2024 PCB Assessment Work Plan
Revision 1

Seaport Midstream Partners, LLC
Portland Terminal
9930 NW St. Helens Road
Portland, Oregon
ECSI #1528

Project number: 60733311

December 23, 2024

Delivering a better world

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	2024-12-23	Revised per DEQ Comments	2024-12-23	Thomas Bialobok	Project Manager

Distribution List

# Hard Copies	PDF Required	Association / Company Name
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0	Yes	Doug Hall / SeaPort Midstream Partners
0	Yes	Brian Hoyman / SeaPort Midstream Partners

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Table of Contents

Figures

Tables

Appendices

Acronyms

bgs	below ground level
B1A	designated area of Portland Superfund Site located on the Lower Willamette River
BP	BP Products of North America, Inc. and its affiliates
CPD	City of Portland Datum
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CUL	Cleanup Level
DQCR	Data Quality Control Report
DEQ	Oregon Department of Environmental Quality
EPA	Environmental Protection Agency
ft	feet
HASP	Health and Safety Plan
JSA	Job Safety Analysis
LLC	limited liability company
LNAPL	light non-aqueous phase liquid
mg/kg	milligrams per kilogram
MW	monitoring well
NAPL	non-aqueous phase liquid
OWS	oil-water separator
PCBs	polychlorinated biphenyls
PPE	personal protective equipment
SMP	Seaport Midstream Partners, LLC
SOP	standard operating procedure
µg/L	micrograms per liter
µg/kg	micrograms per kilogram

1. Introduction

Under the direction of BP Products North America Inc. (BP) and their consults, AECOM has prepared this work plan regarding the Seaport Midstream Partners, LLC (SMP) Bulk Fueling Terminal (Portland Terminal), located in Portland, Oregon, on behalf of SMP and BP. This work plan is for the proposed second phase of fieldwork designed to evaluate if there is a potential upland source of PCBs behind Lower Tieback 09 (adjacent to which PCBs were detected in sediment samples collected in 2023) or the nearby oil water separator (OWS) which was abandoned in place in 2008. The work plan for a proposed second phase of the assessment will include groundwater collection from existing monitor wells and upland soil samples from five new borings to be advanced upland of Lower Tieback 09.The 2024 Upland PCB Screening Report (AECOM, 2024c) presents the results of the first fieldwork phase, completed in September 2024.

For clarity, a timeline of deliverables and field work associated with locating potential upland sources of PCBs is included below:

August 2023: PCBs detected outboard of Lower Tieback 09 (Jacobs, 2024; AECOM, 2024a)

May 2024: Request from DEQ for additional upland investigation (DEQ, 2024)

September 2024: 2024 PCB Screening Work Plan (AECOM, 2024b)

December 2024: 2024 PCB Screening Report, Revision 1 (AECOM, 2024c)

December 2024: 2024 PCB Assessment Work Plan, Revision 1 (this document)

1.1 Project Background

The Portland Terminal is a bulk petroleum product storage and transfer facility located at 9930 NW Saint Helens Road (Oregon Highway 30) in Portland, Oregon (Figure 1). The Portland Terminal is bordered to the east by the Willamette River, to the west by NW Saint Helens Road, to the north by the former Linnton Plywood Association property (now Linnton Water Credits), and to the south by the NuStar Energy LP Bulk Terminal (Figure 2). The Portland Terminal is located at River Mile 4.9 of the lower Willamette River and is adjacent to the Portland Harbor Superfund Site.

The Portland Terminal consists of a 14-acre facility with 27 above-ground storage tanks, a truck loading rack, several buildings, a remanufacturing warehouse, a dock structure, a boat house, a groundwater extraction and treatment system, and a sheet pile wall (seawall) along the riverfront. The facility operation includes bulk petroleum storage, additive storage, fuel blending, and the transfer of bulk petroleum via pipeline, barge, and rail throughout the region (AECOM, 2021a).

The seawall was constructed in 2009. It consists of a 40-foot AZ-18 sheet pile with two levels of tieback anchors at 20 and 10 feet (ft) above the City of Portland Datum (CPD) (23.2 and 13.2 ft above Columbia River Datum). Tieback anchors on the bottom row are spaced at about 12.4 ft on center. Foam was used to seal perforations where the tiebacks were installed in the sheet pile. A sealant (Roxan™ or equivalent) was placed within the sheet pile interlocks.

Suspected petroleum hydrocarbons were observed in the engineered fill material outboard of the seawall, causing a sheen on the water surface on December 13, 2021. In response to the sheen observed, AECOM conducted tieback inspection and maintenance activities on the seawall in 2022 and 2023, as documented in the Seawall Maintenance Construction Completion Report (AECOM, 2022), and the Seawall Maintenance Tieback Inspection Summary Report (AECOM, 2024a). Four tiebacks in 2022 and twelve in 2023 were exposed and inspected for signs of seeps and leaks.

To streamline sampling efforts on the river side of the seawall, SMP voluntarily granted site access to the Portland Harbor Superfund Site B1A group to complete independent sampling at each of the 2023 tieback inspection locations. B1A group members include two previous Portland Terminal owners and operators (Atlantic Richfield Company and BP Products North America Inc.) and three other companies that are current or former owners of facilities located near the Portland Terminal. During the 2023 inspection event, PCBs at a concentration of ~5 milligrams per kilogram (mg/kg) were detected in the B1A group sample of visually-impacted-fill collected at a depth of 5.5 ft below the surface, immediately beneath Lower Tieback 09 (Jacobs, 2024) (sample location TP-01-TB09 in Figure 3). A lower concentration of PCBs was detected in a 5-foot-deep sediment sample collected 10 ft riverward of Tieback 09 (sample location TP-01 in Figure 3). All visually-impacted-fill was excavated and disposed of offsite (AECOM, 2024a).

1.2 Potential Upland Sources of PCBs

In 2011, Atlantic Richfield Company responded to an USEPA CERCLA Section 104e Information Request (ARC, 2011) about potential PCB sources on site, stating that:

> "PCBs were possibly used in cathodic rectifier oil and fluorescent lights. In the 1990s, the Terminal conducted a survey and removed all equipment potentially containing PCBs. During a routine upgrade in November 2005, fluorescent lamps from the office building were replaced. Based on the apparent age of the bulbs and fixtures, it was assumed that these lamps possibly contained PCBs. There were no releases of PCBs or PCB containing oil to the environment. Please see the documents provided in response to Request 40 for further information and documentation."

The referenced survey did not identify any potential PCB-containing transformers at the Terminal or locate any records of PCB-containing equipment; but in an abundance of caution, the survey identified the items mentioned above as potentially containing PCBs prior to the 1970s. The cathodic rectifier oil units were historically located in an "electrical building" outside the southwest corner of the North Tank Farm (labeled in Figure 2). The precise location of the building is unknown, but the equipment was stored indoors and there were no known releases of cathodic rectifier oil into the environment. The fluorescent lights were located within the building labeled "office" in Figure 2. There is no record of any breakage of the fixtures and all were located entirely indoors so there was no known pathway for releases into the environment.

A former OWS decommissioned in place during seawall installation in 2007 is located behind the seawall adjacent to Lower Tieback 09. It was historically used to treat stormwater runoff before discharging to the Willamette River. No other information is available regarding the use of this OWS.

1.3 Project Objectives and Overview

In an email from Jeff Schatz dated May 29, 2024, the Oregon Department of Environmental Quality (DEQ) requested sampling behind the seawall to determine whether there any potential source of PCBs at the Terminal may enter the river and require response action under the Portland Harbor Superfund Site remedy. As discussed in Section 1.2, no records have been found of any PCB-containing transformers or other sources of PCBs at the facility. The only indication that there may be PCBs in upland media is the measurement of PCBs in sediment sampled adjacent to Lower Tieback 09 as described in Section 1.1

DEQ's request is being addressed in two Phases. In the PCB Screening Phase, existing well points upgradient of Lower Tieback 09 were sampled to evaluate the possibility that PCBs are present around the perimeter of the PCB Screening focus area. The PCB Assessment Phase includes advancement of new soil borings to examine soils in the area immediately upland of Lower Tieback 09 and around the adjacent former OWS.

1. In the PCB Screening Phase, particulates from seven existing wells and groundwater from two monitor wells indicated in Figure 3 were sampled for PCBs (as Aroclors). PCBs were not detected above the method detection limits in samples collected during the screening phase. Details regarding the field activities, observations, and analytical results are included in the 2024 PCB Screening Report (AECOM, 2024c).

2. For the PCB Assessment Phase, five soil borings will be advanced, and soil samples collected and analyzed for PCBs as congeners by EPA Method 1668A to achieve lower detection limits and allow comparison to the Portland Harbor Record of Decision cleanup level (CUL) of 9 µg/kg (EPA, 2020). The assessment will focus on the area immediately upland of Lower Tieback 09 and around the adjacent former OWS. In addition, the two monitor wells sampled in the PCB Screening Phase will be resampled and analyzed for PCB congeners using Method 1668A to allow comparison to the groundwater CUL of 0.014 µg/L (EPA, 2020).

1.4 Work Plan Organization

This Work Plan is organized as follows:

- Section 1. Introduction, Project Objectives, and Overview
- Section 2. Sampling Design and Approach
- Section 3. Laboratory Analysis and Methodology
- Section 4. Reporting and Work Schedule

2. PCB Assessment Sample Design and Approach

As described in Section 1, the objective of the PCB Assessment Phase is to collect upland subsurface soil and groundwater to determine if there is any potential upland source of PCBs at the Terminal that may enter the river and require response action under the Portland Harbor Superfund Site remedy. adjacent to Lower Tieback 09. As discussed in Section 1.2, there is no record of any PCB-containing Transformers or other sources of PCBs at the facility. The only indication that there may be PCBs in upland media is the measurement of PCBs in sediment sampled adjacent to Lower Tieback 09 as described in Section 1.1. The non-detect results for well particulates and groundwater in the locations sampled during the PCB Screening Evaluation suggest that PCBs are not present around the perimeter of the PCB Screening Area upgradient of Lower Tieback 09 at a concentration that could explain the PCBs observed in sediment adjacent to Lower Tieback 09. If there is an upland source of these PCBs, it is most likely an isolated occurrence near Lower Tieback 09.

This section describes the various elements of the PCB Assessment sampling strategy and implementation.

2.1 Sampling Design

The historical OWS located immediately upland of Tieback 09 has been identified as the only potential source of PCBs in this area. If detected, PCBs may have originated from stormwater particulates or other materials that accumulated in the decommissioned OWS (Figure 3). Little information is available regarding the OWS that was decommissioned in place in 2007 except that the former OWS outfall was at a depth of about 8 ft below the top of the old concrete seawall (Figure 4) and the bottom depth of the separator is believed to be approximately 10 ft below ground surface (bgs) or at an elevation of approximately 20 ft (CPD).

This PCB Assessment Phase focuses on subsurface soils adjacent to Lower Tieback 09 and surrounding the decommissioned OWS. Five soil borings will be advanced in the locations shown in Figures 3 and 4; slight adjustments may be necessary to avoid subsurface obstructions, including the upper and lower tiebacks. One boring (SB-03) will be advanced as close as possible to Lower Tieback 09 and another boring (SB-02) will be advanced at the former OWS outfall location. The other three borings (SB-01, SB-04, and SB-05) will surround the former OWS (Figure 3). The ground surface elevation in this area is approximately 31-32 ft CPD, and the lower row of tiebacks is at 10 ft CPD. The B1A Group samples with PCB detections were collected at approximately 9-9.5 ft CPD (AECOM, 2024c).

If the PCBs observed riverward of Lower Tieback 09 are the result of PCBs dissolved in light non-aqueous phase liquid (LNAPL) floating on the groundwater table, PCB residues would be found in soils in the groundwater smear zone that spans the seasonally varying groundwater elevations adjacent to the sheet pile seawall. Alternatively, if the PCBs found riverward of the seawall originate from PCB-impacted soil transported as particulates entrained in groundwater, the impacted soil would be found somewhere between the top of the water table and the elevation of the lower row of tiebacks (or slightly deeper). Soil sampling and analysis will, therefore, focus on the zone of seasonally fluctuating groundwater elevations and continue to approximately ten feet deeper than the elevation of the lower tieback seawall penetration. The seasonally varying groundwater elevation adjacent to the seawall typically fluctuates between 20.4 and 2.8 ft CPD (depths of approximately 13 to 31 ft bgs at the measured monitor wells). To sample this entire interval, soil borings will be advanced to a total depth of approximately 32 ft CDP, with samples collected between elevations 21 and -1 ft CPD (or between approximately 10 and 32 ft bgs, Figure 4).

Another potential pathway for PCB residues could be the historical OWS outfall, which was cut off flush with the former concrete seawall when the sheetpile seawall was installed (Figure 4). Therefore, the two borings installed riverward of the old seawall will also be sampled between depths of 6.5 to 10 ft bgs (Figure 4) to evaluate the possibility that the backfill material placed between the seawalls may have been impacted by post-construction seepage through the former outfall perforation in the old seawall.

All borings will be continuously logged, and soil samples will be collected in two-foot intervals from the elevations listed on Table 1. If visual and/or olfactory indications of NAPL are observed in a core, sample intervals will be adjusted to collect a discrete sample(s) of impacted soil.

All soil samples will be analyzed for PCB congeners using EPA Method 1668A. In addition, the two monitoring wells closest to Lower Tieback 09 (MW-17 and P-24, Figure 4) will be resampled and analyzed for PCB congeners. Section 3.4 details the evaluation of analytical data against screening criteria.

2.2 Pre-Sampling Preparation

2.2.1 Health and Safety Activities

A site-specific Health and Safety Plan (HASP) and Job Safety Analyses (JSAs) meeting BP safety criteria will be created through the hazard identification process. The HASP and JSAs will be reviewed and accepted by BP, SMP, and AECOM personnel. Level D personal protective equipment (PPE) will be used while implementing these work plan-specific tasks.

2.2.2 Agency Notification

AECOM will coordinate with and notify DEQ a minimum of five days in advance of sampling to meet the requirements under Voluntary Agreement No. WMCVC-NWR-00-16 dated June 20, 2000

2.2.3 Utility Locating and Clearance for Drilling Activities

Prior to commencing fieldwork, the Oregon Utility Notification Center will be contacted to locate utilities entering the property. In addition, a private underground utility locating service will be contracted to locate utilities and tiebacks in the vicinity of soil boring activities. Utilities and tiebacks will be marked on the ground surface using paint, pin flags, or other appropriate means.

2.3 Sampling Equipment and Supplies

Sampling equipment and supplies will include core barrel or split spoon samplers, an oil-water interface probe, peristaltic pump, tubing, temperature/conductivity/pH meter, sample containers, coolers, field forms, PPE (e.g., hard hats, gloves), personal gear, large stainless bowls and spoons, and decontamination supplies. The BP-contracted analytical laboratory will supply sample containers, preservatives (Table 2), and coolers and packing material (Pace Analytical of Minneapolis, Minnesota).

2.4 Sampling Media and Procedures

2.4.1 Boring Advancement

The following procedures will be performed at each of the four boring locations identified in Figure 3.

- Advance boring to a depth of 6.5 feet (or required ground disturbance clearance depth) using unpowered or “soft dig” equipment. Cuttings recovered from the ground clearance activities will be generally logged on boring logs.
- Advance boring to target depth using sonic or rotary drilling methods. Continuous soil cores will be collected and logged for each soil boring, consistent with ASTM standards. Sheens, odors, and/or NAPL will be noted. Reference SOPs are in Appendix A.
- Tiebacks are present in the proposed soil sampling locations; therefore, if resistance is encountered during the advancement of a boring, drilling will be stopped to investigate if a tieback has been encountered. If a tieback is encountered while advancing a soil boring, the soil boring will be abandoned properly, and a step-out boring location will be advanced.
- Soil samples will be collected using the procedures described in the following section.
- Each borehole will be backfilled with cement bentonite grout using a tremie pipe.

- Investigation-derived waste (IDW), including soil cuttings generated during boring activities, will be handled according to the procedure outlined in Section 2.8.

2.4.2 Soil Sample Collection

Soil samples for laboratory analysis will be collected from each boring in continuous 2-ft intervals at the target sample elevations indicated in Table 1. If visual and/or olfactory indications of NAPL are observed in any of the cores, sample intervals will be adjusted to collect discrete sample(s) of impacted soil. The material from each sample interval will be homogenized using large stainless-steel bowls and stainless-steel spoons by field staff on location prior to placement into laboratory-supplied containers.

Soil samples will be packed and shipped to the laboratory directly contracted by BP. Chains-of-custody (COCs) will be completed appropriately in coordination with the on-site BP technical representative. Reference SOPs are in Appendix A.

2.4.3 Groundwater Sample Collection

Groundwater samples will be collected from existing monitoring wells MW-17 and P-24 in accordance with the practices outlined in the 2021 *Modified Annual Groundwater Monitoring Sampling and Analysis Plan, Revision 1* (AECOM, 2021b).

- A decontaminated oil-water interface probe will measure the depth from the top of the casing to NAPL (if any), groundwater, and the bottom of the well.
- A clean length of dedicated tubing will be inserted to a depth halfway between the depth to water and the bottom of the well, and a peristaltic pump will be used to purge until groundwater parameters stabilize. Field-measured groundwater parameters will be considered stable when all parameters meet the following conditions:
  - Turbidity – Nephelometric Turbidity unit (NTU) values are within 10% for values greater than 5 NTU or three consecutive turbidity values are less than 5 NTU
  - DO – values are within 10% for values greater than 0.5 milligrams per liter (mg/L) or if three consecutive DO values are less than 0.5 mg/L
  - Specific Conductance – fluctuation is equal to or less than 3%
  - Temperature – fluctuation is equal to or less than 3%
  - pH – fluctuation is equal to or less than 0.1 unit
  - ORP – fluctuation is equal to or less than 10 millivolts
- Unfiltered water samples will then be collected directly into laboratory-supplied containers.

2.5 Field QA/QC Samples

Two rinsate blanks will be collected. The first will consist of laboratory-provided deionized water run over the decontaminated mixing bowls and spoons and other non-dedicated supplies used for homogenizing soil samples. The second will consist of laboratory-provided deionized water pumped through the groundwater sampling system.

