PBS Engineering and Environmental Inc.

Digitally signed by James Welles
Date: 2020.11.20 13:55:23 -08'00'

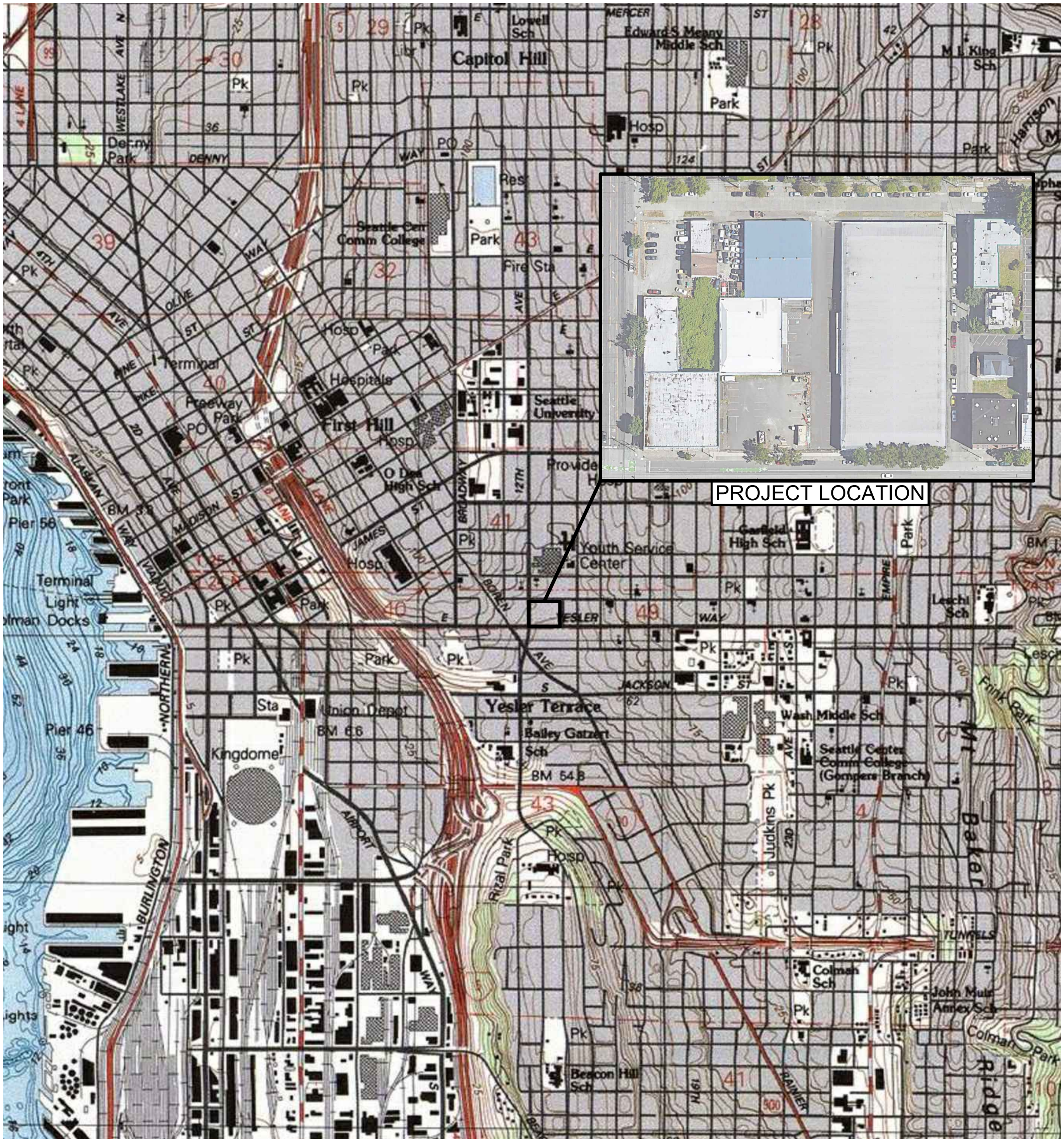


James Welles, LG — Date
Project Geologist

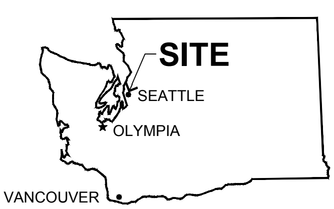
Digitally signed by Melanie Young
Date: 2020.11.20 14:09:37 -08'00'

Melanie Young, PE — Date
Senior Environmental Engineer

FIGURES



SOURCE: USGS SEATTLE SOUTH E, WA QUADRANGLE 1978, PHOTO REVISED 1983.