One field duplicate per 20 samples will be collected and analyzed for each medium. The field team will choose the locations at the time of sampling.

2.6 Sample Naming Convention

The following sample naming convention below shall be used for soil and groundwater during this investigation.

- SB-XX-##-##-yymmdd

- MW-XX-yymmdd

Where:

- SB-XX – Boring ID (SB-01 through SB-04)
- ##-## - Depth interval of soil sample in feet bgs
- GW – Groundwater sample
- MW-XX –Well ID (MW-17 or P-24).
- yymmdd – The year, month, and day, the sample is collected (e.g., 241119 for November 19, 2024).

For example, a soil sample collected from a depth of 20-22 ft bgs from boring SB-## on November 19, 2024, will be:

- S-SB-##-20-22-241119

2.7 Decontamination Procedures

Potential contamination sources in the field include sampling equipment, vehicles, and dust. Decontamination procedures, as described below, will be followed during sampling activities. Sample handling will be minimized, and potential known contamination sources will be avoided. Reusable sampling equipment will be decontaminated before first use and after each sample location. Samplers will wear powder-free disposable gloves during all decontamination and sampling procedures.

2.7.1 Non-Dedicated Sampling Equipment

Non-dedicated sampling equipment (spoons, oil/water interface probe, etc.) will be decontaminated using a four-stage method:

1. Tap water rinse
2. Non-phosphate soap (such as Alconox®) and water solution rinse
3. Distilled water rinse
4. 10% Methanol rinse

Equipment decontamination will be performed over a bucket to prevent decontamination water from flowing onto the ground surface. All decontamination fluids generated will be placed in appropriate containers (i.e., 5-gallon buckets with snap lids) during the workday and disposed of using the on-site treatment system.

2.7.2 Non-Dedicated Drilling Equipment

Each core recovered with the drill rig will be placed in a new (dedicated) sleeve. Exploratory equipment (e.g., drive rods, and the back of the drill rig) will be decontaminated between boring locations. Sampling personnel will wear a new pair of nitrile gloves prior to each sampling location and during decontamination procedures.

A temporary decontamination station will be established for the vacuum (vac) truck for the duration of the soil investigation. This location will be used to empty the vac truck contents into 55-gallon drums and decontaminate the vac truck. This decontamination station will be sized to accommodate the vac truck and hold wastewater generated during the decontamination of the vac truck. This temporary decontamination station will consist of a couple of layers of heavy-duty Visqueen anchored by 2 x 4s to hold it in place.

All decontamination fluids generated at boring and well locations and the vac truck decontamination area will be placed in appropriate containers (e.g., 5-gallon buckets with snap lids or 55-gallon drums) during the workday. At the end of the day, the fluids will be placed in an appropriate storage container with a label stating the contents and date started, and the buckets will be cleaned and covered for future use.

2.8 Investigation Derived Waste

All disposable sampling items (gloves, tubing, plastic sheeting, core sleeves, etc.) will be placed in garbage bags for disposal in a municipal landfill using the Terminal's waste disposal containers.

Purge water collected during groundwater will be discharged to the Terminal Hydraulic SCM system GAC adsorption groundwater treatment system and discharged to the Willamette River in accordance with the NPDES 1500A wastewater permit.

Wastewater and soil will be generated from decontaminating drilling equipment, vac truck, and sampling will be placed within appropriate containers (e.g., 55-gallon drums), which will be labeled and sealed when not in use, and temporarily staged onsite in the warehouse. Waste will be characterized, manifested, transported off-Site, and disposed of appropriately. Waste characterization sampling and permit applications for the appropriate disposal facilities will be completed prior to transporting materials off-Site for disposal. SMP will be identified as the Owner on the waste profiles and manifests as the generator of the remediation waste.

2.9 Field Documentation

Field personnel will document sampling activities at each well location, including the sample ID, collection time, depth to water, presence/absence of NAPL, visual observations, etc. Appendix B presents an example data quality control report (DQCR). Field data collected during sampling will be reported in the final report as within DQCRs. Photographic logs will also be reported.

2.10 Surveying

After fieldwork is complete, ground surface elevations for the soil borings will be surveyed by a professional surveyor licensed in the state of Oregon with an accuracy of 0.1 feet.

3. Laboratory Analysis and Data Evaluation

3.1 Laboratory Methods

Soil and groundwater samples will be submitted to a BP-contracted laboratory (Pace Analytical of Minneapolis, Minnesota) and analyzed for PCB congeners using EPA Method 1668A. Soil samples will also be analyzed for percent moisture and reported as dry-weight concentrations. The analytical methods and extraction procedures will be based on the most current analytical protocols per ongoing EPA guidance. Table 2 includes sample media, sample containers, holding times, and targeted sample volume. For each soil sample, an aliquot will be archived frozen for up to six months for potential future analysis.

3.2 Quantitation Limits

Table 3 includes reporting and method detection limits for solid and aqueous media as analyzed by Method 1668A as provided by Pace Analytical (at the time of report production). Analyte concentrations will be reported to the method detection limits. Analytes detected at concentrations between the method detection limit and the practical quantitation limit will be reported with a “J” qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the method detection limit. The laboratory will adjust the method detection limit as necessary to reflect sample volume/weight, extract dilution, matrix interference, etc.

3.3 Data Validation

Data validation will be completed following the applicable EPA National Functional Guidelines for Data Review. A summary of the data validation will be submitted with the analytical results in the data summary report.

3.4 Data Reporting and Summation

Total PCBs will be reported in microgram per kilogram (µg/kg) or microgram per liter (µg/L). Summation calculations (including handling of non-detect values) will follow the guidelines outlined in the Portland Harbor Data Management Plan (EPA, 2021). Total PCB concentrations will be compared to the Portland Harbor CULs for total PCBs in riverbank soil/sediment (9 ug/kg) and groundwater (0.014 ug/L) (EPA, 2020). If a lateral PCB concentration gradient is found, that information may help identify any potential upland source(s) of PCBs.

4. Reporting and Work Schedule

Project activities will be documented in a data summary report prepared for DEQ review. The report will include a summary of fieldwork completed, field observations, procedures, laboratory reports, groundwater depths, any occurrence of NAPL, boring logs, analytical summary tables, and figure(s).

Investigations activities are tentatively planned for the week of January 13, 2025. A data summary report will be submitted to DEQ approximately 90 days following receipt of analytical results.

5. Limitations

This PCB Screening Report and PCB Investigation Work Plan has been prepared for specific application to this project and has been developed in a manner consistent with the level of care and skill normally exercised by members of the environmental science profession currently practicing under similar conditions in the area and following the terms and conditions outlined in the contracted agreement between AECOM and BP, working in cooperation with SMP. No warranty or other conditions express or implied should be understood.

This report is for the use of BP and its representatives and affiliates, SMP and its representatives and affiliates, and applicable regulatory agencies. No other parties shall have the right to rely on AECOM's opinions rendered in connection with the services or this report without our written consent.

6. References

Atlantic Richfield Company (ARC), 2011. *Responses to U.S. EPA CERCLA Section 104(e) Information Request.* July.

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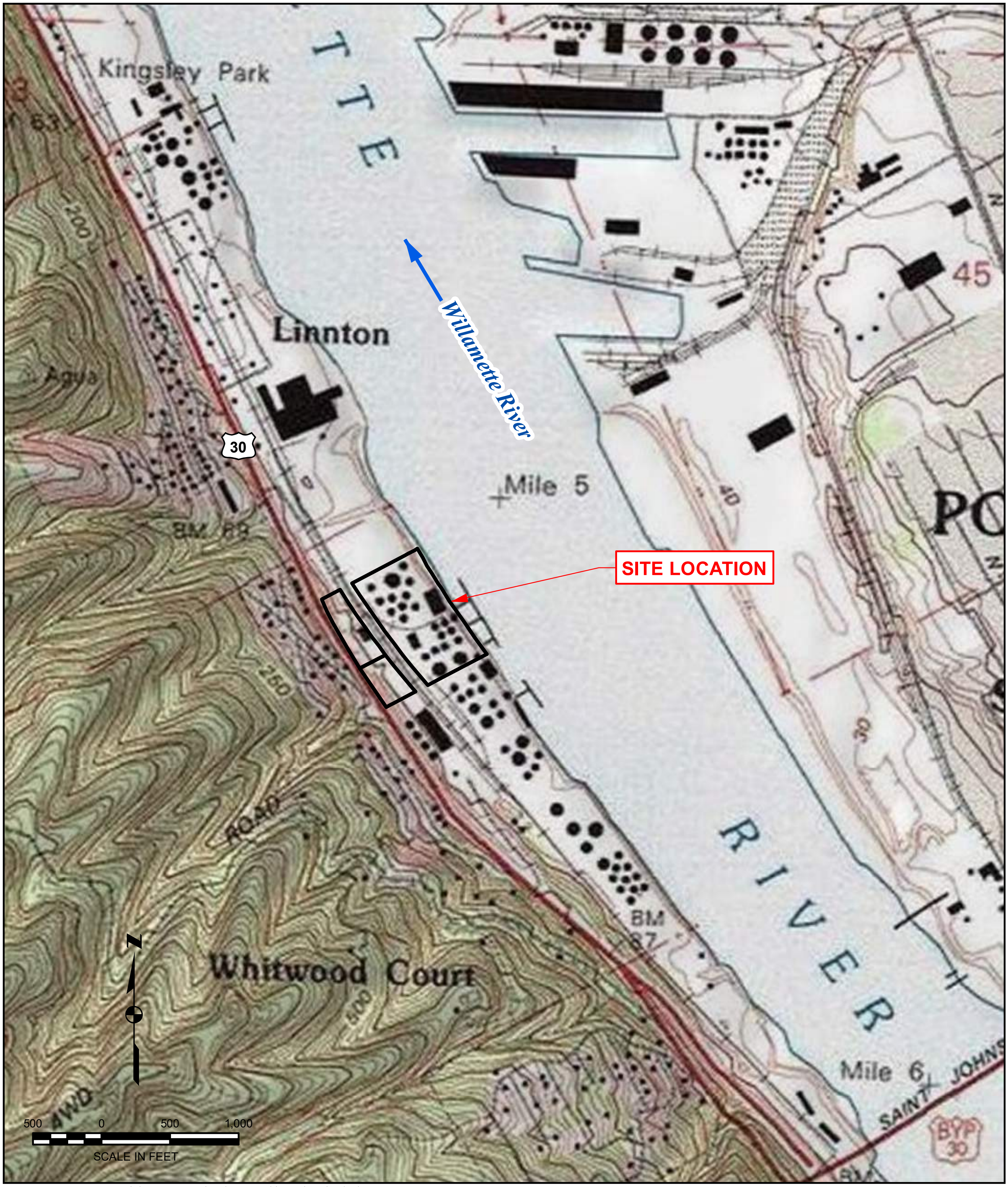
Figures



Source: USGS 2020.Copyright:© 2013 National Geographic Society, i-cubed

K:\BP\GW Contours\2023\Annual GW Report 2023\Fig 1 Site Vicinity Map.mxd

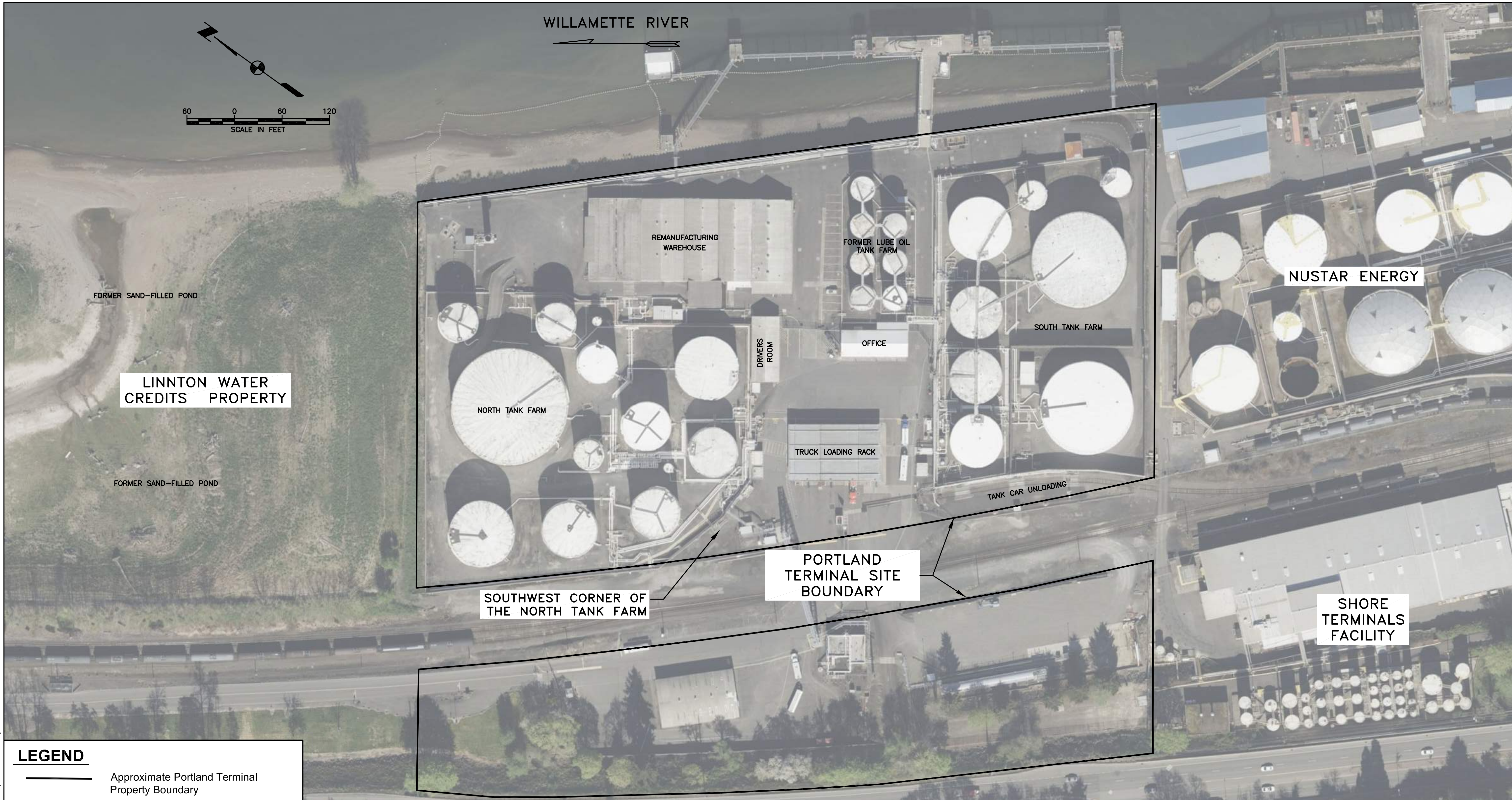
SITE VICINITY MAP

PORTLAND TERMINAL
9930 NW ST HELENS ROAD
PORTLAND, OREGON

AECOM

Project Number: 60733311

FIGURE 1



LEGEND

Approximate Portland Terminal Property Boundary

Imagery Source: Microsoft Bing ©2023

AECOM

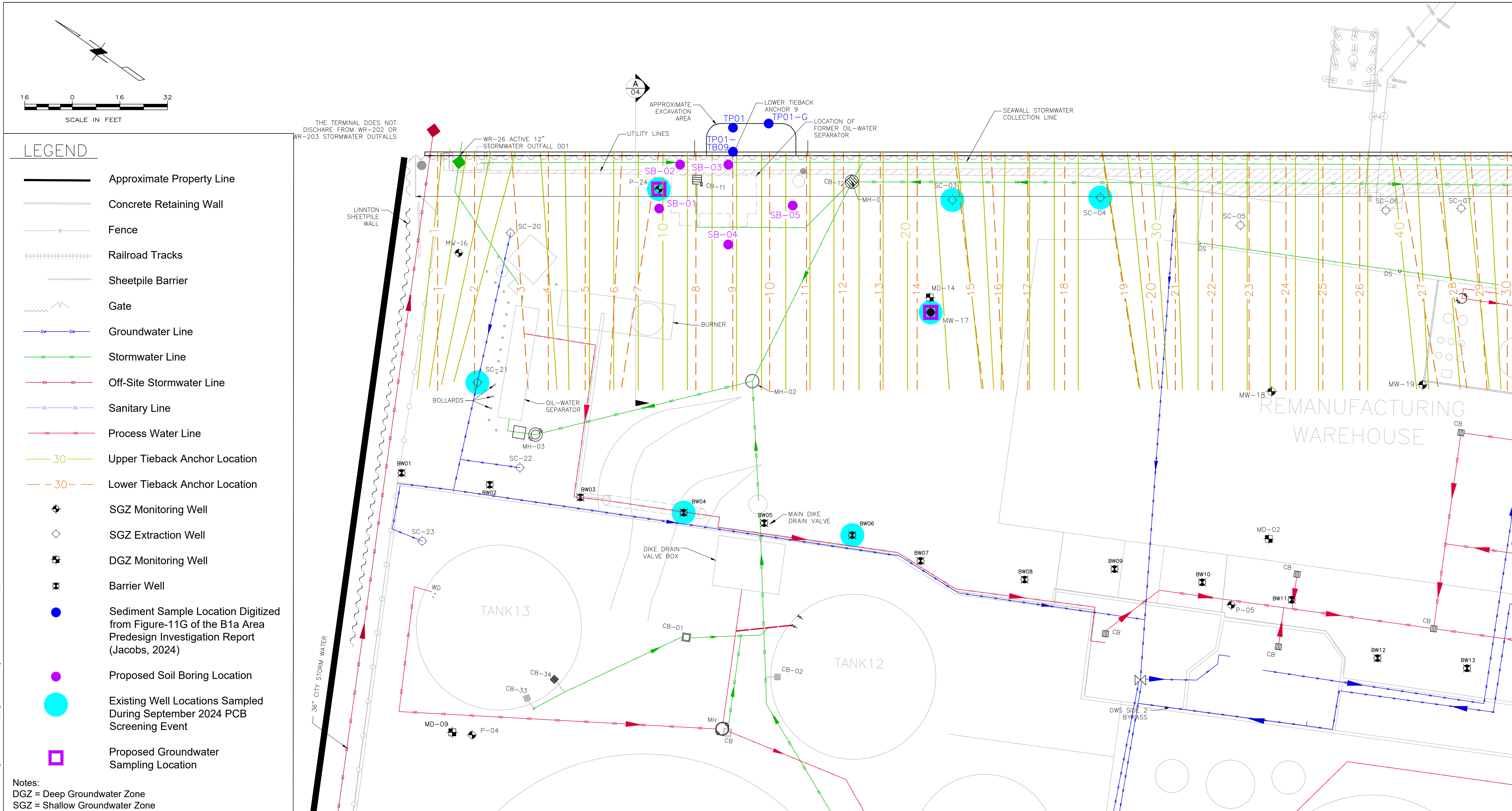
SITE MAP OF TERMINAL AND SURROUNDING PROPERTY