WASHINGTON

Scale 1" = 2000'

0' 1000' 2000' 4000'

PREPARED FOR: BIG VILLAGE LLLP

PBS

VICINITY MAP

1215 EAST FIR STREET
SEATTTLE, WASHINGTON

NOV 2020
41593.000

FIGURE
1

SOURCE: © 2019 GOOGLE EARTH PRO

LEGEND

MW-1 PROPOSED MONITORING WELL NUMBER AND LOCATION

N

Scale 1" = 60'

0' 30' 60' 120'

PREPARED FOR: SCID

PBS

PROPOSED MONITORING WELL LOCATIONS

1215 EAST FIR STREET
SEATLE, WASHINGTON

NOV 2020
41593.005

FIGURE
2

APPENDIX A

Standard Operating Procedures

STANDARD OPERATING PROCEDURE
Drilling and Soil Sampling Procedures

1 PURPOSE
This Standard Operating Procedure (SOP) provides an overview of mobile drilling methods typically used during environmental investigations along with associated health and safety issues. This document outlines procedures to be followed by PBS personnel during drilling and soil sampling activities. Groundwater and soil gas sample collection through the use of drill rigs are covered under separate SOPs.

2 TYPES OF DRILL RIGS
There are three types of drilling methods that are typically used for environmental investigations: direct push, auger, and sonic. Each type of drilling method is described below. A fourth option, discussed in Section 2.4, is a hand auger tool.

2.1 Direct-Push Drilling
Direct-push drilling methods are a common drilling technology used in environmental investigations due to the small diameter borehole (two and one-quarter inch (2.25")) that generates significantly less investigation-derived waste (IDW). The rigs are hydraulically powered, and use static and percussion force to advance the drill rods. Limited access rigs are available for interior locations while track-mounted rigs allow for sampling in locations with unimproved roads.

The rods are equipped with disposable plastic liners that contain the soil retrieved for observation and sampling. The entire column of rods is removed from the ground each time to retrieve soil for sampling. The rod lengths can be 3, 4, or 5 feet. Because of this, if caving or excessive slough is a concern, the borehole may be temporarily cased to keep it clear and open during soil sample retrieval.

2.2 Hollow Stem Auger Drilling (HSA)
Hollow stem auger drilling methods use hollow corkscrew drilling flights to advance into the subsurface. The borehole is typically 11 inches in diameter, with the flights having a 6-inch inner diameter space in which to retrieve samples or construct wells. The hollow stem auger drill rigs have better capability to penetrate higher density deposits that the direct push probe method. Some direct-push rigs have the capacity to drill with hollow stem auger flights, but these rigs typically do not have the mechanical power to drill through challenging soil. The use of auger drill rigs for environmental investigations is typically for the installation and decommissioning of monitoring wells.

Soil sampling with an auger drill rig is conducted through the use of split spoon samplers or Shelby tubes deployed through the inner hollow space. Split spoon samplers are typically 2.5 feet in length and advanced by hammer weight blow into the undisturbed soil. Shelby tubes are typically used in soft deposits such as clays. Soil brought to the surface on the exterior of drilling flights is considered drill or soil cuttings. Soil samples should not be collected and analyzed from the cuttings because that soil may have come in contact with other soil or contamination from varying depths.

2.3 Rotosonic Drilling
Rotosonic drilling methods (hereafter referenced as sonic method) advance drill rod flights into the ground through the use of vibration, and full-size sonic rigs can advance rods through very challenging unconsolidated geologic formations including large cobbles. The borehole size varies but typically is 4 to 6 inches in diameter.

Due to the nature of the drilling technology, the soil can be disturbed by the vibrations, so consistency and compaction are unreliable. Soil is vibrated out of the lead flight into plastic bags for observation and sampling. The entire column of rods is removed from the ground each time to retrieve soil for sampling; if caving or excessive slough is a concern, the borehole may be temporarily cased to keep it clear during soil sample retrieval.