60733311

PORTLAND TERMINAL
9930 NW ST HELENS
PORTLAND, OREGON

FIGURE 2

K:\BP\MXD\2024\Fig 2 Site Location Map.dwg Dec 19, 2024 – 12:09pm



PROPOSED PCB ASSESSMENT SOIL BORING AND WELL SAMPLING LOCATIONS

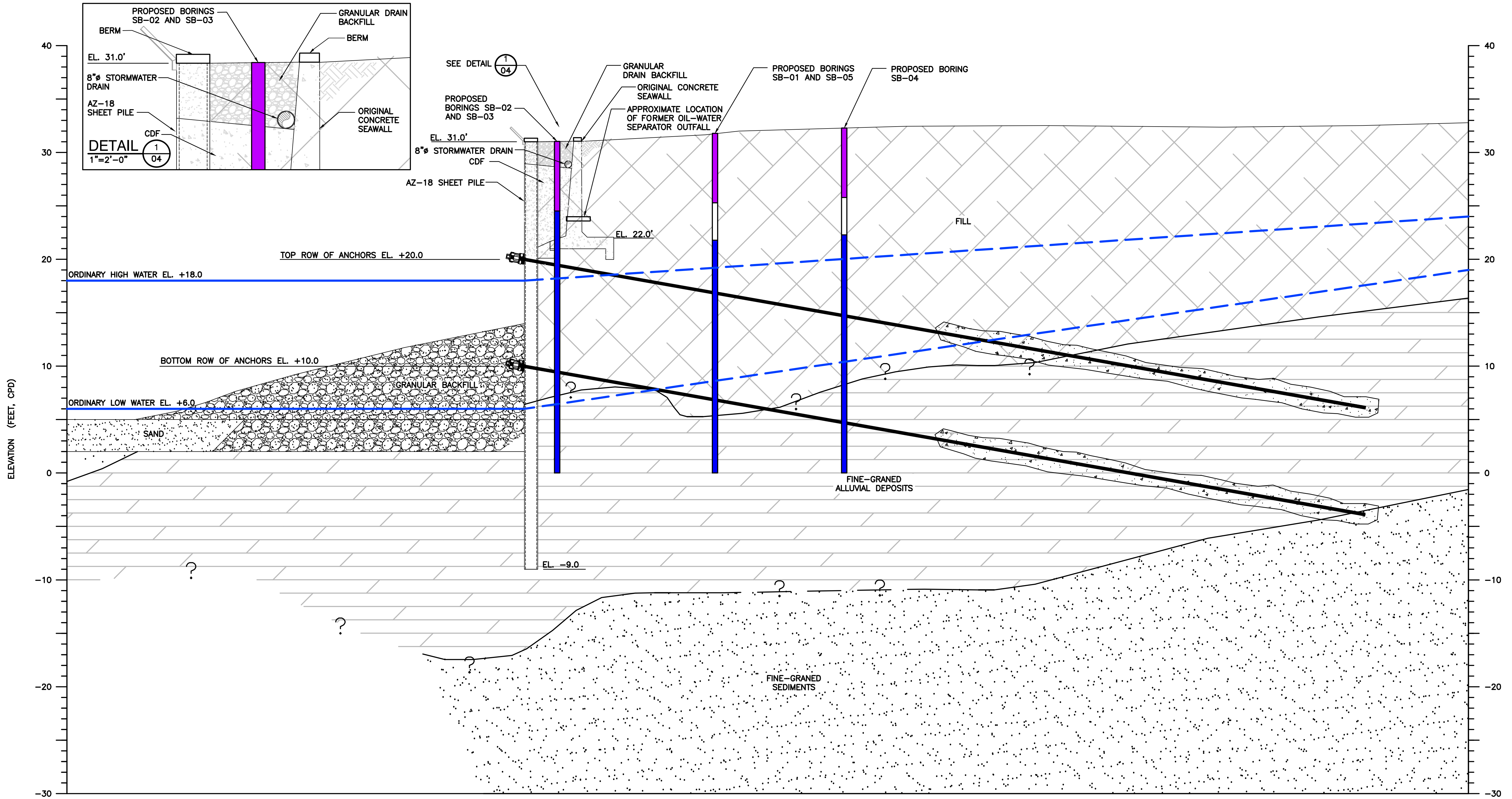
PORTLAND TERMINAL
9930 NW ST HELENS ROAD
PORTLAND, OREGON

AECOM

60733311

FIGURE 3

K:\BP\MXD\2024\Fig 3 Proposed PCB Assessment Soil Boring and Well Sampling Locations.dwg Dec 20, 2024 – 2:42pm



FOR ADDITIONAL INFORMATION REGARDING SEAWALL TIEBACK INSTALLATION, SEE DRAWING PACKAGE PREPARED FOR REVETMENT REMOVAL RECORD REVISION. (URS, 2009)

GEOLOGIC CROSS-SECTION INFORMATION SOURCED FROM FINAL GEOTECHNICAL ANALYSIS REPORT, PROPOSED SEAWALL REPLACEMENT (URS, 2009)

CDF = CONTROLLED DENSITY FILL

TYPICAL SECTION A/03
1"=5'-0"

LEGEND

- SOIL BORING – PROPOSED SOFT DIG EXTENT
- SOIL BORING – PROPOSED SAMPLING EXTENT

PROPOSED ASSESSMENT SOIL BORING LOCATIONS CROSS SECTION

60733311

PORTLAND TERMINAL
9930 NW ST HELENS
PORTLAND, OREGON

AECOM

FIGURE 4

Tables

Table 1
Target Depths and Elevations for PCB Assessment Soil Samples
2024 PCB Assessment Work Plan
SMP Terminal, Portland Oregon

Boring ID	X Coordinate NAD83 Oregon North (International ft)	Y Coordinate NAD83 Oregon North (International ft)	Approximate Ground Surface Elevation[1] (ft CPD)	Proposed Elevation Interval of Composite Sample[1] (ft CPD)	Proposed Depth Interval of Composite Sample (ft bgs)
SB-01	7618590.60	711396.86	31	21 - 19	10 - 12
				19 - 17	12 - 14
				17 - 15	14 - 16
				15 - 13	16 - 18
				13 - 11	18 - 20
				11 - 9	20 - 22
				9 - 7	22 - 24
				7 - 5	24 - 26
				5 - 3	26 - 28
				3 - 1	28 - 30
				1 - -1	30 - 32
SB-02	7618605.04	711402.10	31	24.5 - 23	6.5 - 8
				23 - 21	8 - 10
				21 - 19	10 - 12
				19 - 17	12 - 14
				17 - 15	14 - 16
				15 - 13	16 - 18
				13 - 11	18 - 20
				11 - 9	20 - 22
				9 - 7	22 - 24
				7 - 5	24 - 26
				5 - 3	26 - 28
				3 - 1	28 - 30
				1 - -1	30 - 32
SB-03	7618616.19	711386.59	31	24.5 - 23	6.5 - 8
				23 - 21	8 - 10
				21 - 19	10 - 12
				19 - 17	12 - 14
				17 - 15	14 - 16
				15 - 13	16 - 18
				13 - 11	18 - 20
				11 - 9	20 - 22
				9 - 7	22 - 24
				7 - 5	24 - 26
				5 - 3	26 - 28
				3 - 1	28 - 30
				1 - -1	30 - 32
SB-04	7618594.35	711370.96	31	21 - 19	10 - 12
				19 - 17	12 - 14
				17 - 15	14 - 16
				15 - 13	16 - 18
				13 - 11	18 - 20
				11 - 9	20 - 22
				9 - 7	22 - 24
				7 - 5	24 - 26
				5 - 3	26 - 28
				3 - 1	28 - 30
				1 - -1	30 - 32
SB-05	7618617.64	711361.01	31	21 - 19	10 - 12
				19 - 17	12 - 14
				17 - 15	14 - 16
				15 - 13	16 - 18
				13 - 11	18 - 20
				11 - 9	20 - 22
				9 - 7	22 - 24
				7 - 5	24 - 26
				5 - 3	26 - 28
				3 - 1	28 - 30
				1 - -1	30 - 32

Notes:

bgs - below ground surface
CPD - City of Portland Datum
ft - feet
NA - not applicable
NAVD88 - north american vertical datum 1988
[1] All elevations are provided relative to CPD. Add 2.1 feet to convert to NAVD88.

Table 2
Sample Containers, Preservation, and Holding Time
2024 PCB Assessment Work Plan
SMP Terminal, Portland Oregon

Parameter	Method	Medium	Sample Volume	Container Type	Preservation	Extraction Holding Time	Analysis Holding Time
Polychlorinated Biphenyls (PCBs)	EPA 1668A	Soil	50 g (allows for % moisture)	8-oz glass jar with teflon-lined lid	Cool 0 to 6ºC	1 year [1]	40 days [2]
		Water	1 liter	2 x 1 liter glass amber	Cool 0 to 6ºC	1 year [1]	40 days [2]

EPA - Environmental Protection Agency
g - grams
ºC - degrees Celcius

[1] For this project, 1 year is selected to provide a timeframe to complete analysis, data evaluation, and final reporting before sample disposal by the laboratory.
[2] Days from extraction date

Table 3
Laboratory Limits for Polychlorinated Biphenyl (PCB) Congeners by Method 1668A
2024 PCB Assessment Work Plan
SMP Terminal, Portland Oregon

IUPAC #	Congener	Water				Soil	
		MDL (pg/L)	MDL (ng/L)	PQL (pg/L)	PQL (ng/L)	MDL (ng/kg)	PQL (ng/kg)
PCB-1	2-Chlorobiphenyl	17.7	0.0177	250	0.250	3.58	25
PCB-2	3-Chlorobiphenyl	16.4	0.0164	250	0.250	3.76	25
PCB-3	4-Chlorobiphenyl	17.0	0.0170	250	0.250	3.77	25
PCB-4	2,2'-Dichlorobiphenyl	15.9	0.0159	250	0.250	4.27	25
PCB-10	2,6-Dichlorobiphenyl	18.8	0.0188	250	0.250	3.70	25
PCB-9	2,5-Dichlorobiphenyl	20.7	0.0207	250	0.250	3.38	25
PCB-7	2,4-Dichlorobiphenyl	19.9	0.0199	250	0.250	3.52	25
PCB-6	2,3'-Dichlorobiphenyl	18.3	0.0183	250	0.250	3.93	25
PCB-5	2,3-Dichlorobiphenyl	17.7	0.0177	250	0.250	2.63	25
PCB-8	2,4'-Dichlorobiphenyl	37.3	0.0373	250	0.250	6.85	25
PCB-14	3,5-Dichlorobiphenyl	20.2	0.0202	250	0.250	2.88	25
PCB-11	3,3'-Dichlorobiphenyl	359	0.359	2450	2.45	91.5	245
PCB-(13/12)	PCB-(13/12)	25.9	0.0259	500	0.500	7.01	50
PCB-15	4,4'-Dichlorobiphenyl	23.2	0.0232	330	0.330	6.52	33
PCB-19	2,2',6-Trichlorobiphenyl	14.4	0.0144	250	0.250	2.78	25
PCB-(30/18)	PCB-(30/18)	48.6	0.0486	500	0.500	17.9	50
PCB-17	2,2',4-Trichlorobiphenyl	23.9	0.0239	250	0.250	7.97	25
PCB-27	2,3',6-Trichlorobiphenyl	17.8	0.0178	250	0.250	4.82	25
PCB-24	2,3,6-Trichlorobiphenyl	20.6	0.0206	250	0.250	3.93	25
PCB-16	2,2',3-Trichlorobiphenyl	23.5	0.0235	250	0.250	7.11	25
PCB-32	2,4',6-Trichlorobiphenyl	20.3	0.0203	250	0.250	7.78	25
PCB-34	2,3',5'-Trichlorobiphenyl	20.4	0.0204	250	0.250	3.06	25
PCB-23	2,3,5-Trichlorobiphenyl	19.3	0.0193	250	0.250	2.79	25
PCB-(26/29)	PCB-(26/29)	30.0	0.0300	500	0.500	6.38	50
PCB-25	2,3',4-Trichlorobiphenyl	13.6	0.0136	250	0.250	3.48	25
PCB-31	2,4',5-Trichlorobiphenyl	72.2	0.0722	1300	1.30	22.7	130
PCB-(28/20)	PCB-(28/20)	69.1	0.0691	1290	1.29	26.8	129
PCB-(21/33)	PCB-(21/33)	46.6	0.0466	1350	1.35	14.7	135
PCB-22	2,3,4'-Trichlorobiphenyl	40.0	0.0400	950	0.950	12.5	95
PCB-36	3,3',5-Trichlorbiphenyl	14.6	0.0146	250	0.250	2.76	25
PCB-39	3,4',5-Trichlorobiphenyl	16.2	0.0162	250	0.250	3.09	25
PCB-38	3,4,5-Trichlorobiphenyl	14.6	0.0146	250	0.250	2.36	25
PCB-35	3,3',4-Trichlorobiphenyl	14.9	0.0149	250	0.250	3.70	25
PCB-37	3,4,4'-Trichlorobiphenyl	27.0	0.0270	530	0.530	5.93	53
PCB-54	2,2',6,6'-Tetrachlorbiphenyl	13.5	0.0135	250	0.250	2.46	25
PCB-(50/53)	PCB-(50/53)	33.9	0.0339	500	0.500	8.39	50
PCB-(45/51)	PCB-(45/51)	27.9	0.0279	500	0.500	10.4	50
PCB-46	2,2',3,6'-Tetrachlorobiphenyl	13.9	0.0139	250	0.250	3.48	25
PCB-52	2,2',5,5'-Tetrachlorobiphenyl	80.3	0.0803	1290	1.29	23.1	129
PCB-(73/43)	2,3',5',6-Tetrachlorobiphenyl	35.8	0.0358	500	0.500	11.3	50
PCB-(69/49)	PCB-(69/49)	33.9	0.0339	500	0.500	11.1	50
PCB-48	2,2',4,5-Tetrachlorobiphenyl	14.9	0.0149	250	0.250	4.24	25
PCB-(44/47/65)	PCB-(44/47/65)	64.8	0.0648	750	0.750	21.0	75
PCB-(59/62/75)	PCB-(59/62/75)	44.1	0.0441	750	0.750	5.88	75
PCB-42	2,2',3,4'-Tetrachlorobiphenyl	15.1	0.0151	250	0.250	5.54	25
PCB-(41/40/71)	PCB-(41/40/71)	28.2	0.0282	750	0.750	13.9	75
PCB-64	2,3,4',6-Tetrachlorobiphenyl	23.0	0.0230	250	0.250	5.96	25
PCB-72	2,3',5,5'-Tetrachlorobiphenyl	13.4	0.0134	250	0.250	2.33	25
PCB-68	2,3',4,5'-Tetrachlorobiphenyl	13.6	0.0136	250	0.250	2.73	25
PCB-57	2,3,3',5-Tetrachlorobiphenyl	11.4	0.0114	250	0.250	2.55	25
PCB-58	2,3,3',5'-Tetrachlorobiphenyl	17.4	0.0174	250	0.250	2.18	25
PCB-67	2,3',4,5-Tetrachlorobiphenyl	13.4	0.0134	250	0.250	2.44	25
PCB-63	2,3,4',5-Tetrachlorobiphenyl	13.5	0.0135	250	0.250	2.68	25
PCB-(61/70/74/76)	PCB-(61/70/74/76)	53.1	0.0531	1000	1.00	17.2	100
PCB-66	2,3',4,4'-Tetrachlorobiphenyl	30.1	0.0301	590	0.590	14.6	59
PCB-55	2,3,3',4-Tetrachlorobiphenyl	13.5	0.0135	250	0.250	3.36	25
PCB-56	2,3,3',4'-Tetrachlorobiphenyl	15.4	0.0154	250	0.250	5.66	25
PCB-60	2,3,4,4'-Tetrachlorobiphenyl	10.8	0.0108	250	0.250	5.76	25
PCB-80	3,3',5,5'-Tetrachlorobiphenyl	11.6	0.0116	250	0.250	1.80	25
PCB-79	3,3',4,5'-Tetrachlorobiphenyl	12.1	0.0121	250	0.250	2.96	25

Table 3
Laboratory Limits for Polychlorinated Biphenyl (PCB) Congeners by Method 1668A
2024 PCB Assessment Work Plan
SMP Terminal, Portland Oregon