2.4 Hand Auger Tool

A fourth drilling option is the use of a hand auger tool, sometimes called a handheld auger. This tool, made of steel, is used to bore a hole in soil or sediments. It is intended for use only by hand and is powered by human force by twisting or screwing the tool into the soil. The soil is retrieved through a short barrel that attaches to the base of the auger rods. This tool is used for sites where the soil is relatively easy to penetrate, and when sampling is limited to the upper 5 to 10 feet of the shallow surface. Different barrels are available for coarse-grained or fine-grained material.

3 HEALTH AND SAFETY PLAN

A Health and Safety Plan (HASP) must be developed prior to fieldwork commencing. Typically, a site-specific HASP is prepared from a PBS template for drilling investigations. In all cases, pertinent safety information must be relayed to field personnel, including subcontractors, to communicate mandatory elements from the federal code for hazardous waste operations and emergency response (29 CFR 1910.120(b)(4)).

4 UTILITY LOCATES

Utility locates will be completed on all drilling projects including hand-augered sampling. The property owner or site manager should be interviewed regarding the potential location of buried utilities or other subsurface obstructions on the property. The call-in numbers are provided below. Alternately, PBS personnel can obtain log-ins to file locate requests on-line (Internet Ticket Processing, http://www.callbeforeyoudig.org/index.asp).

Oregon Utility Notification Center: 1-800-332-2344
Washington Utility Notification Center: 1-800-424-5555

The Utility Notification Center needs to be contacted at least 48 hours (two business days) in advance to locate utility-owned lines up to the meter (e.g., water, gas, electric), and public utilities within the public right-of-way (e.g., sewer). In addition, a private utility locating company is typically contracted to survey for private utilities such as utility lines from meters to buildings, drain lines, buried electric cables, or irrigation and sprinkler lines.

When filing utility notification requests, PBS personnel should be as specific as possible about where to locate. Washington law requires that the proposed excavation/drilling work areas are field-marked with white paint prior to the locating event.

When beginning a project, PBS personnel must carefully think through where boreholes can be safely drilled, considering both subsurface and overhead obstructions. A site walk may be prudent once the utilities have been marked and prior to the drilling fieldwork. If safe drilling conditions cannot be confirmed, the PBS Project Manager should determine if engineering controls should be implemented, such as shielding or shutting down utility and/or power lines.

SAFETY NOTE: Drill rig masts must be a safe distance from overhead power lines to prevent mast lines and power lines being moved together by wind. Occupational Safety and Health Administration (OSHA) rules for drillers require a minimum distance of 10 feet, with additional spacing required depending on the voltage carried by the power line. The drill rig subcontractor is responsible for ensuring sufficient clearance. However, PBS personnel should verify that potentially unsafe conditions do not exist.

5 SAFETY EQUIPMENT REQUIREMENTS

The following safety equipment is required for all drilling investigations:

- Hard hat
- Hearing protection (ear muffs or plugs, must be worn when drill rig is in operation)
- Safety-toe work boots
- Safety vest
- Gloves (typically disposable)
- Safety goggles or glasses
- Life vests (only when working over water)

6 FIELD EQUIPMENT AND SUPPLIES REQUIREMENTS

The following equipment is typically required for drilling projects when soil sampling will occur. Groundwater or soil gas sampling is discussed in separate SOPs. PBS personnel should confirm that the drilling contractor will provide decontamination water, soap, brushes, and buckets.

General field supplies/equipment includes:

- 5-gallon buckets
- Bags (garbage)
- Bags (plastic zipper-type)
- Camera
- Cellular telephone and phone numbers of client, project laboratory, subcontractors, etc.
- Field notebook or daily log
- Measuring tape
- Paper towels
- Pens
- Spray paint (optional)

Soil sampling supplies/equipment includes:

- Project proposal/scope of work
- Alconox/Liquinox or similar decontamination detergent
- Distilled water (for decontamination)
- Environmental borehole log forms
- Hand auger (if required by scope)
- Ice chest with blue ice or party ice
- Nitrile or other chemically compatible gloves
- Photoionization detector (PID)
- Sample chain-of-custody forms
- Sample containers (ask lab about sample volume, preservatives, etc.)
- Sampling spade or spoons (if required by scope)

7 PRE-DRILLING ACTIVITIES

The following tasks must be performed before beginning work:

- Conduct tailgate safety meeting with all field personnel, including visitors such as the client or regulator; review Health and Safety Plan.
- Install traffic cones/barrier tape or other barrier to control pedestrian and vehicle access to work area as necessary.

The drilling subcontractor is responsible to ensure that the area on which the rig is to be positioned is cleared of removable obstacles and the rig should be leveled if parked on a sloped surface. The cleared/leveled area should be large enough to accommodate the rig and supplies. PBS personnel must confirm that the work area is cleared and safe for work prior to initiating drilling activities.

8 SOIL SAMPLING PROCEDURES

8.1 Logging and Field Screening Soil

Upon retrieval of the soil, describe as per the Geo-Environmental Field Classification chart for soil (included as an attachment). Record observations on an environmental borehole log.

If conducting head-space screening with a PID, remove one-quarter to one-half cup of soil and place in a sealable plastic bag. Seal the bag, break up the soil, and let sit for a minimum of five minutes (in colder weather, either wait for 15 to 30 minutes or put into a warm car or room). The purpose of the headspace screening is to measure what is off-gassing from the sample, and sufficient time must be allowed for that to occur. After the appropriate interval, place the end of the PID probe into the bag (through a small opening in the "zipper") and record the peak value.

If performing sheen testing, place a small sample volume (preferably darker or stained material) in a bowl partially filled with water and observe sheen indicative of petroleum contamination.

8.2 Collecting Soil Samples for Laboratory Analysis

Prior to collecting a sample for laboratory analysis, the sampler should don new gloves. If there are multiple samples to be collected from a single borehole, the gloves should be replaced to avoid cross-contamination.

Collect soil samples using a gloved hand or a clean sampling tool and place directly into the sample jar(s). For volatile organic compounds (VOCs), pack the soil to minimize jar headspace, or field preserve for VOCs using EPA Method 5035 (the field kit is obtained from the laboratory). Label samples as described under Section 8.3 Sample Numbering. Place labeled sample container(s) in the cooler with ice.

8.3 Sample Identification

Sample labels will be completed and attached to the jars in the field to prevent misidentification. All sample labels will include the following information:

- Project name or number
- Sample identification
- Sample collection date and time

The sample identification is unique to a particular sample and the format must be consistently used for all samples collected at the site. The sample identification typically includes the sample location and the collection depth. The sample location is the soil boring number or otherwise designated sample location. Standard abbreviations for sample location types are:

- DP = Direct push
- MW = Monitoring well
- SB = Soil boring
- SE = Sediment
- SO = Surface soil
- SS = Soil sample
- TP = Test pit
- WP = Well point

Examples of sample identifications are: DP-5 (4'), SS-22 (1'), and MW-3 (15')

Other naming conventions may be used, as long as the labeling is consistent and each location is clearly identifiable.

9 BOREHOLE ABANDONMENT

The licensed driller is responsible for abandoning boreholes in compliance with state regulations. PBS personnel should ensure that this occurs, and that the sealing material (typically bentonite chips) is sufficiently hydrated for a proper seal. State regulations governing this are:

- Oregon Administration Rule (OAR) 690-240
- Washington Administrative Code (WAC) 173-160

10 DECONTAMINATION PROCEDURES

Minimizing the possibility of cross-contamination between samples is a critical component of a successful soil sampling project. This is achieved by consistent and thorough decontamination of sampling equipment, such as drill rods, sampling devices (split spoons, trowels, etc.), and other tools that may come in contact with soil to be sampled.

For drilling equipment, the drilling contractor is responsible for the decontamination procedures. Typically, a pressure washer with hot water or water with added detergent is used to clean drill rods and other equipment. The use of a steam cleaner is not appropriate because of the risk of burns, and steam cleaners do a poor job of removing soil particles from equipment.

For equipment and supplies used by PBS personnel, water with added detergent is typically used for decontamination. Alternately, disposable supplies, such as gloves and sampling scoops, can be used to avoid having to decontaminate them.

PBS field personnel should work with the PBS Project Manager to confirm the appropriate decontamination procedure for each project. For example, it may be important to know the source of the driller's water used for decontamination, and distilled or deionized water may need to be used to clean hand tools.

All water and sludge generated during decontamination will be captured for later disposal. Release of water directly onto the ground or into drains or catch basins is not allowed.