IUPAC #	Congener	Water				Soil	
		MDL (pg/L)	MDL (ng/L)	PQL (pg/L)	PQL (ng/L)	MDL (ng/kg)	PQL (ng/kg)
PCB-78	3,3',4,5-Tetrachlorobiphenyl	13.4	0.0134	250	0.250	2.93	25
PCB-81	3,4,4',5-Tetrachlorobiphenyl	11.0	0.0110	250	0.250	2.37	25
PCB-77	3,3',4,4'-Tetrachlorobiphenyl	10.3	0.0103	250	0.250	3.19	25
PCB-104	2,2',4,6,6'-Pentachlorobiphenyl	13.5	0.0135	250	0.250	2.90	25
PCB-96	2,2',3,6,6'-Pentachlorobiphenyl	20.7	0.0207	250	0.250	4.27	25
PCB-103	2,2',4,5',6-Pentachlorobiphenyl	22.2	0.0222	250	0.250	3.26	25
PCB-94	2,2',3,5,6'-Pentachlorobiphenyl	14.5	0.0145	250	0.250	2.27	25
PCB-95	2,2',3,5',6-Pentachlorobiphenyl	56.9	0.0569	700	0.700	16.0	70
PCB-(100/93/102/98)	PCB-(100/93/102/98)	62.2	0.0622	1000	1.00	9.61	100
PCB-(88/91)	PCB-(88/91)	31.4	0.0314	500	0.500	6.67	50
PCB-84	2,2',3,3',6-Pentachlorobiphenyl	11.7	0.0117	250	0.250	4.51	25
PCB-89	2,2',3,4,6'-Pentachlorobiphenyl	15.7	0.0157	250	0.250	3.40	25
PCB-121	2,3',4,5',6-Pentachlorobiphenyl	17.6	0.0176	250	0.250	2.40	25
PCB-92	2,2',3,5,5'-Pentachlorobiphenyl	16.6	0.0166	250	0.250	3.76	25
PCB-(113/90/101)	PCB-(113/90/101)	36.9	0.0369	750	0.750	13.1	75
PCB-83	2,2',3,3',5-Pentachlorobiphenyl	15.6	0.0156	250	0.250	3.01	25
PCB-99	2,2',4,4',5-Pentachlorobiphenyl	17.2	0.0172	250	0.250	5.04	25
PCB-112	2,3,3',5,6-Pentachlorobiphenyl	14.3	0.0143	250	0.250	2.72	25
PCB-(108/119/86/97/125/87)	PCB-(108/119/86/97/125/87)	60.3	0.0603	1500	1.50	13.6	150
PCB-(117/116/85)	PCB-(117/116/85)	36.1	0.0361	750	0.750	7.43	75
PCB-(110/115)	PCB-(110/115)	26.7	0.0267	500	0.500	8.96	50
PCB-82	2,2',3,3',4-Pentachlorobiphenyl	14.8	0.0148	250	0.250	7.39	25
PCB-111	2,3,3',5,5'-Pentachlorobiphenyl	15.6	0.0156	250	0.250	2.67	25
PCB-120	2,3',4,5,5'-Pentachlorobiphenyl	19.1	0.0191	250	0.250	2.84	25
PCB-(107/124)	PCB-(107/124)	23.8	0.0238	500	0.500	4.47	50
PCB-109	2,3,3',4,6-Pentachlorobiphenyl	12.7	0.0127	250	0.250	3.46	25
PCB-123	2,3',4,4',5'-Pentachlorobiphenyl	13.8	0.0138	250	0.250	2.78	25
PCB-106	2,3,3',4,5-Pentachlorobiphenyl	15.9	0.0159	250	0.250	2.62	25
PCB-118	2,3',4,4',5-Pentachlorobiphenyl	20.2	0.0202	390	0.390	6.41	39
PCB-122	2,3,3',4',5'-Pentachlorobiphenyl	23.3	0.0233	250	0.250	3.93	25
PCB-114	2,3,4,4',5-Pentachlorobiphenyl	11.3	0.0113	250	0.250	2.40	25
PCB-105	2,3,3',4,4'-Pentachlorobiphenyl	14.0	0.0140	250	0.250	4.44	25
PCB-127	3,3',4,5,5'-Pentachlorobiphenyl	15.1	0.0151	250	0.250	2.81	25
PCB-126	3,3',4,4',5-Pentachlorobiphenyl	10.6	0.0106	250	0.250	2.52	25
PCB-155	2,2',4,4',6,6'-Hexachlorobiphenyl	12.6	0.0126	250	0.250	2.98	25
PCB-152	2,2',3,5,6,6'-Hexachlorobiphenyl	15.2	0.0152	250	0.250	3.22	25
PCB-150	2,2',3,4',6,6'-Hexachlorobiphenyl	18.7	0.0187	250	0.250	2.96	25
PCB-136	2,2',3,3',6,6'-Hexachlorobiphenyl	15.5	0.0155	250	0.250	4.78	25
PCB-145	2,2',3,4,6,6'-Hexachlorobiphenyl	15.4	0.0154	250	0.250	2.63	25
PCB-148	2,2',3,4',5,6'-Hexachlorobiphenyl	18.5	0.0185	250	0.250	5.48	25
PCB-(151/135)	PCB-(151/135)	33.8	0.0338	500	0.500	9.27	50
PCB-154	2,2'4,4',5,6'-Hexachlorobiphenyl	16.1	0.0161	250	0.250	3.32	25
PCB-144	2,2',3,4,5',6-Hexachlorobiphenyl	17.1	0.0171	250	0.250	4.04	25
PCB-(147/149)	PCB-(147/149)	26.6	0.0266	500	0.500	11.6	50
PCB-(134/143)	PCB-(134/143)	23.3	0.0233	500	0.500	4.61	50
PCB-(139/140)	PCB-(139/140)	24.7	0.0247	500	0.500	4.42	50
PCB-131	2,2'3,3',4,6-Hexachlorobiphenyl	11.6	0.0116	250	0.250	3.30	25
PCB-142	2,2',3,4,5,6-Hexachlorobiphenyl	14.6	0.0146	250	0.250	2.93	25
PCB-132	2,2',3,3',4,6'-Hexachlorobiphenyl	12.1	0.0121	250	0.250	4.78	25
PCB-133	2,2',3,3',5,5'-Hexachlorobiphenyl	15.3	0.0153	250	0.250	3.16	25
PCB-165	2,3,3',5,5',6-Hexachlorobiphenyl	14.1	0.0141	250	0.250	2.12	25
PCB-146	2,2',3,4',5,5'-Hexachlorobiphenyl	17.3	0.0173	250	0.250	3.95	25
PCB-161	2,3,3',4,5',6-Hexachlorobiphenyl	14.9	0.0149	250	0.250	2.29	25
PCB-(153/168)	PCB-(153/168)	30.9	0.0309	500	0.500	7.64	50
PCB-141	2,2',3,4,5,5'-Hexachlorobiphenyl	14.1	0.0141	250	0.250	4.05	25
PCB-130	2,2',3,3',4,5'-Hexachlorobiphenyl	12.3	0.0123	250	0.250	3.00	25
PCB-137	2,2',3,4,4',5-Hexachlorobiphenyl	14.6	0.0146	250	0.250	3.61	25
PCB-164	2,3,3',4',5',6-Hexachlorobiphenyl	10.9	0.0109	250	0.250	2.98	25
PCB-(138/163/129)	PCB-(138/163/129)	36.0	0.0360	750	0.750	10.9	75
PCB-160	2,3,3',4,5,6-Hexachlorobiphenyl	11.0	0.0110	250	0.250	2.85	25

Table 3
Laboratory Limits for Polychlorinated Biphenyl (PCB) Congeners by Method 1668A
2024 PCB Assessment Work Plan
SMP Terminal, Portland Oregon

IUPAC #	Congener	Water				Soil	
		MDL (pg/L)	MDL (ng/L)	PQL (pg/L)	PQL (ng/L)	MDL (ng/kg)	PQL (ng/kg)
PCB-158	2,3,3',4,4',6-Hexachlorobiphenyl	7.85	0.00785	250	0.250	2.33	25
PCB-(128/166)	PCB-(128/166)	28.1	0.0281	500	0.500	5.47	50
PCB-159	2,3,3',4,5,5'-Hexachlorobiphenyl	13.2	0.0132	250	0.250	2.79	25
PCB-162	2,3,3',4',5,5'-Hexachlorobiphenyl	12.5	0.0125	250	0.250	2.56	25
PCB-167	2,3',4,4',5,5'-Hexachlorobiphenyl	11.5	0.0115	250	0.250	2.94	25
PCB-(156/157)	PCB-(156/157)	19.1	0.0191	500	0.500	4.27	50
PCB-169	3,3',4,4',5,5'-Hexachlorobiphenyl	10.5	0.0105	250	0.250	3.24	25
PCB-188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	10.3	0.0103	250	0.250	2.19	25
PCB-179	2,2',3,3',5,6,6'-Heptachlorobiphenyl	12.5	0.0125	250	0.250	3.87	25
PCB-184	2,2',3,4,4',6,6'-Heptachlorobiphenyl	16.9	0.0169	250	0.250	2.74	25
PCB-176	2,2',3,3',4,6,6'-Heptachlorobiphenyl	17.3	0.0173	250	0.250	3.49	25
PCB-186	2,2',3,4,4',5,6'-Heptachlorobiphenyl	12.5	0.0125	250	0.250	2.92	25
PCB-178	2,2',3,4,5,6,6'-Heptachlorobiphenyl	10.1	0.0101	250	0.250	3.48	25
PCB-175	2,2',3,3',5,5',6-Heptachlorobiphenyl	10.4	0.0104	250	0.250	2.48	25
PCB-187	2,2',3,3',4,5',6-Heptachlorobiphenyl	27.6	0.0276	250	0.250	5.68	25
PCB-182	2,2',3,4',5,5',6-Heptachlorobiphenyl	17.4	0.0174	250	0.250	3.21	25
PCB-(183/185)	PCB-(183/185)	17.0	0.0170	500	0.500	6.21	50
PCB-174	2,2',3,3',4,5,6'-Heptachlorobiphenyl	17.8	0.0178	250	0.250	5.32	25
PCB-177	2,2'3,3',4,5',6'-Heptachlorobiphenyl	14.7	0.0147	250	0.250	4.32	25
PCB-181	2,2',3,4,4',5,6-Heptachlorbiphenyl	10.7	0.0107	250	0.250	2.88	25
PCB-(171/173)	PCB-(171/173)	16.6	0.0166	500	0.500	4.72	50
PCB-172	2,2'3,3',4,5,5'-Heptachlorobiphenyl	10.9	0.0109	250	0.250	3.23	25
PCB-192	2,3,3',4,5,5',6-Heptachlorobiphenyl	11.8	0.0118	250	0.250	2.83	25
PCB-(180/193)	PCB-(180/193)	39.4	0.0394	500	0.500	9.21	50
PCB-191	2,3,3',4,4',5',6-Heptachlorobiphenyl	15.7	0.0157	250	0.250	2.23	25
PCB-170	2,2',3,3',4,4',5-Heptachlorobiphenyl	17.5	0.0175	250	0.250	5.09	25
PCB-190	2,3,3',4,4',5,6-Heptachlorobiphenyl	11.4	0.0114	250	0.250	2.78	25
PCB-189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	10.2	0.0102	250	0.250	3.33	25
PCB-202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	8.7	0.00868	250	0.250	1.75	25
PCB-201	2,2',3,3',4,5',6,6'-Octachlorobiphenyl	7.48	0.00748	250	0.250	2.46	25
PCB-204	2,2',3,4,4',5,6,6'-Octachlorobiphenyl	13.5	0.0135	250	0.250	2.29	25
PCB-(197/200)	PCB-(197/200)	44.3	0.0443	500	0.500	6.05	50
PCB-(198/199)	PCB-(198/199)	27.2	0.0272	500	0.500	4.65	50
PCB-196	2,2',3,3',4,4',5,6'-Octachlorobiphenyl	12.9	0.0129	250	0.250	2.82	25
PCB-203	2,2',3,4,4',5,5',6-Octachlorobiphenyl	14.4	0.0144	250	0.250	3.41	25
PCB-195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	10.12	0.0101	250	0.250	3.00	25
PCB-194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl	12.8	0.0128	250	0.250	3.39	25
PCB-205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	9.4	0.00937	250	0.250	2.79	25
PCB-208	2,2'3,3',4,4',5,5',6,6'-Nonachlorobiphenyl	7.3	0.00734	250	0.250	2.43	25
PCB-207	2,2'3,3',4,4',5,6,6'-Nonachlorobiphenyl	9.0	0.00902	250	0.250	2.28	25
PCB-206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	10.0	0.0100	250	0.250	2.89	25
PCB-209	Decachlorobiphenyl	10.3	0.0103	250	0.250	3.73	25

Notes:
IUPAC - International Union of Pure and Applied Chemistry
MDL - method detection limit
PQL - practical quantification limit
ng/kg - nanogram per kilogram
ng/L - nanrogram per liter
pg/L - microgram per liter

[A] - PQLs and MDLs as presented were provided by Pace Analytical of Minneapolis, Minnesota at the time of report production. PQLs and MDLs will vary based on sample size, dilutions, matrix interference and/or moisture content.

Appendix A

Standard Operating Procedures (SOPs)

Utility Clearance

Procedure 3-01

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.

1.2 This procedure is the Program-approved professional guidance for work performed by AECOM under the client contract.

1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.

1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

1.5 If there are procedures, whether it be from AECOM, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific Quality Assurance Project Plan (QAPP).

1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

3.0 Terms and Definitions

3.1 **Utility**

For the proposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 **As-Built Plans**

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 **One-Call**

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at www.call811.com.

Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type or work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

3.4 **Toning**

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 Training and Qualifications

4.1 The **Task Order (TO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

6.0 Procedure

Proceed with the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

6.1 **Prepare Preliminary Site Plan**

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific QAPP. Include as many of the cultural and natural features as practical in this plan.

6.2 Review Background Information

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the TO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The TO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a TO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

6.3 Site Visit/Locate Utilities/Toning

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radio detection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.
- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed

exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the client, the TO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the client to verify its accuracy prior to initiating subsurface sampling activities.

7.0 Quality Control and Assurance

7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.

8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

9.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual.* Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)

Logbooks or Daily Field Reports

Procedure 3-02

1.0 Purpose and Scope

1.1 This standard operating procedure describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with project requirements for technical planning and review.

2.0 Safety

2.1 In order to keep the logbook and associated field data records clean, store them in a clean location and use them only when outer gloves used for Personal Protective Equipment (PPE) have been removed.

3.0 Terms and Definitions

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent binding or pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 Daily Field Report

A daily field report that is clearly identified with the name of the relevant activity and person completing the report may be completed each day instead of a logbook.

3.3 Data Form

A data form is a predetermined format used for recording field data that may become, by reference, a part of the logbook (e.g., sediment sampling forms, soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4.0 Training and Qualifications

4.1 The **Field Coordinator** or **Designee** is responsible for determining which team members shall record information in the logbook or daily field report and for obtaining and maintaining control of the logbook or daily field report. The **Field Coordinator** shall review the logbook or daily field report at the end of each day. The **Field Coordinator** or **Designee** is responsible for reviewing entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

4.2 The **Field Coordinator** is responsible for ensuring that all **Field Personnel** follow these procedures and that the logbook or daily field report is completed properly and daily. The **Field Coordinator** is also responsible for submitting copies to the **Project Manager.**

4.3 The **logbook or daily field report user** is responsible for recording pertinent data to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook or daily field report user** is also responsible for safeguarding the logbook while having custody of it.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with water-repellent binding or pages.

5.2 Daily field reports and data forms shall ideally be printed on rite-in-rain paper.

5.3 Ballpoint pens shall have indelible black or blue ink.

6.0 Procedure

6.1 The logbook or daily field report serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook and field forms in a clean location and use them only when outer gloves used for PPE have been removed.

6.2 Enter field descriptions and observations into the logbook or daily field report, as described in Attachment 1, using indelible black or blue ink.

6.3 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms
- Site name and description
- Site location by longitude and latitude, if known
- Weather conditions, including temperature and relative humidity
- Fieldwork documentation, including site entry and exit times
- Descriptions of, and rationale for, approved deviations from the Quality Assurance Project Plan (QAPP) or Field Sampling Plan (FSP)
- Field instrumentation readings
- Names, job functions, and organizational affiliations of on-site personnel
- Photograph references
- Site sketches and diagrams made on site
- Identification and description of sample morphology, collection locations, and sample numbers
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers
- Sample naming convention
- Field quality control (QC) sample information
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations
- Meeting information
- Important times and dates of telephone conversations, correspondence, or deliverables
- Field calculations
- PPE level

- Calibration records
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number)
- Equipment decontamination procedures and effectiveness
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested
- User signatures

6.4 The logbook or daily field report shall reference data maintained in other logs, forms, etc.

6.5 Correct entry errors by drawing a single line through the incorrect entry, then initialling and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

6.7 Enter page numbers on each page to facilitate identification of photocopies.

6.8 If a person’s initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook or daily field report.

6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook or daily field report is lost.

7.0 Quality Control and Assurance

Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

8.1 Retain the logbook or daily field reports as a permanent project record. If a particular **Field Coordinator** requires submittal of photocopies of logbooks or daily field reports, perform this as required.

8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Project Manager**.

9.0 Attachments or References

Attachment 1 – Description of Logbook Entries

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O’Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Nicky Moody Environmental Scientist	Jennifer Ray Environmental Engineering	Rev 3 – Update & Review (September 2024)

Attachment 1
Description of Logbook or Daily Field Report Entries

Logbook or daily field report entries shall contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Surface Sediment Sampling, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the FSP.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the Work Plan.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
COC and Distribution	Indicate COC for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day, including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook and daily field report entries are for recording data and chronologies of events. The author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

Recordkeeping, Sample Labelling, and Chain of Custody

Procedure 3-03

1.0 Purpose and Scope

1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, writing sample logs, labelling samples, ensuring that proper sample custody procedures are utilized, and completing the chain-of-custody (COC) forms.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with project requirements for technical planning and review.

2.0 Safety

Not applicable.

3.0 Terms and Definitions

3.1 Logbook

A logbook is a bound field notebook with consecutively numbered, water-repellent binding or pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 Daily Field Report

A daily field report that is clearly identified with the name of the relevant activity and person completing the report may be completed each day instead of a logbook.

3.3 Chain-of-Custody Form

A COC form documents the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory and through analysis and storage prior to disposal. COC forms may be carbon copy or computer generated.

4.0 Training and Qualifications

4.1 The **Field Coordinator** is responsible for determining which team members shall record information in the logbook or daily field report and for checking the logbook or daily field report and COC forms to ensure compliance with these procedures.

4.2 The **Project Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The Analytical **Laboratory Project Manager** or **Sample Control Department Manager** is responsible for reporting any sample documentation or COC problems to the **Field Coordinator** or **Quality Assurance/Quality Control (QA/QC) Manager** within 24 hours of sample receipt.

4.4 The **Field Coordinator** is responsible for ensuring that all **Field Personnel** follow these procedures. The **QA/QC Manager** is responsible for verifying that the COCs have been completed properly and match the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). The **Field Coordinator** or **QA/QC Manager** is responsible for notifying the **Laboratory Manager** in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract (e.g., client remedial action contract).

4.5 All **Field Personnel** are responsible for following these procedures while conducting sampling activities. **Field Personnel** are responsible for recording pertinent data into the logbook or daily field report to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

5.0 Procedure

This procedure provides standards for documenting field activities, labelling the samples, documenting sample custody, and completing COCs. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 Recordkeeping

The logbook or daily field report serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct each day's events. Sampling forms or logs such as soil boring logs and groundwater sampling logs will also be used. These procedures are described in Procedure 3-02, *Logbooks and Daily Field Reports*.

5.2 Sample Labelling

Affix a sample label with adhesive backing to each individual sample container. Record the following information with a ballpoint pen, permanent ink pen, or pre-printed text on each label:

- Sample identifier
- Date and time of collection
- Matrix (optional)
- Sample preservatives (if applicable)
- Analysis to be performed on sample (this shall be identified by the method number or name identified in the subcontract with the laboratory)

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

5.3 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Maintain custody of samples in accordance with the U.S. Environmental Protection Agency (EPA) COC guidelines prescribed in EPA *NEIC Policies and Procedures* (1986); EPA *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (1992); *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (1988); Appendix 2 of the *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports* (Water Resources Control Board 1988); and *Test Methods for Evaluating Solid Waste* (EPA 1997)

A description of sample custody procedures is provided below.

5.3.1 Sample Collection Custody Procedures

According to EPA guidelines, a sample is in custody if one of the following conditions is met:

- It is in one's actual physical possession or view.
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal).
- It is retained in a secured area with restricted access.
- It is placed in a cooler and secured with an official seal such that the sample cannot be reached without breaking the seal.

Field Personnel shall place custody seals on coolers immediately after sample collection and on shipping coolers if the cooler is to be removed from the sampler's custody. Place custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

Field Personnel shall also log individual samples onto COC forms when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 5.4. The samplers will sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the analytical laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler, and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall include copies of the completed COC forms in the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

5.3.2 Laboratory Custody Procedures

The following custody procedures are to be followed by an independent laboratory receiving samples for chemical analysis. A designated sample **Custodian** shall take custody of all samples upon their arrival at the analytical laboratory. The **Custodian** shall inspect all sample labels and COC forms to ensure that the information is consistent, and that each is properly completed. The **Custodian** will also measure the temperature of the temperature blank in the coolers upon arrival using either a National Institute for Standards and Technology calibrated thermometer or an infra-red temperature gun. The **Custodian** shall note the condition of the samples including:

- If the samples show signs of damage or tampering;
- If the containers are broken or leaking;
- If headspace is present in sample vials;
- If proper preservation of samples has occurred (made by pH measurement, except volatile organic compounds [VOCs] and purgeable total petroleum hydrocarbons [TPH] and temperature). The pH of VOC and purgeable TPH samples will be checked by the laboratory analyst after the sample aliquot has been removed from the vial for analysis; and
- If any sample holding times have been exceeded.

All the above information shall be documented on a sample receipt sheet by the **Custodian**.

The **Custodian** shall then assign a unique laboratory number to each sample and distribute the samples to secured storage areas. The unique laboratory number for each sample, COC sample number, client name, date and time received, analysis due date, and storage shall be logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The **Custodian** shall sign the shipping bill and maintain a copy.

Laboratory Personnel shall be responsible for the care and custody of samples from the time of their receipt at the laboratory through their exhaustion or disposal. Samples should be logged in and out on internal laboratory COC forms each time they are removed from storage for extraction or analysis.

5.4 Completing COC Forms

COC form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a generic COC that may be used by **Field Personnel**. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Attachment 3 is an example of a completed site-specific COC, with box numbers identified and discussed in text below.

COC forms should be tailored to the project to eliminate the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; turnaround time (TAT); and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all VOC analyte vials into one cooler to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the **Field Personnel**. A brief description of COC fields is summarized below:

Box 1 **Client Contact:** List the name and address of the person/company in addition to the name and number the results report should be addressed to.

Box 2 **Bill To**: List the name and address of the person/company to bill only if it is not in the subcontract with the laboratory

Box 3 **Sample Disposal Instructions:** These instructions will be stated in the Master Service Agreement or each Task Order statement of work with each laboratory.

Shipment Method: State the method of shipment (e.g., hand carry, laboratory courier or air courier).

Comments: This area shall be used by the field team to communicate observations, potential hazards, or limitations that may have occurred in the field or additional information regarding analysis (e.g., a specific metals list, samples expected to contain high analyte concentrations).

Box 4 **Cooler No.:** This will be written on the inside or outside of the cooler and shall be included on the COC. Some laboratories attach this number to the trip blank identification, which helps track samples for VOC analysis. If a number is not on the cooler, field personnel shall assign a number, write it on the cooler, and write it on the COC.

QC Level: Enter the reporting QC requirements (e.g., Full Data Package, Summary Data Package).

Turnaround time: TAT will be determined by a sample delivery group, which may be formed over a multi-day period, not to exceed 20 samples. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each COC to remind the laboratory.

Box 5 **Type of Containers:** Write the type of container used (e.g., 1-liter glass amber, for a given parameter in that column).

Preservatives: Field personnel must indicate on the COC the correct preservative used for the analysis requested. Indicate the pH of the sample (if tested) in case there are buffering conditions found in the sample matrix.

Box 6 **Description (Sample ID):** This name will be determined by the location and description of the sample, as described in the project-specific FSP. If a computer COC version is used, the sample identification can be input

Date Collected: Record the collection date to track the holding time of the sample. Note: For trip blanks, record the date it was placed in company with samples.

Time Collected: When collecting samples, record the time the sample is first collected. Use of the 24-hour military clock will avoid a.m. or p.m. designations (e.g., 1815 instead of 6:15 p.m.). Record local time; the laboratory is responsible for calculating holding times to local time.

Lab ID: This is for laboratory use only.

Box 7 **Matrix/QC:** Identify the matrix (e.g., water, soil, air, tissue, freshwater sediment, marine sediment, or product). If a sample is expected to contain high analyte concentrations (e.g., a tank bottom sludge or distinct product layer), notify the laboratory in the comment section. Mark an “X” for the sample(s) that have extra volume for laboratory QC matrix spike/matrix spike duplicate (MS/MSD) purposes. The sample provided for MS/MSD purposes is usually a field duplicate.

Box 8 **Analytical Parameters:** Enter the parameter by descriptor and the method number desired (e.g., BTEX 8260B, PAHs 8270C, etc.). Whenever practicable, list the parameters as they appear in the laboratory subcontract to maintain consistency and avoid confusion.

If the COC does not have a specific box for number of sample containers, use the boxes below the analytical parameter, to indicate the number of containers collected for each parameter.

Box 9 **Sampler’s Signature:** The person who collected samples must sign here.

Relinquished By: The person who turned over the custody of the samples to a second party other than an express mail carrier, such as FedEx or DHL, must sign and date here.

Received By: Typically, a representative of the receiving laboratory signs and dates here, or a field crew member who delivered the samples in person from the field to the laboratory might sign here. A courier, such as FedEx or DHL, does not sign here because they do not open the coolers. It must also be used by the prime contracting laboratory when samples are to be sent to a subcontractor.

Relinquished By: In the case of subcontracting, the primary laboratory will sign and date the Relinquished By space and fill out an additional COC to accompany the samples being subcontracted.

Received By (Laboratory): This space is for the final destination (e.g., at a subcontracted laboratory). A representative of the final destination (e.g., subcontracted laboratory) must sign and date here.

Box 10 **Lab No. and Questions:** This box is to be filled in by the laboratory only.

Box 11 **Control Number:** This number is the "COC" followed by the first contractor identification number in that cooler or contained on that COC. This control number must be unique (i.e., never used twice). Record the date the COC is completed. It should be the same date the samples are collected.

Box 12 **Total # of Containers:** Sum the number of containers in that row.

Box 13 **Totals:** Sum the number of containers in each column.

Because COC forms contain different formats depending on who produced the form, not all the information listed in Boxes 1 to 13 may be recorded; however, as much of this information as possible shall be included.

6.0 Quality Control and Assurance

6.1 Recordkeeping, sample labelling, and COC activities must incorporate QC measures to ensure accuracy and completeness.

6.2 Deviations from this procedure or the QAPP shall be documented in field records. Significant changes shall be approved by the **Project Manager**.

7.0 Records, Data Analysis, Calculations

7.1 The COC forms shall be emailed approximately daily to the **QA/QC Manager** for verification of accuracy. Following the completion of sampling activities, the logbook or daily field report and COC forms will be transmitted to the **Field Coordinator** for storage in project files. The original COC shall be submitted by the laboratory along with the laboratory reports. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the **QA/QC Manager** and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

7.2 Deviations from this procedure or the FSP or QAPP shall be documented in the records. Significant changes shall be approved by the **Project Manager**.

8.0 Attachments or References

Attachment 1 – Generic Chain-of-Custody Seal

Attachment 2 – Generic Chain-of-Custody Form

Attachment 3 – Sample Completed Chain-of-Custody

Procedure 3-02, *Logbooks and Daily Field Reports*.

EPA (Environmental Protection Agency, United States). 1986. *NEIC Policies and Procedures*. National Enforcement Investigations Center, Denver, Colorado, revised May 1986

EPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.

EPA. 1992. *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*. EPA/530/R-93/001. Office of Solid Waste. November.

EPA. 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846*. 3rd ed., Final Update IIIA. Office of Solid Waste.

Water Resources Control Board, State of California. 1988. *Technical Guidance Manual for Solid Waste Water Quality Assessment Test (SWAT) Proposals and Reports*. August.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Nicky Moody Environmental Scientist	Jennifer Ray Environmental Engineering	Rev 3 – Update & Review (September 2024)

Attachment 1
Generic Chain-of-Custody Seal

CHAIN-OF-CUSTODY SEAL

<table>
<tr><td rowspan="3">[LABORATORY]</td><td>SAMPLE NO.</td><td>DATE</td><td>SEAL
BROKEN BY</td></tr>
<tr><td colspan="2">SIGNATURE</td><td>DATE</td></tr>
<tr><td colspan="3">PRINT NAME AND TITLE (Inspector, Analyst or Technician</td></tr>
</table>

Attachment 2
Generic Chain-of-Custody Form

M901376

CHAIN OF COUSTODY RECORD

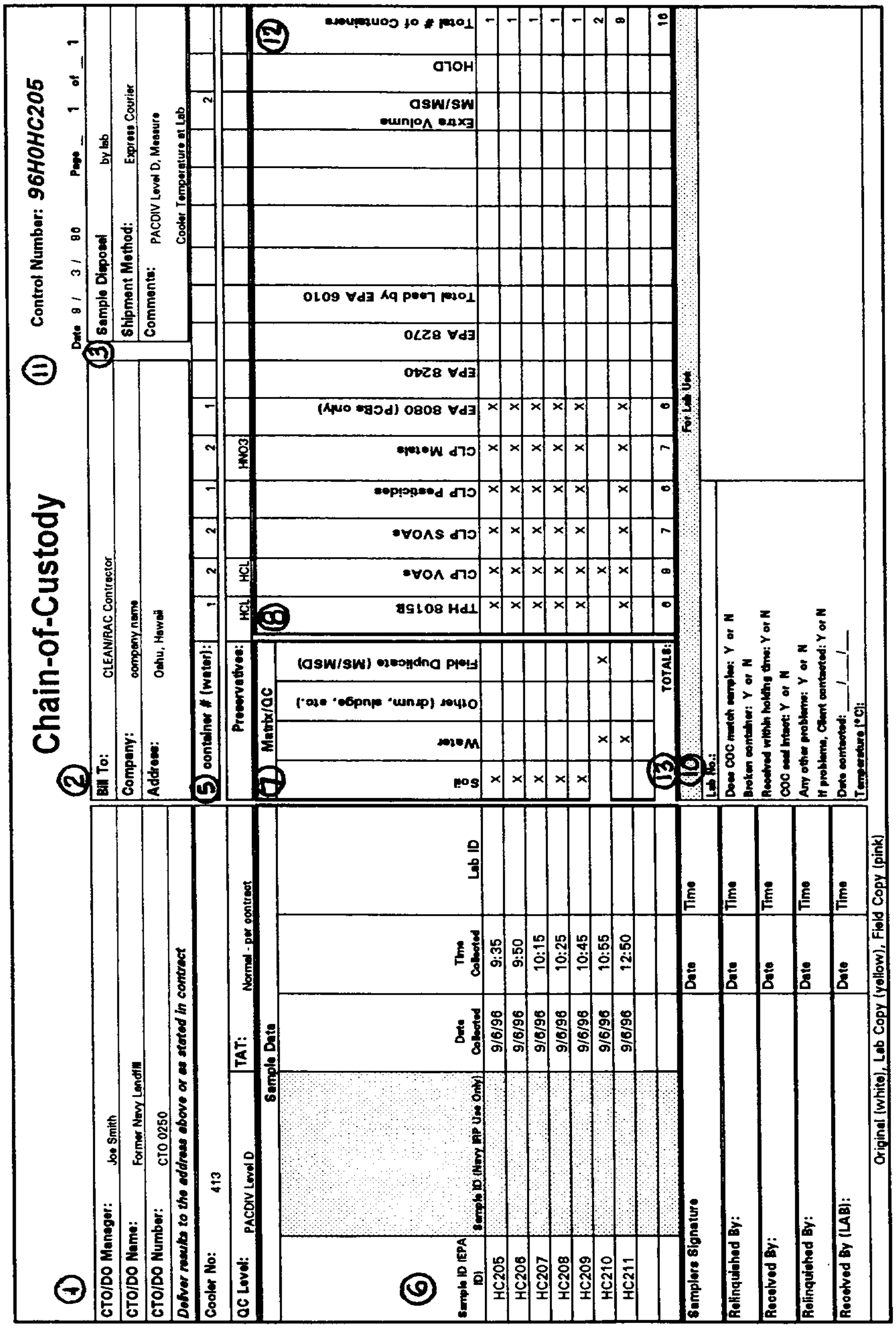
Page ____ of ____

Client/Project Name:	Project Location:	Analysis Requested
Project Number:	Field Logbook No.:	
Sampler: (Print Name) /Affiliation: Signature:	Chain of Custody Tape No.: Send Results/Report to:	

Field Sample No./ Identification	Date	Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid, Sludge, Etc.)	Preservative	Field Filtered							Lab I.D.	Remarks

Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Analytical Laboratory (Destination):
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	
Relinquished by: (Print Name) Signature:	Date: Time:	Received by: (Print Name) Signature:	Date: Time:	Serial No.

Attachment 3
Sample Completed Chain of Custody



Chain-of-Custody

(11) Control Number: **96H0HC205**

Date 9 / 3 / 96 Page 1 of 1

(1)
CTO/DO Manager: Joe Smith
CTO/DO Name: Former Navy Landfill
CTO/DO Number: CTO 0250
Deliver results to the address above or as stated in contract

(2)
Bill To: CLEAN/RAC Contractor
Company: company name
Address: Oahu, Hawaii

(3)
Sample Disposal: by lab
Shipment Method: Express Courier
Comments: PACDIV Level D, Measure Cooler Temperature at Lab

(4)
Cooler No: 413
QC Level: PACDIV Level D
TAT: Normal - per contract

(5) container # (water): 1, 2, 2, 1, 2, 1, 2
Preservatives: HCL, HCL, HNO3

Sample Data (6) / Matrix/QC (7) / Analyses (8) / (12)

Sample ID (EPA ID)	Sample ID (Navy IRP Use Only)	Date Collected	Time Collected	Lab ID	Soil	Water	Other (drum, sludge, etc.)	Field Duplicate (MS/MSD)	TPH 8015B	CLP VOAs	CLP SVOAs	CLP Pesticides	CLP Metals	EPA 8080 (PCBs only)	EPA 8240	EPA 8270	Total Lead by EPA 6010	Extra Volume MS/MSD	HOLD	Total # of Containers
HC205		9/6/96	9:35		X				X	X	X	X	X	X						1
HC206		9/6/96	9:50		X				X	X	X	X	X	X						1
HC207		9/6/96	10:15		X				X	X	X	X	X	X						1
HC208		9/6/96	10:25		X				X	X	X	X	X	X						1
HC209		9/6/96	10:45		X				X	X	X	X	X	X						1
HC210		9/6/96	10:55			X		X		X										2
HC211		9/6/96	12:50			X			X	X	X	X	X	X						9
(13) TOTALS:									6	9	7	6	7	6						16

(9)

	Date	Time
Samplers Signature		
Relinquished By:		
Received By:		
Relinquished By:		
Received By (LAB):		

(10) For Lab Use
Lab No.:
Does COC match samples: Y or N
Broken container: Y or N
Received within holding time: Y or N
COC seal intact: Y or N
Any other problems: Y or N
If problems, Client contacted: Y or N
Date contacted: ___/___/___
Temperature (°C):

Original (white), Lab Copy (yellow), Field Copy (pink)

Sample Handling, Storage, and Shipping

Procedure 3-04

1.0 Purpose and Scope

1.1 This standard operating procedure describes the actions to be used by personnel engaged in handling, storing, and transporting samples. The objective is to obtain samples of actual conditions with as little alteration as possible.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Avoid lifting heavy coolers with back muscles; instead, use leg muscles or dollies.

2.2 Wear powderless nitrile gloves, as defined in the project-specific health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **Field Coordinator** is responsible for ensuring that all samples are shipped according to this procedure.

4.2 The **Field Coordinator** and the **Laboratory Project Manager** are responsible for identifying instances of non-compliance with this procedure and ensuring that future sample transport activities comply with this procedure.