11 INVESTIGATION-DERIVED WASTE

Investigation-derived waste consists of soil cuttings, decontamination water, purge water (if groundwater is encountered), and personal protective equipment (e.g., nitrile gloves, rags, paper towels, Tyvex suits, disposable bailers, and tubing). All disposable personal protective equipment may be disposed of as general refuse unless otherwise instructed by the PBS Project Manager.

Soil cuttings are typically placed in 5-gallon buckets or other appropriate containers during the execution of the fieldwork, and transferred to 55-gallon drums as the project progresses. If appropriate, the cuttings may remain in buckets as long as tight-fitting lids are placed on each bucket. For some projects, the PBS Project Manager may request that decontamination/purge water be placed into the same drums as the soil, instead of keeping the two media separate. Depending on the type of contamination, this may result in cost savings for the client during disposal. Field personnel should confirm how to contain soil and water prior to each field event.

11.1 Drum Labeling

The storage containers must be labeled as hazardous, non-hazardous, or unknown pending laboratory results. The labels must be completed using an indelible marker and include:

- Date that the contents were generated
- Nature of the contents - for example:
    - Drill cuttings
    - Purged groundwater
    - Decontamination water and/or sludge
- Contact phone number in the event emergency response personnel need to identify the contents of the container.

Drums or other storage containers should be placed in as secure a location as possible, which may be a building if the exterior area is not secure from vandalism.

12 POST-DRILLING ACTIVITIES

Upon return to the office, PBS personnel should:

- Clean and calibrate equipment prior to placing back into storage. If there were any operational issues noted, they should be reported immediately to the equipment manager.
- Submit field borehole logs for electronic formatting for future reports.
- Submit the daily field notes to the PBS Project Manager for placement into the project file. If a field notebook was used, and that notebook is not dedicated to that project, a copy of those notebook pages should be submitted.

STANDARD OPERATING PROCEDURE
Sampling Groundwater Monitoring Wells

1 BACKGROUND AND PURPOSE

Groundwater samples are collected from monitoring wells for analysis of physical and chemical parameters, either by using field observations and portable equipment and/or using established laboratory analytical methods. The goal of this process is to obtain groundwater samples that are representative of the aquifer (i.e., avoiding a sample that has been impacted by surface or atmospheric conditions).

Low-flow or zero volume purging and sampling methods were developed to produce samples with the least amount of interference resulting from the collection method. Low-flow purging techniques became the industry standard for collecting a groundwater sample because the methods slow groundwater velocity to the well, minimize turbidity and agitation in the water column, and reduce the volume of purged groundwater requiring disposal. These techniques include the use of pumps dedicated to specific wells or the use of a portable pump system. A zero volume/no purging method requires installation of a collection vessel within the well prior to the sample collection event, allowing the water column within the well to equilibrate with the aquifer prior to retrieving the sample. The appropriate technique is dependent on project-specific goals and data quality requirements. Sampling methodology should be confirmed with the PBS project manager (PM) prior to preparing for groundwater monitoring.

The procedures in this Standard Operating Procedure (SOP) are specific to standard monitoring wells with a single-slotted interval. It is assumed that low-flow purging and sampling protocols are used, although these protocols can be easily adjusted for other sampling methods. Temporary borings advanced for a single field event may be sampled using the techniques presented in this SOP.

2 EQUIPMENT AND SUPPLY LIST

- Well lock keys
- Groundwater Sampling Field Form and Depth to Groundwater Field Form
- Copies of field forms and data tables from previous groundwater monitoring event
- Electronic water level probe or interface probe (if dense or light non-aqueous phase liquids [DNAPL or LNAPL] are potentially present)
- Tubing cutters, knife or scissors (note: some sites do not allow the use of a knife on-site)
- Decontamination equipment
- Measuring cup
- Safety cones
- Bolt cutters
- Replacement well caps, bolts, and padlocks
- Small cup, turkey baster, or large sponge to purge standing water inside well monument
- Fish hooks, stainless steel weight, and fishing line to retrieve objects in the well
- Site map and health and safety plan

- Personal protection equipment (PPE) required for the site, including nitrile gloves (confirm with site-specific health and safety plan)
- Submersible pump or peristaltic pump and associated equipment
- Compressed gas source (nitrogen or air compressor), battery source, or generator and fuel
- Control box
- Disposable tubing, if necessary
- Flow-through cell and water quality parameter meter (e.g. YSI model)
- Buckets or containers for purge water and drum labels
- Sample containers, labels, packaging material
- Coolers and ice for samples

3 PROCEDURE

This section outlines standard procedures used for collecting groundwater samples from a monitoring well. Project Managers may modify or remove tasks as dictated by project needs; for example, turbidity or depth-to-bottom measurements may not be warranted at a site with sufficiently developed wells.