4.3 **All Field Personnel** are responsible for the implementation of this procedure.

4.4 The **Quality Assurance/Quality Control (QA/QC) Manager** is responsible for ensuring that sample handling, storage, and transport activities comply with this procedure.

5.0 Procedure

5.1 Handling and Storage

Immediately following collection, label all samples according to Procedure 3-03, *Recordkeeping, Sample Labelling, and Chain of Custody*. The lids of the containers shall not be sealed with duct tape but may be covered with custody seals or placed directly into self-sealing polyethylene (e.g., Ziploc brand) bags. Place the sample containers in an insulated cooler with water ice in double, sealed self-sealing Ziploc bags. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material) on the bottom of the cooler to contain liquids in case of spillage. Prior to shipping, wrap glass sample containers on the sides, tops, and bottoms with polyethylene plastic wrap or other appropriate padding and/or surround them in Styrofoam to prevent breakage during transport. Pack all glass containers for water samples in an upright position, never stacked or on their sides. Prior to shipment, replace the ice in the coolers so that samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory. Ship samples within 24 hours or on a schedule allowing the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C pertain to all field samples.

5.2 Shipping

Follow all appropriate U.S. Department of Transportation regulations (e.g., 49 Code of Federal Regulations Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized below.

6.0 Quality Control and Assurance

6.1 Sample handling, storage, and shipping must incorporate QC measures to ensure conformance to these and the project requirements.

7.0 Records, Data Analysis, Calculations

7.1 Maintain records as required by implementing these procedures.

7.2 Deviations from this procedure or the project-specific sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Project Manager**.

8.0 Attachments or Reference

8.1 Procedure 3-03, *Recordkeeping, Sample Labelling, and Chain of Custody*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Nicky Moody Environmental Scientist	Jennifer Ray Environmental Engineering	Rev 3 – Update & Review (September 2024)

Investigation Derived Waste Management

Procedure 3-05

1.0 Purpose and Scope

This standard operating procedure (SOP) describes activities and responsibilities of the client with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labelling, temporary storage, inventory, classification, and disposal of IDW generated under the client contract. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

If there are procedures whether it be from AECOM, state and/or federal that are not addressed in this SOP and are applicable to IDW then those procedures may be added as an appendix to the project specific SAP.

This procedure shall serve as management-approved professional guidance for the client and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Task Order (TO) Manager and the Quality Assurance (QA) Manager or Technical Director and documented.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated under the client contract. It focuses on the requirements for minimizing, segregating, handling, labelling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

2.0 Safety

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the TO WP and/or direction from the **Site Safety Officer (SSO)**.

All **Field Personnel** responsible for IDW management must adhere to the HASP and must wear the PPE specified in the site-specific HASP. Generally, this includes, at a minimum, steel-toed boots or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). If safe alternatives are not achievable, discontinue site activities immediately.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **TO Manager** is responsible for ensuring that IDW management activities comply with this procedure. The **TO Manager** is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all IDW is managed according to this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

All AECOM personnel who will perform any duties related to management of Resource Conservation and Recovery Act (RCRA) hazardous wastes or shipping of Department of Transportation (DOT) Hazardous Materials will be properly trained in accordance with 40 CFR § 262.34 and §265.16 for RCRA Waste Generators, as well as 49 CFR § 172.704 for DOT Hazardous Materials Shippers. All RCRA Hazardous Wastes are by definition DOT Hazardous Materials. See Section 6.1 for details on determining the IDW waste classification.

5.0 Equipment and Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., [U.S. Department of Transportation] DOT approved 55-gallon open and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering);
- Hazardous /non-hazardous waste drum labels (weatherproof);
- Permanent marking pens;
- Inventory forms for project file;
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting; and
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the HASP.

6.0 Procedure

The following procedures are used to handle the IDW.

6.1 Drum Handling

6.1.1 IDW shall be containerized using DOT approved drums. The drums shall be made of steel or polyethylene, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Always consider IDW physical and chemical characterises to make sure the drum material is compatible. Typically, 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. Large overpack drums may be used if smaller drums become damaged. New drums are preferred. The use of recycled drums should be avoided.

6.1.2 Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.

6.1.3 For long-term IDW storage at other project locations, the DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids.

6.1.4 If the sealing ring is only partially attached to the drum lid, or if a portion of the sealing ring is missing, select another drum lid with a sealing ring that is in sound condition.

6.1.5 To prevent damage to drums, loss of drum integrity/containment, and/or presenting hazards to drum handlers, the following "Rules-of-Thumb" should be applied when filling drums.

- Liquid, soil, PPE/plastics, and construction debris must be segregated by media into individual drums.
- A **void space of 4 to 6 inches** from the top of the drum (the upper drum ring on most drums) will be left in the drum to allow room for ice expansion when filling drums with water or oil/water emulsions. Under freezing temperatures, expanding ice in a full drum can deform the bottom of a drum such that it is no longer DOT compliant, cause ruptures and/or dislodge the drum lid and present a containment breach. The consequences of this damage can be both economic and environmental.
- Compatibility between the chemical component(s) of the IDW and the drum material must be considered before choosing the type of drum/container to use. Steel drums are susceptible to corrosion and loss of integrity when in contact with high pH water. Lime-based products (cement, concrete, grout, etc.) should not be disposed in steel drums containing water or soil water mixtures, and liquid IDW should not be disposed in steel drums used to mix lime-based products (separate reusable containers for mixing should be used when possible). If high (>12) or low (<2) pH conditions are possible, IDW liquids should be monitored for pH using a calibrated pH meter or pH test strips. The use of plastic drum liners or polyethylene drums is also recommended for high or low pH liquid IDW.
- Soil drums will be filled to no more than two thirds of the drum capacity. Drums completely full of soil can weigh over 600 pounds. Although drum handling tools and carts provide some assistance, moving such excessive weights present significant hazards, including; muscle strain, crushing (foot and fingers), and loss of drum control, such as sliding off of lift gates.
- Drums should not be overfilled filled with PPE and plastic (tubing, old macrocores) such that the material is excessively compacted. Pinch points are presented as the drum is closed under force, and the compressed material can spring up when the drums are opened.

6.1.6 Stacking full or partially full drums is prohibited.

6.1.7 To prepare IDW drums for labelling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labelling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and disposable sampling equipment. Label all IDW drums and place them on pallets prior to storage.

6.2 Labelling

6.2.1 Containers used to store IDW must be properly labelled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.

6.2.2 For situations where the waste characteristics are known, the waste containers should be packaged and labelled in accordance with state regulations and any federal regulations that may govern the labelling of waste.

6.2.3 The following information shall be placed on all non-hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

6.2.4 The following information shall be placed on all hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Generator information (i.e., name, address, contact telephone number);
- EPA identification number (supplied by on-site client representative);
- Date when the waste was first accumulated.

6.2.5 When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words "waste characterization pending analysis" and the following information included on the label:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

6.2.6 Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.

6.2.7 Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight (faded entries should be remarked during inspections performed as specified in Section 6.2.4). It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it may also be helpful to include labels on the top of the containers to facilitate organization and disposal. In addition to a label, each drum should be numbered on the side and top with a paint pen or wax pencil for easy identification.

6.2.8 Each container of waste generated shall be recorded in the field notebook used by the person responsible for labelling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

6.3 Types of Site Investigation Waste

Several types of waste are generated during site investigations that may require special handling. These include solid, liquid, and used PPE, as discussed further below.

<u>Solid Waste</u>

Soil cuttings from boreholes will typically be placed in containers unless site specific requirements allow for soil cuttings to be placed back into the borehole after drilling is complete. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labelled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labelled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

6.1 IDW Waste Classification

State and federal regulations require specific handling and storage requirements for wastes classified as hazardous, such as secondary containment and waste removal deadlines (see Section 6.2.2). The Site owner/operator must determine whether the IDW may contain a listed hazardous waste based on the source of contamination, contaminants, and waste manifests or any other documentation of wastes generated at the Site. It is presumed that the IDW will be considered a solid waste (40 CFR 261.2) but this should be verified during the work plan development. If the available documentation indicates that a listed hazardous waste was generated at the Site, then the IDW will be considered a hazardous waste regulated under RCRA.

If there is inconclusive documentation concerning the IDW generated at the Site, then the U.S. EPA has stated the IDW is not a listed hazardous waste. However, in this case, further evaluation is necessary to evaluate whether the IDW in question exhibits a characteristic of hazardous waste. This is determined by analytical testing or knowledge. An IDW that may be characteristically hazardous should be evaluated for the following hazardous characteristics:

- Characteristic of ignitability (40 CFR §261.21)
- Characteristic of corrosivity (40 CFR §261.22)
- Characteristic of reactivity (40 CFR §261.23)
- Characteristic of toxicity (40 CFR §261.24)

If the RDW contains a listed hazardous waste, then U.S. EPA's contained-in policy (53 FR 31138, 31142, 31148, 57 FR 21453, 61 FR 18795) for contaminated environmental media should be evaluated. U.S. EPA considers IDW to contain hazardous waste:

- when it exhibits a characteristic of hazardous waste; or
- when it is impacted with concentrations of hazardous constituents from listed hazardous wastes that are above health-based levels.

Generally, IDW that does not (or no longer) contain hazardous waste are not subject to RCRA, but in some circumstances, the IDW that contained hazardous waste when first generated remain subject to land disposal restrictions (LDR) (40 CFR §268.45). There are also special LDR standards specific to contaminated debris (40 CFR §268.45).

6.2 Waste Accumulation On-Site

6.2.1 Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or "characterization pending analysis" should be disposed of as soon as possible. Until off-site transport and disposal is arranged, drums should be moved to a staging location accessible by pickup by truck. This location should be relatively flat, have a hard surface (densely compact dirt, concrete, or asphalt), and be secure (by a fence or building).

6.2.2 Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous **shall not** be accumulated on-site longer than **90 days**. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labelling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher;
- Adequate aisle space for unobstructed movement of personnel.

6.2.3 When possible, drums should be segregated in the storage area by media and or classification (liquid, solid, non-hazardous, hazardous, etc.) to facilitate type identification during characterization sampling and pickup and reduce the need to rearrange drums if multiple pickups by type are required.

6.2.4 Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated. During active site work, weekly storage area inspections should be performed and documented to ensure compliance with the requirements specified above. Monthly storage area inspections should be performed following the completion of active site work and the date the IDW is removed from the storage area by the waste hauler. Containers should be inventoried and inspected regularly. Labels should be checked to make sure they remain legible. Inspection notes should include the condition of the staging area as this will be important when coordinating the labour and equipment the waste hauler will require. Anomalies should be documented and photographed.

6.3 Waste Disposal

6.3.1 Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers. The selected disposal facility will prepare a waste profile based on the characterization results. The waste generator (Navy representative or authorized agent) will review and sign the profile.

6.3.2 All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.

6.3.3 Disposal facilities for waste generated during activities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) will require EPA approval under the Off-Site Rule (OSR) procedures (40 CFR 300.440) to ensure the facility is operating in compliance with RCRA or other Federal and State requirements. After the waste profile is finalized, the generator will submit it with an OSR request form to the EPA project manager for approval. An example OSR request form is provided in Attachment A. IDW may not be shipped to the facility until approval is granted by the EPA. OSR approvals per waste profile are valid for 90 days.

6.3.4 In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

6.4 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- Code of Federal Regulations (CFR), Title 40, Part 261; and
- CFR, Title 49, Parts 172, 173, 178, and 179.

6.5 Waste Transport

A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

7.0 Quality Control and Assurance

7.1 Management of IDW must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 Maintain records as required by implanting the procedures in this SOP.

8.2 Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

Department of Defence, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual.* Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Department of Energy, United States (DOE). 1994. *The Off-Site Rule*. EH-231-020/0194. Office of Environmental Guidance. March.

1999. *Management of Remediation Waste under the Resource Conservation and Recovery Act (RCRA)*. Office of Environmental Policy and Assistance. 20 December.

Environmental Protection Agency, United States (EPA). 1991. *Management of Investigative-Derived Wastes During Site Inspections*. Office of Emergency and Remedial Response. EPA/540/G-91/009. May.

1992a. *Guidance for Performing Site Inspections under CERCLA*. EPA/540/R-92/021. Office of Emergency and Remedial Response. September.

1992b. *Guide to Management of Investigative-Derived Wastes*. Quick reference fact sheet. OSWER Dir. 9345.3-03FS. Office of Solid Waste and Emergency Response. January.

1997a. *Sending Wastes Off Site? OSC and RPM Responsibilities under the Off-Site Rule*. EPA/540-F-97-006, Office of Solid Waste and Emergency Response. September.

1997b. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.* 3rd ed., Final Update IIIA. Office of Solid Waste. Updates available: www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

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(No Date). *Compliance with the Off-Site Rule During Removal Actions.* Office of Regional Counsel (Region 3). Hendershot, Michael.

Author	**Reviewer**	**Revisions (Technical or Editorial)**
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)
Joshua Millard Senior Geologist	Andrew Borden Geologist	Rev 1 – Technical (Jan 2017)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 2 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 3 – Update & Review (June 2022); updated Attachment A

Attachment A
Off Site Rule Request Form

United States Environmental Protection Agency – Region 1

Off-Site Rule Compliance Request Form

Date: (mm/dd/yy)		**Supporting Documentation Required-Attached?** (yes/no)	

RECEIVING FACILITY INFORMATION:		
1	**Name of Facility receiving CERCLA waste:**	
2	**Address of Facility:**	
3	**City:**	
4	**State:**	
5	**Zip Code:**	
6	**EPA/State Facility ID:**(e.g. Haz. Waste/Municipal Waste ID)	
7	**Other Pertinent ID Numbers: (**e.g. License #, permit #**)**	
8	**Phone Number (**if available**):**	
9	**Contact Name (**if available**):**	
10	**FAX Number (**if available**):**	
11	**E-mail address (**if available**):**	

GENERATING FACILITY INFORMATION:		
12	**CERCLA Site Name:**	
13	**CERCLA Site Address:**	
14	**City:**	
15	**State:**	
16	**Zip Code:**	
17	**CERCLA Site ID:** (i.e. alpha-numeric)	
18	**EPA CERCLA ID #:**	
19	**Waste Media: (**e.g., Soil, Water, Air, etc.**)**	
20	**CERCLA Hazardous Waste Contaminates: (**e.g. tce, lead**)**	
21	**Amount of CERCLA Waste:** (e.g. gallons, pounds, tons, ft^3, yd^3**)**	
22	**EPA representative making waste determination:** (e.g. OSC, RPM & Tel.#)	
23	**Basis of Waste Determination: (**e.g. analyses, TCLP, etc.**)**	
24	**Site Billing Code:**	

[Form: Off-Site Compliance Request] [Revised December 8, 2020]

For more information on the Off-Site Rule, please contact the appropriate Regional Off-Site Contact (ROC) listed at **https://www.epa.gov/superfund/site-rule#contacts**

	Regional Off-Site Contacts (listed as of January 4, 2021)	
Region # U.S. & DC,PR,VI	**Contact Name**	**Telephone #**
1 CT,MA,ME,NH,RI,VT	Conor O'Brien (OBrien.Conor@epa.gov)	**617.918.1769**
2 NY,NJ,PR,VI	Beckett Grealish (Region2_OSR@epa.gov)	**732.321.4341**
3 DC,DE,MD,PA,VA,WV	David Iacono (R3CERCLA_Offsite@epa.gov)	**215.814.3231**
4 AL,FL,GA,KY,MS,NC,SC,TN	Hector Danois (r4cercla_offsitecontact@epa.gov)	**404.562.8556**
5 IL,IN,MI,MN,OH,WI	William Damico (r5cercla.roc@epa.gov)	**312.353.8207**
6 AR,LA,NM,OK,TX	Wilkin (Ron) Shannon (shannon.wilkin@epa.gov)	**214.665.2282**
7 IA,KS,MO,NE	Mike Martin (martin.mike@epa.gov)	**913.551.7149**
8 CO,MT,ND,SD,UT,WY	Linda Jacobson (jacobson.linda@epa.gov)	**303.312.6503**
9 AZ,CA,HI,NV	Sharon Lin (lin.sharon@epa.gov)	**415.972.3446**
10 AK,ID,OR,WA	Cheryl Williams (williams.cherylb@epa.gov)	**206.553.2137**

[Form: Off-Site Compliance Request] [Revised December 8, 2020]

Equipment Decontamination

Procedure 3-06

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

It is the responsibility of the **Site Safety and Health Officer (SSHO)** to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally, the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. Typically, for equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure or the Task Order (TO) Quality Assurance Project Plan (QAPP) and deionized water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All **Field Personnel** responsible for equipment decontamination must adhere to the site-specific Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP) and must wear the personal protective equipment (PPE) specified in the site-specific APP/SSHP. Generally, this includes, at a minimum, Tyvek® coveralls, steel-toed boots with boot covers or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). Air monitoring by the **SSHO** may result in an upgrade to the use of respirators and cartridges in the decontamination area; therefore, this equipment must be available on site. If safe alternatives are not achievable, discontinue site activities immediately.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

2.1 Chemical Hazards associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water;
- Utilize PPE as specified in the site-specific APP/SSHP to maximize splash protection;
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory); and
- Take the necessary precautions when handling detergents and reagents.

2.2 Physical Hazards associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area 1 to 2 feet above ground level;
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel; and

- Take necessary precautions when handling field sampling equipment.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **TO Manager** is responsible for ensuring that decontamination activities comply with this procedure. The **TO Manager** is responsible for ensuring that all personnel involved in equipment decontamination shall have the appropriate education, experience, and training to perform their assigned tasks.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedure

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, wipe, asbestos, and unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted;
- Types of equipment requiring decontamination;
- Frequency of equipment decontamination;
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern;
- Method for containing the residual contaminants and wash water from the decontamination process; and
- Use of a quality control measure to determine the effectiveness of the decontamination procedure.