Preparation for a monitoring event begins in the office. The first step is to read the scope of work (e.g., proposal, sampling and analysis plan (SAP), work plan) to determine the number and location of monitoring wells to be sampled, health and safety considerations, quality control (QC) samples needed, sample containers required, and equipment needed for the site (peristaltic pump, bladder pump, both, etc.). Recommended preplanning procedures are as follows:

- Prepare, review, or update Health and Safety Plan (HASP) for the site.
- Obtain appropriate PPE for the site (e.g., hard hat, safety vest, gloves, safety glasses, life vest, flame retardant [FR] shirt or other client-required PPE).
- Determine number and type of samples to be collected.
- Determine which laboratory can meet analytical requirements (required analysis, screening levels).
- Order sample containers from laboratory, making sure to order QC sample containers and at least one extra set of containers. Ensure that a Safety Data Sheet (SDS) is provided for any sample preservative supplied by the laboratory.
- Print all forms needed for sampling event (work plan, HASP, depth to water forms, groundwater sampling forms, labels, chain of custody, etc.).
- Schedule PBS vehicle and equipment use on PBS calendars, as warranted.
- Order rental equipment for sampling event, if not available internally.

After arriving at the site, the following procedures should be followed:

- Don appropriate PPE and place safety cones around the work zone, if required by the HASP or deemed necessary by site conditions.
- Open all of the monitoring wells on-site and wait a minimum of 15 minutes for water levels to approach an equilibrium state with atmospheric pressure before taking any measurements.

- Note the general condition of the well on the depth to groundwater field form. Check well for damage or evidence of tampering, and record pertinent observations. Note any maintenance tasks that should be completed, such as well cap or padlock replacement.
- Collect depth to water measurements from each monitoring well, decontaminating the probe between locations. If possible, gauging should be conducted in order from the least to the most contaminated well. The measurements should be collected from all wells prior to beginning sample collection, unless project scope or site conditions indicate otherwise.
- Measure the depth to water relative to the marking on the well casings. If there is no mark, use the north side of the casing. Record the water level on the depth to groundwater field form. Note if DNAPL or LNAPL is present (this typically requires a meter capable of detecting NAPL-water interfaces). If NAPL is present, additional decontamination procedures will be warranted.
- Measure depth to bottom of well to record if sedimentation in the well has occurred.
- Make sure all information is completed on the depth to groundwater field form and sign and date it.

Sampling a groundwater monitoring well utilizing low-flow techniques relies on stabilization of field water quality parameters to determine when groundwater is representative of aquifer conditions. Measurement of groundwater quality parameters with a water quality parameter meter occurs in a closed system in which groundwater does not come in contact with open air; this is important for valid measurements because dissolved oxygen (DO), oxidation-reduction potential (ORP), and pH measurements can be sensitive to reactions with the atmosphere. A flow-through cell (flow cell) connected to the water quality parameter meter provides this closed system and is used to measure field parameters prior to collecting groundwater samples. Stabilization of selected parameters indicates that collected groundwater is representative of the aquifer and conditions are suitable for sampling to begin. See protocol below for stabilization parameters.

Low-flow purge and sample methods require care when placing a portable pump and/or tubing in the well to minimize disturbance to the water column. Pumping rates must be maintained at 0.1 to 0.5 liter per minute to reduce drawdown; the pump should never be run higher than 0.5 liters per minute prior to sampling.