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.1 Decontamination Area

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

5.2 Types of Equipment

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels, hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.3 Frequency of Equipment Decontamination

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.4 Cleaning Solutions and Techniques

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment and rinse it with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a PFAS-free detergent (Alconox®, Liquinox®, or other suitable detergent) and deionized water solution, and (2) rinse in triplicate with deionized water. If possible, disassemble equipment prior to cleaning. Add an additional wash as needed at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and deionized water solution, and (2) rinse in triplicate with deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent; however, if samples are also to be analysed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of deionized water. Decontamination solvents to be used during field activities will be specified in the TO QAPP.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized water after each measurement. Also wash new, unused soil sample liners and caps with a fresh detergent solution and rinse them with deionized water to remove any dirt or cutting oils that might be on them prior to use.

5.5 Containment of Residual Contaminants and Cleaning Solutions

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure 3-05, *IDW Management*.

6.0 Quality Control and Assurance

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free deionized water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a PFAS-free cotton cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

7.0 Records, Data Analysis, Calculations

Any project where sampling and analysis is performed shall be executed in accordance with an approved sampling and analysis plan. This procedure may be incorporated by reference or may be incorporated with modifications described in the plan.

Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

8.0 Attachments or References

8.1 ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites.* ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.

8.2 Procedure 3-05, *IDW Management*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)

Soil Classification

Procedure 3-16

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) to thoroughly describe the physical characteristics of the sample and classify it according to the Unified Soil Classification System (USCS).

1.2 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the **Project Manager**. Deviations to this SOP will be documented in the field records.

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling. All **Field Personnel** responsible for sampling activities must review the project-specific Health and Safety Plan (HASP), paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel.

2.2 In addition, observe standard health and safety practices according to the HASP. Suggested minimum protection during sampling and classification activities includes nitrile gloves, steel-toed boots, and an American National Standards Institute-standard hard hat. Refer to the HASP for additional Personal Protective Equipment (PPE) and other safety equipment requirements.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Field Coordinator** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied.

2.4 The health and safety considerations for the work associated with soil classification include:

- At no time during classification activities are **Field Personnel** to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils without the use of gloves and safety glasses.
- Stay clear of all moving equipment and be aware of pinch points on machinery. Avoid wearing loose fitting clothing.
- When using cutting tools, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear insulating clothing.

3.0 Terms and Definitions

None.

4.0 Interference

None.

5.0 Training and Qualifications

5.1 The **Field Coordinator** is responsible for ensuring that the soil classification activities comply with this procedure. The **Field Coordinator** is responsible for ensuring that all personnel involved in soil classification shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2 The **Project Manager** is responsible for ensuring overall compliance with this procedure.

5.3 The **Field Coordinator** is responsible for ensuring that all project **Field Personnel** follow these procedures.

5.4 The **Field Coordinator** is responsible for directly supervising the soil classification procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the **Project Manager** and then documented in the field logbook and associated report or equivalent document.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- PPE and other safety equipment, as required by the HASP
- Logbook or daily field report and pen with indelible ink
- Field form (sampling form or boring log)
- Munsell Soil Color Chart
- Scoopula, spatula, and/or other small hand tools

7.0 Calibration or Standardization

None.

8.0 Procedure

8.1 Soil Classification

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system. The USCS was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log, logbook, and/or electronic field data collection device. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as consistency, density, and structure
- USCS classification symbol

The USCS serves as ”shorthand“ for classifying soil into 15 basic groups:

- GW[1] Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)
- GP[1] Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)
- GM[1] Silty gravel (>50 percent gravel, >15 percent silt)
- GC[1] Clayey gravel (>50 percent gravel, >15 percent clay)
- SW[1] Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)
- SP[1] Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)
- SM[1] Silty sand (>50 percent sand, >15 percent silt)
- SC[1] Clayey sand (>50 percent sand, >15 percent clay)
- ML[2] Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)
- CL[2] Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)
- MH[2] Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)
- CH[2] Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)
- OL Organic low plasticity silt or organic silty clay
- OH Organic high plasticity clay or silt
- PT Peat and other highly organic soil

Figure 8-1 defines the terminology of the USCS. Flow charts presented in Figure 8-2 and Figure 8-3 indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

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[1] If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC.

[2] If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words “with sand” or “with gravel” (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words “sandy” or “gravely” (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use “sandy.”

DEFINITION OF TERMS

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	**GRAVELS** More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	**CLEAN GRAVELS** (Less than 6% Fines)	**GW**	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS With Fines	**GM**	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	**CLEAN SANDS** (Less than 6% Fines)	**SW**	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		SANDS With Fines	**SM**	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	**SILTS AND CLAYS** Liquid Limit is Less Than 50%		**ML**	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines
			CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid Limit is Greater Than 50%		**MH**	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt
			CH	inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			**PT**	Peat and other highly organic soils

GRAIN SIZES

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

200 40 10 4 3/4" 3" 12"

U.S. STANDARD SERIES SIEVE — CLEAR SQUARE SIEVE OPENINGS

Figure 8-1: Unclassified Soil Classification System (USCS)

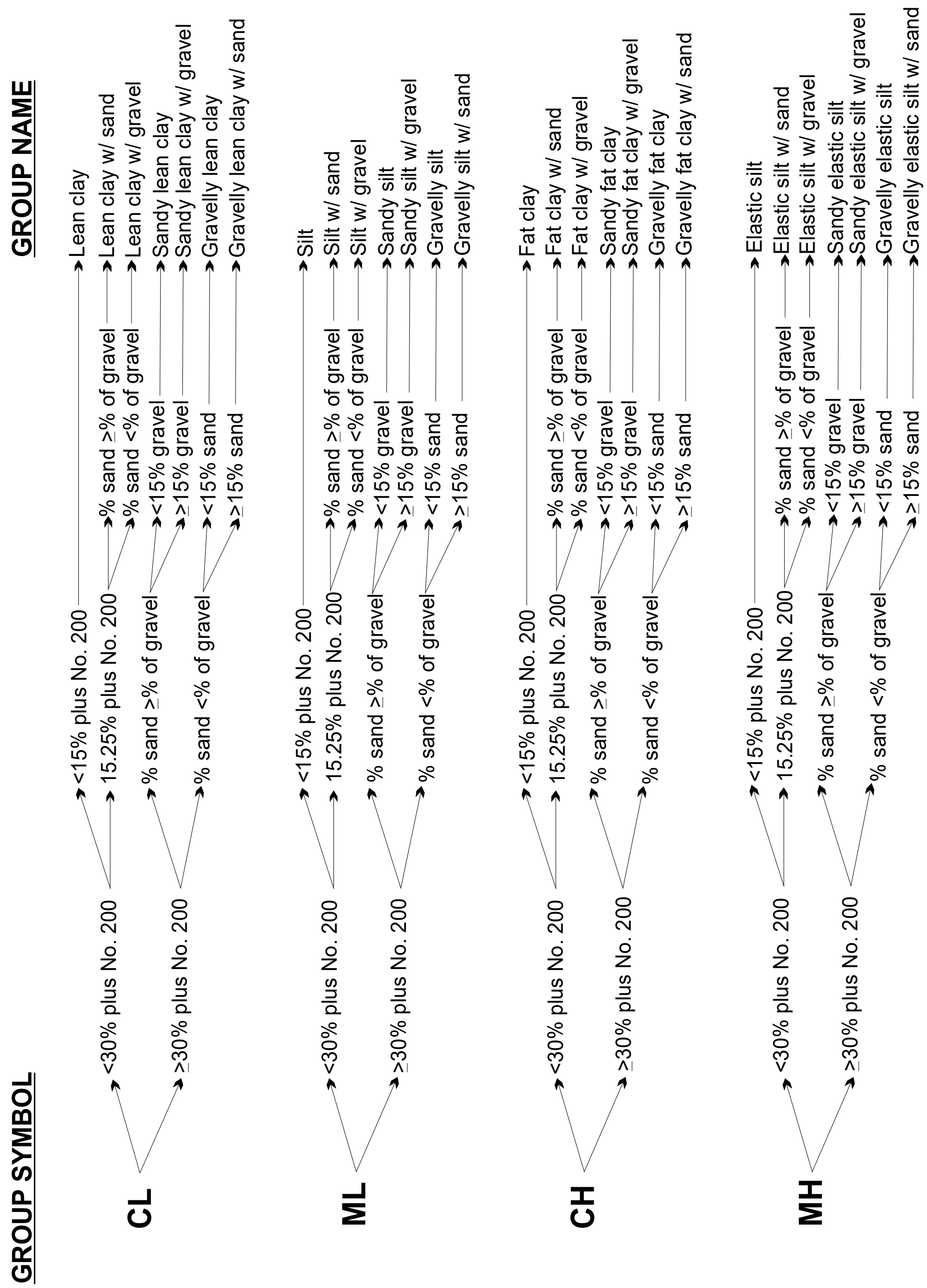

Figure 8-2: Flow Chart for Fine Grain Soil Classification

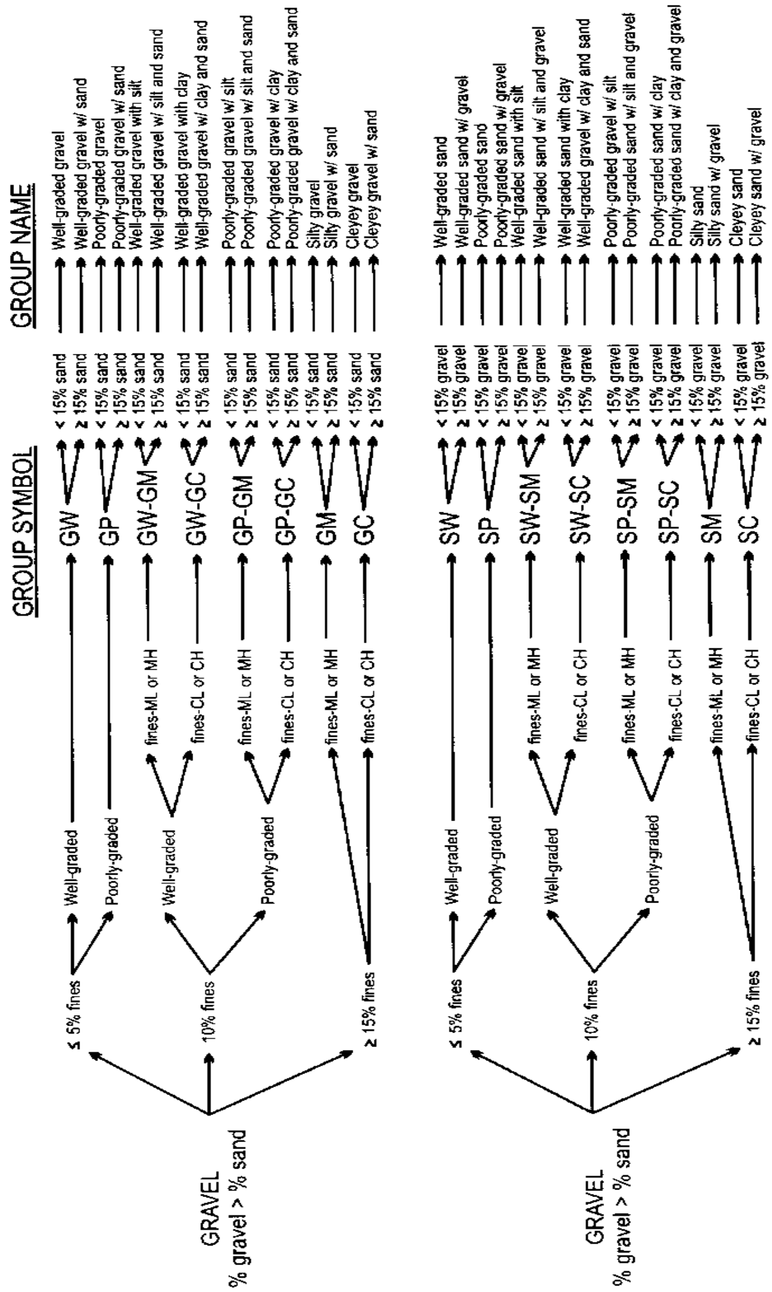

Figure 8-3: Flow Chart for Soil with Gravel

8.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

a) Select a representative sample (approximately half of a 6-inch-long by 2.5-inch-diameter sample liner).

b) Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.

c) Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).

d) Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).

e) Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).

f) Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term “trace.”

g) The percentages of gravel, sand, and fines must add up to 100 percent. “Trace” is not included in the 100 percent total.

8.1.2 Soil Dilatancy, Toughness, and Plasticity

8.1.2.1 Dilatancy

To evaluate dilatancy, follow these procedures:

a) From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

b) Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 8-1. The reaction is the speed with which water appears while shaking and disappears while squeezing.

Table 8-1: Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

8.1.2.2 Toughness

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 8-2.

Table 8-2: Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.

8.1.2.3 Plasticity

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table 8-3 presents the criteria for describing plasticity in the field using the rolled thread method.

Table 8-3: Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

8.1.3 Angularity

The following criteria describe the angularity of the coarse sand and gravel particles:

- **Rounded** particles have smoothly curved sides and no edges.
- **Subrounded** particles have nearly plane sides but have well-rounded corners and edges.
- **Subangular** particles are similar to angular but have somewhat rounded or smooth edges.
- **Angular** particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

8.1.4 Color, Moisture, and Odor

The natural moisture content of soil is very important. Table 8-4 shows the terms for describing the moisture condition and the criteria for each.

Table 8-4: Soil Moisture Content Qualifiers

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like “5YR 5/6, yellowish-red.” Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

8.1.5 In-Place Conditions

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

8.1.5.1 Density/Consistency

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 pounds (63.5 kilograms [kg]) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter (I.D.) Modified California Sampler equipped with brass or stainless-steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table 8-5 and Table 8-6 present representative descriptions of soil density/consistency vs. N-values.

Table 8-5: Measuring Soil Density with a California Sampler – Relative Density (Sands, Gravels)

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	**2 in. ID Sampler using 1.43 factor**
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	> 50	> 71

Table 8-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	**2 in. ID Sampler using 1.13 factor**
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	> 32	> 36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or Shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (psf). Table 8-7 presents the values.

Table 8-7: Measuring Soil Consistency with a Hand-Held Penetrometer

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1000
Stiff	1000–2000
Very Stiff	2000–4000
Hard	>4000

Consistency can also be estimated using thumb pressure using Table 8-8.

Table 8-8: Measuring Soil Consistency Using Thumb Pressure

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

8.1.5.2 Cementation

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

- Quartz – siliceous
- Chert – chert-cemented or chalcedonic
- Opal – opaline
- Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
- Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
- Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
- Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

- Weak – friable; crumbles or breaks with handling or slight finger pressure
- Moderate – friable; crumbles or breaks with considerable finger pressure
- Strong – not friable; will not crumble or break with finger pressure

8.1.5.3 Structure

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- Granular – spherically shaped aggregates with faces that do not accommodate adjoining faces
- Stratified – alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- Laminated – alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- Blocky – cohesive soil that can be broken down into small angular or subangular

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lumps that resist further breakdown

- Lensed – inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- Prismatic or Columnar – particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- Platy – particles are arranged about a horizontal plane

8.1.5.4 Other Features

- Mottled – soil that appears to consist of material of two or more colors in blotchy distribution
- Fissured – breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- Slickensided – fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

8.1.6 Development of Soil Description

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

8.1.6.1 Coarse-grained Soil

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is "sand-sized." It is classified as a gravel if over 50 percent of the coarse fraction is composed of "gravel-sized" particles.

The written description of a coarse-grained soil shall contain, in order of appearance: typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: <u>POORLY SORTED SAND WITH SILT</u>, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

8.1.6.2 Fine-grained Soil

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY LEAN CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

8.1.6.3 Organic Soil

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

9.0 Quality Control and Assurance

None

10.0 Data and Records Management

10.1 Document soil classification information collected during soil sampling onto the field boring or sampling data forms, and into the field logbook. Copies of this information shall be sent to the **Field Coordinator** for the project files.

10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – *Recordkeeping, Sample Labeling, and Chain of Custody*. The information pertinent to soil classification activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

11.0 Attachments or References

SOP 3-03, *Recordkeeping, Sample Labeling, and Chain of Custody*

Folk, Robert L. 1980. *Petrology of Sedimentary Rocks*. Austin, TX: Hemphill Publishing Company.

Munsell (Munsell Color Company). 2000. *Munsell Soil Color Chart*, (Revised). Baltimore.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue
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Nicky Moody Environmental Scientist	Jennifer Ray Environmental Engineering	Rev 3 – Update & Review (September 2024)

Surface and Subsurface Soil Sampling Procedures

Procedure 3-21

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the procedures for soil sampling. The procedure includes surface and subsurface sampling by various methods using hand auguring, test pit, direct-push, sonic drilling, and split-spoon equipment.

1.2 For project-specific information (e.g., sampling depths, equipment to be used, and frequency of sampling), refer to the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), which take precedence over these procedures. Surface soil sampling is typically accomplished using hand tools such as shovels or hand augers. Test pit samples are considered subsurface samples, although are normally collected via hand tools similar to surface soil sampling or by excavation machinery. Direct-push and split-spoon sampling offer the benefit of collecting soil samples from a discrete or isolated subsurface interval without the need of extracting excess material above the target depth. These methods dramatically reduce time and cost associated with disposal of material from soil cuttings when compared to test pit sampling. In addition, direct-push, sonic drilling, and split-spoon sampling methods can obtain samples at targeted intervals greater than 15 feet in depth, allowing for discrete depth soil sampling while speeding up the sampling process. Direct-push methods work best in medium to fine-grained cohesive materials, such as medium to fine sands, silts, and silty clay soils. Sonic drilling sampling works well in all types of soil and bedrock. Split-spoon sampling works well in all types of soil but is somewhat slower than direct-push and sonic drilling methods. With the exception of volatile organic compounds (VOCs) samples, the soil sample interval is composited so that each sample contains a homogenized representative portion of the sample interval. Due to potential loss of analytes, samples for VOC analysis are not composited. Samples for chemical analysis can be collected by any of the above-mentioned sampling methods, as disturbed soil samples. Undisturbed samples are best collected with direct push or by Shelby Tube (not covered in this SOP). They are collected, sealed, and sent directly to the laboratory for analysis without homogenizing.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). Work will also be conducted according to the **Field Coordinator**.