For monitoring wells, sampling should proceed as follows:

- If using a portable pump setup, slowly lower the pump or tubing to the midpoint of the screen or sample interval. Secure the pump or tubing at the surface to prevent it from moving (not applicable if using dedicated pumps).
- Connect the bladder pump (attaching control box, compressor or nitrogen tank with regulator) or peristaltic pump to flow cell containing water quality parameter probes. Place the water level probe in the well so water levels can be measured as you are pumping. Start the pump and adjust the pumping rate to between 0.1 and 0.5 liters per minute (using a measuring cup to calculate the flow rate). Begin recording readings on the groundwater sampling field form. Be sure to purge the initial volume of water in the tubing before taking a reading.
- During purging, record readings of groundwater parameters (listed below) and water level every 3 to 5 minutes on the groundwater sampling field form. A drawdown of less than 0.3 feet in the water column, once the pumping rate has stabilized, is desirable; however, less permeable aquifer material or a clogged well filter pack may result in a deeper drawdown. At a minimum, the depth-to-water should be stabilized for three consecutive readings taken between 3 to 5 minutes apart (in conjunction with the stabilization of the other parameters). Visually describe and record turbidity. Purging is considered complete when the groundwater parameters have stabilized for three consecutive readings.

Field Parameter	Stabilization Goal
Temperature	+/-3%
Specific Conductance	+/- 3% mS/cm
pH	+/- 0.1 pH units
DO	+/- 10% or +/- 0.3 mg/L
ORP	+/- 10 millivolts
Depth to Water	+/- 0.3 feet

Please note that multi-parameter meters may have a resolution greater than the stabilization goal. Note the meter capabilities. If the field parameters do not stabilize within the stabilization goal, but are within the resolution of the meter, it may be acceptable to collect a sample in this scenario. This MUST be noted on the field form.

- Measure turbidity of the sample water using field instruments prior to sample collection and upon any obvious visual changes in turbidity during sample collection.
- Prior to collecting the water sample, the tubing originating in the well must be disconnected from the influent (inflow) side of the flow cell.
- Directly fill the sample containers from the tubing originating in the well. If you are collecting samples for volatile organic compound (VOC) analysis, you may need to decrease the pump rate to minimize volatilization of compounds from the sample; if this is the case, other samples should be collected first. You may restore the flow rate upon completion of filling sample containers for VOC analysis. Fill unpreserved bottles first. Filtered samples should be collected after all other samples have been collected.
- Groundwater samples collected for VOC analysis must be collected with zero headspace in the sample vial. This can be confirmed by gently tapping the sealed vial against a gloved hand to ensure that air bubbles are not present.
- If a duplicate sample is required for the well, it should be filled concurrently with the regular sample. This is accomplished by alternating bottles of the same type during sample collection (e.g., filling one bottle from each sample, then the second bottle from each sample.)
- Groundwater samples for dissolved metals analysis must be field filtered with a 0.45 micron filter directly connected to the tubing. Mark “field filtered” or “FF” on the bottle label, field form, and chain of custody.
- Prior to filling or just after filling, label each bottle with the project name, sample name, and sample date and time, and make sure it is properly sealed. The sample containers may also be labeled with what analysis will be performed (confirm with Project Manager). Place in a cooler with ice and pack for transportation.
- As necessary, pull pump and discard tubing. Decontaminate the pump based on the decontamination procedures established for the site.
- Make sure all information is completed on the groundwater field form and sign and date it.
- Close and lock the well.
- Contain purge and decontamination water in the appropriate containers as established for the project.
- Dispose of used sampling supplies and other waste in appropriate container as established for the project.

If low-flow sampling is not used at the site, these procedures should be modified as appropriate. The objective is to provide high-quality groundwater samples representative of the aquifer. Modifications to this SOP should keep this objective in mind at all times.

After fieldwork is completed:

- Ensure that chain-of-custody form has necessary information including site name, project manager, sample names, date and time collected, requested analysis, special notes (field filtered, MS/MSD, etc.).
- Scan and save field sheets to project folder on server. Retain original field copies in project folder; these are legal documents and should be retained as per PBS guidelines for document retention.
- Report any sampling or well maintenance issues to the project manager for evaluation and remedy.
- Clean and store PBS equipment for use on next project. Report any equipment damage or malfunctions or missing/depleted calibration solutions to the office equipment manager.
- Ship rental equipment back to vendor immediately to minimize project costs. Borrowed PBS equipment should be returned promptly to the lending office.

References

Puls, R.W. and M.J. Barcelona. *Groundwater Issue Paper: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. US Environmental Protection Agency, EPA 540-S-95-504 (1996).

Yeskis, D. and Bernard Zavala. *Groundwater Issue Paper: Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers*. US Environmental Protection Agency, EPA 542-S-02-001 (May 2002).