2.2 Before soil sampling commences, appropriate entities (e.g., DigSafe, local public works departments, company facilities) must be contacted to ensure the anticipated soil sampling locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Low recovery of soil from sampling equipment will prevent an adequate representation of the soil profile and sufficient amount of soil sample. If low recovery is a problem, the hole may be offset and re-advanced, terminated, or continued using a larger diameter sampler.

4.2 Asphalt in soil samples can cause false positive results for hydrocarbons. To ensure samples are free of asphalt, do not collect samples that may contain asphalt. If the collection of samples potentially containing asphalt is unavoidable, note the sampling depths at which the presence of asphalt are suspected.

4.3 Cross contamination from sampling equipment must be prevented by using sampling equipment constructed of stainless steel that is adequately decontaminated between samples.

5.0 Training and Qualifications

5.1 Qualifications and Training. The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **Field Coordinator** is responsible for ensuring that soil sampling activities comply with this procedure. The **Field Coordinator** is responsible for ensuring that all **Field Personnel** involved in soil sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 All **Field Personnel** are responsible for the implementation of this procedure.

6.0 Equipment and Supplies

The depth at which samples will be collected and the anticipated method of sample collection will be presented in the FSP. The following details equipment typically needed for soil sampling, based on the various methods. See the FSP for specific detail of equipment and supply needs.

6.1 Depending on the nature of suspected contamination, field screening instrumentation may be used for direct sampling. Appropriate instrumentation and calibration standards should be available.

6.2 Appropriate decontamination procedures must be followed for sampling equipment. Refer to FSP Section 4.3 for equipment decontamination procedures. Equipment necessary for decontamination activities includes but is not limited to the following:

- Alconox® or Liquinox®
- Methanol
- Plastic buckets or washbasins
- Brushes
- Aluminum foil

6.3 The following general equipment is needed for all soil sampling, regardless of method:

- Stainless steel bowls
- Stainless steel trowels
- Appropriate sample containers for laboratory analysis
- Personal Protective Equipment (PPE)
- Water-repellent logbook
- Cooler and ice for preservation
- Stakes and flagging to document sampling location

6.4 The following additional equipment is needed for volatile organic sampling:

- Electronic pan scale and weights for calibration

- Syringes or other discrete soil core samplers

6.5 The following additional equipment may be needed for surface and test pit soil sampling:

- Hand auger
- Shovel

6.6 The following additional equipment may be needed for soil sampling from direct push and/or split-spoon equipment:

- Tape measure or folding carpenter's rule for recording the length of soil recovered

Note: All subsurface drilling equipment will be provided and maintained by the subcontractor.

7.0 Procedure

7.1 General Soil Sampling Procedure for All Soil Sampling Methods

7.1.1 Record the weather conditions and other relevant on-site conditions.

7.1.2 Select the soil sampling location, clear vegetation, if necessary, and record the sampling location identification number and pertinent location details.

7.1.3 Verify that the sampling equipment is properly decontaminated, in working order, and situated at the intended sampling location.

7.1.4 Place polyethylene sheeting on the ground and assemble all necessary sampling equipment on top of it. Cover surfaces onto which soils or sampling equipment will be placed (i.e., tables with polyethylene sheeting).

7.1.5 Follow the appropriate procedures listed below for the sampling.

7.1.6 Collect soil samples according to procedures listed in Section 7.7 depending on project-specific analyses.

7.1.7 Record date/time, sample ID, and sample descriptions in the field logbook or field data form. A sketch or description of the location may also be recorded so the sample location can be re-constructed, especially if the location will not be recorded using GPS equipment.

7.1.8 Immediately label the sample containers and place them on ice, if required for preservation. Complete the chain-of-custody form(s) as soon as possible.

7.1.9 Dispose of all excess excavated soil in accordance with the FSP.

7.1.10 If required, mark the sample location with a clearly labelled wooden stake or pin flag. If the location is on a paved surface, the location may be marked with spray paint.

7.1.11 Decontaminate the sampling equipment according to FSP.

7.2 Surface Sampling

7.2.1 The criteria used for selecting surface soil locations for sampling may include the following:

- Visual observations (soil staining, fill materials)
- Other relevant soil characteristics
- Site features
- Screening results
- Predetermined sampling approach (i.e., grid or random)
- Sampling objectives as provided in the QAPP

7.2.2 The following procedures are to be used to collect surface soil samples. Surface soils are considered to be soils that are up to 2 feet below ground surface, though state regulations and project objectives may define surface soils differently; therefore, the FSP should be consulted for direction on the depth from which to collect the surface soil samples. Sampling and other pertinent data and information will be recorded in the field logbook and/or on field forms.

7.2.2.1 Gently scrape any vegetative covering until soil is exposed. Completely remove any pavement.

7.2.2.2 Remove soil from the exposed sampling area with a stainless-steel trowel, hand auger, or shovel. Put soils within the sampling interval in a stainless-steel bowl for homogenizing. Monitor the breathing zone and sampling area as required in the HASP.

7.2.2.3 For VOC analyses, collect representative soil samples directly from the recently exposed soil using a syringe or other soil coring device (e.g., TerraCore®, EnCore®). Follow procedures in Section 7.7.1 for VOC sampling.

7.2.2.4 Collect sufficient soil to fill all remaining sample jars into a stainless-steel bowl. Homogenize the soil samples to obtain a uniform soil composition that is representative of the total soil sample collected according to the following procedure:

a) Remove all rocks and non-soil objects using a stainless-steel spoon or scoop.

b) Form a cone-shaped mound with the sample material, then flatten the cone and split the sample into quarters.

c) Use the stainless-steel spoon/scoop to mix the quarter samples that are opposite.

d) After mixing the opposite quarters, reform the cone-shaped mound.

e) Repeat this procedure a minimum of five times, removing any non-soil objects and breaking apart any clumps.

7.3 Split-Spoon Sampling

7.3.1 At each boring location, the frequency and depth of split-spoon samples will be determined from the FSP. Split-spoon samples may be collected continuously, intermittently, or from predetermined depths.

7.3.2 Split-spoon samplers shall be driven into undisturbed soil by driving the spoon ahead of the drill augers/casing. In cohesive soils, or soils where the borehole remains open (does not collapse), two split-spoon samples may be taken prior to advancing the augers/casing.

7.3.3 After split-spoons are retrieved, open the split-spoon and measure the recovery of soil. If a photoionization detector (PID) will be used for screening, immediately scan the recovered sample for VOCs using the PID. Scan the recovered soil boring by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the highest PID reading and the depth at which it was observed along with all other pertinent observations. If required in the FSP, VOC and headspace samples should be collected (see Section 7.7.1) prior to logging the sample.

7.3.4 If headspace screening for VOCs is required in the FSP, collect a soil sample (as defined in the FSP) and perform headspace screening according to SOP 3-19, *Headspace Screening for Total VOCs*.

7.3.5 Soils collected using the split-spoon sampler will be logged by the field representative using the procedure required in the FSP.

7.3.6 Collect the remainder of the sample volume required into a stainless-steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.3.7 The FSP may specify that intervals to be sent to the laboratory be determined by visual observation and/or highest PID screening or headspace results, which can only be determined once the boring is complete. In this instance, a VOC sample should be collected at each interval. The remainder of the soil from that interval will be set aside in a clearly labelled stainless steel bowl covered with polyethylene sheeting. Once the boring has been completed and the sample interval has been determined, the remainder of the soil can be homogenized according to Section 7.2 and submitted for laboratory analysis.

7.3.8 Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the FSP (e.g., completed as a monitoring well, backfilled with bentonite, etc.).

7.4 Sonic Drilling Sampling

7.4.1 At each boring location, the frequency and depth of sonic drilling samples will be determined from the FSP.

7.4.2 Sonic drilling methods, also known as vibratory drilling, use an eccentrically oscillating drill head to produce high-frequency vibratory energy that is then transmitted down a drill string to a core barrel to quickly advance through the subsurface. Sonic drilling utilizes a double-cased system using an inner core barrel and a larger override casing. This ensures that the borehole is continuously cased to the total depth, minimizing the potential for borehole collapse and providing the means to alter casing diameters to telescope through semi-confining units to prevent downhole cross contamination.

7.4.3 Upon retrieval of the core barrel, place the tubular plastic sleeve (confirmed PFAS-free) with sealed bottom over the bottom of the core barrel. The core barrel will then be vibrated, causing the soil sample to be extruded into the sleeve. Place the sleeve on the work surface (i.e., PFAS-free plastic covered table or ground). Open the sleeve and measure the recovery of soil.

7.4.4 If a PID will be used for screening, immediately scan the recovered sample for VOCs using the PID. Scan the recovered soil boring by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the soil core and/or in any areas of stained or disturbed soil. Record the highest PID reading and the depth at which it was observed along with all other pertinent observations. If required in the FSP, VOC and headspace samples should be collected (see Section 7.7.1) prior to logging the sample.

7.4.5 If headspace screening for VOCs is required in the FSP, collect a soil sample (as defined in the FSP) and perform headspace screening according to SOP 3-19, *Headspace Screening for Total VOCs*.

7.4.6 Soils collected using sonic drilling will be logged by the field representative using the procedure required in the FSP.

7.4.7 Collect the remainder of the sample volume required into a stainless-steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.4.8 The FSP may specify that intervals to be sent to the laboratory be determined by visual observation and/or highest PID screening or headspace results, which can only be determined once the boring is complete. In this instance, a VOC sample should be collected at each interval. The remainder of the soil from each interval will be set aside. Once the boring has been completed and the sample interval has been determined, the remainder of the soil can be homogenized according to Section 7.2 and submitted for laboratory analysis.

7.4.9 Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the FSP (e.g., completed as a monitoring well, backfilled with bentonite, etc.).

7.5 Direct Push Sampling

At each boring location, the frequency of direct-push samples will be determined from the FSP. Typically, samples with direct-push equipment are collected in 4-foot intervals, but smaller (e.g., 2-foot) and larger (e.g., 5-foot) intervals are also possible.

7.5.1 Sample using Macro-Core samplers with acetate liners to obtain discrete soil samples at the depths specified in the FSP.

7.5.2 Cut open the acetate liner. If required in the FSP, immediately scan the recovered soil boring for VOCs using a PID by making a hole in the soil with a decontaminated trowel and placing the PID inlet very close to the hole. Be very careful not to get soil on the tip of the PID. Take PID readings every 6 inches along the split-spoon and/or in any areas of stained or disturbed soil. Record the highest PID reading and the depth at which it was observed along with all other pertinent observations. VOC and headspace samples, if required in the FSP, should be collected (see Section 7.7.1) prior to logging the sample.

7.5.3 If required in the FSP, collect a soil sample (as defined in the FSP) and perform headspace screening according to SOP 3-19, *Headspace Screening for Total VOCs*.

7.5.4 Soils collected using the direct-push sampler will be logged by the by the field representative using the procedure required in the FSP.

7.5.5 Collect the remainder of the sample into a stainless-steel bowl. Homogenize the soil collected so that the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.5.6 Once a boring is complete and all required samples have been collected, the boring must be completed as specified in the FSP (e.g., completed as a monitoring well, backfilled with bentonite, etc.).

7.6 Test Pit Sampling

7.6.1 Excavate the test pit to the desired depth.

7.6.2 Using the excavator bucket, collect soil samples as specified in the FSP. Collect a sample and perform screening analyses as required by the FSP. If VOCs contamination is suspected, perform headspace screening according to SOP 3-19, *Headspace Screening for Total VOCs*.

7.6.3 Collect the sample from center of the bucket to avoid potential contamination from the bucket.

7.6.4 VOC samples should also be collected from an undisturbed section of soil in the excavator bucket. The top layer of exposed soil should be scraped away just prior to collecting the VOC samples.

7.6.5 Collect the remainder of the sample volume required into a stainless-steel bowl. Homogenize the soil so the material is uniform in composition and representative of the total soil sample collected. Follow homogenizing techniques as described in Section 7.2.

7.6.6 Dispose of all excavated soil according to the FSP.

7.7 Sample Collection Methods

7.7.1 Volatile Organics Sampling

For soils collected for analyses of volatile organics, including volatile petroleum hydrocarbons (VPH) or other purgeable compounds, a closed system is maintained. From collection through analysis, the sample bottles are not opened. The bottle kit for a routine field sample for these analyses will typically include three 40-milliliter (mL) Volatile Organic Analysis (VOA) vials and one soil jar. Two 40-mL VOA vials will contain either 5 mL reagent water or 5 mL sodium bisulfate and magnetic stir bars (i.e., low level vials). The third VOA vial will contain 15 mL methanol with no magnetic stir bar (i.e., high level vial). These vials are usually provided by the laboratory and are pre-weighed, with the tare weight recorded on the affixed sample label. No additional sample labels are affixed to the VOA vials, as addition of a label would alter the vial weight. All information is recorded directly on the sample label using an indelible marker. The soil jar is provided for percent solids determination. For VOC or VPH analyses, samples are collected prior to sample homogenization. Collect the VOC sample in accordance with the procedure described below.

7.7.1.1 Determine the soil volume necessary for the required sample weight, typically 5 grams:

a) Prepare a 5 mL sampling corer (e.g., Terra Core®) or cut-off plastic syringe.

b) Tare the sampler by placing it on the scale and zeroing the scale.

c) Draw back the plunger to the 5-gram mark or 5 mL (5 cc) mark on cut-off syringe and insert the open end of the sampler into an undisturbed area of soil with a twisting motion, filling the sampler with soil. Note the location of the plunger with respect to the mL (cc) or other graduation printed on the sampler.

d) Weigh the filled sampler and remove or add soil until the desired weight is obtained. Note the location of the plunger which corresponds to this weight. Do not use this sample for laboratory analysis.

7.7.1.2 Once the required soil volume has been determined, pull the plunger back to this mark and hold it there while filling the syringe for each sample.

7.7.1.3 Collect 5 grams of soil using the cut-off syringe or Terra Core® sample device. Extrude the 5 grams of soil into one of the low level 40-mL VOA vials. Quickly wipe any soil from the threads of the VOA vial with a clean Kimwipe® and immediately close the vial. It is imperative that the threads be free from soil or other debris prior to replacing the cap on the vial in order to maintain the closed system necessary for the analysis.

7.7.1.4 Gently swirl the vial so that all of the soil is fully wetted with the preservative.

7.7.1.5 Fill the other low level 40 mL VOA vial in this manner.

7.7.1.6 Repeat the process for the high-level VOA vials, only for the high-level VOA vial three 5-gram aliquots (i.e., 15 grams total) should be extruded into the high-level VOA vial.

Note: Depending on the laboratory, some high-level VOA vials only contain 5 mL or 10 mL of methanol. If this is the case, either 5 grams total or 10 grams total, respectively, should be extruded into the high-level VOA vial. In other words, the mass of soil in grams should be identical to the volume of methanol in mL (i.e., 1:1 ratio of soil to methanol).

7.7.1.7 Collect any additional quality control sample collected (e.g., field duplicate, matrix spike, and matrix spike duplicate) in the same manner as above.

7.7.1.8 Fill the 4-ounce glass jar with soil from the same area for percent moisture determination.

7.7.2 Soil Sampling Method (All other analyses except VOC/VPH)

When all the required soil for a sampling location has been obtained, the soil can be homogenized as described in Section 7.2. Collect sufficient volume to fill all of the remaining sample containers at least ¾ full for all other analyses. Homogenize the soil in a decontaminated stainless-steel bowl, removing rocks, sticks, or other non-soil objects and breaking apart any lumps of soil prior to filling the remaining sample containers.

Note: Soil samples must contain greater than 30 percent solids for the data to be considered valid.

8.0 Quality Control and Assurance

8.1 Sampling personnel should follow specific quality assurance (QA) guidelines as outlined in the QAPP. Proper QA requirements should be provided that will allow for collection of representative samples from representative sampling points. QA requirements outlined in the QAPP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.

8.2 Quality control requirements are dependent on project-specific sampling objectives. The QAPP will provide requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various QA samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

9.0 Records, Data Analysis, Calculations

All data and information (e.g., sample collection method used) must be documented on field data sheets, boring logs, or within site logbooks with permanent ink. Data recorded may include the following:

- Weather conditions
- Arrival and departure time of persons on site
- Instrument type, lamp (PID), make, model and serial number
- Calibration gas used
- Date, time and results of instrument calibration and calibration checks
- Sampling date and time
- Sampling location
- Samples collected
- Sampling depth and soil type
- Deviations from the procedure as written
- Readings obtained

10.0 Attachments or References

SOP 3-19, *Headspace Screening for Total VOCs*

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker, PMP Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Robert Shoemaker, PMP Senior Scientist	Josh Millard, PG, CPG	Rev 2 – Addition of Sonic Drilling Methods (January 2020)
Rose Kelley, Environmental Scientist	Richard Purdy, Project Scientist	Rev 3 – Update & Review (June 2022)
Nicky Moody, Environmental Scientist	Jennifer Ray Environmental Engineering	Rev 3 – Update & Review (September 2024)

Appendix B

Field Quality Control Report

AECOM

Daily Quality Control Report

DATE ____________________

DAY	S	M	T	W	TH	F	S

PROJECT MANAGER:

PROJECT:

PROJECT NUMBER:

AECOM FIELD PERSONNEL:

WEATHER	SNOW	RAIN	OVERCAST	CLEAR	BRIGHT SUN
TEMP	To 32	32-50	50-70	70-85	85 up
WIND	Still	Moder	High	Report No.	
HUMIDITY	Dry	Moder	Humid		

TIME ON-SITE: TIME OFF-SITE:

SUBCONTRACTORS/OTHER PERSONNEL ON SITE:

TAILGATE SAFETY CONDUCTED; TOPICS COVERED:

WORK PERFORMED:

SIGNATURE: NAME:

SHEET OF

Daily Quality Control Report

PROJECT:

REPORT NO.

PROJECT NUMBER:

DATE

PROBLEMS ENCOUNTERED/CORRECTION ACTION TAKEN:

TOMORROW'S EXPECTATIONS:

SIGNATURE:

NAME:

SHEET OF