Naval Facilities Engineering Systems Command Northwest
Silverdale, Washington

Draft

Sampling and Analysis Plan
Site Inspection for Per- and Polyfluoroalkyl Substances

Manchester Fuel Depot
Port Orchard, Washington

April 2022

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SAP Worksheet #1—Title and Approval Page

Naval Facilities Engineering Systems Command Northwest
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Sampling and Analysis Plan
Site Inspection for Per- and Polyfluoroalkyl Substances

Manchester Fuel Depot
Port Orchard, Washington

April 2022

Prepared for NAVFAC Northwest
by CH2M HILL, Inc.
Seattle, Washington
Contract N62470-16-D-9000
Contract Task Order N4425518F4117

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Approval Signatures

Chemist/Quality Assurance Officer, NAVFAC Atlantic	Date
Joy Gryzenia, Remedial Project Manager, NAVFAC Northwest	Date

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Executive Summary

This Uniform Federal Policy Sampling and Analysis Plan (SAP) outlines the sampling activities in support of a Site Inspection (SI) for per- and polyfluoroalkyl substances (PFAS) at Manchester Fuel Depot (MFD) in Port Orchard, Washington. CH2M HILL, Inc. (CH2M) prepared this document under the Department of the Navy (Navy), Naval Facilities Engineering Systems Command (NAVFAC), Comprehensive Long-term Environmental Action—Navy 9000 Contract N62470-16-D-9000, Contract Task Order N4425518F4117, in accordance with the Navy's Uniform Federal Policy-SAP policy guidance to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses.

MFD is located on a small peninsula on the eastern edge of the larger Kitsap Peninsula, which is within Kitsap County, and adjacent to Puget Sound to the east and Clam Bay to the north. MFD is approximately 4.5 miles northeast of the town of Port Orchard, and less than 1 mile north of the census-designated area of Manchester. MFD is a fuel storage facility whose primary mission is to provide bulk fuel support to area Navy activities. The 234-acre facility encompasses underground and aboveground petroleum storage tanks, associated pipelines, and a fuel pier. The facility is divided into an eastern side and a western side by Little Clam Bay. The eastern and western sides are connected by a 100-foot-wide causeway.

A Preliminary Assessment (PA) for PFAS at MFD was conducted to identify potential PFAS release areas (CH2M, 2021). The PA evaluated 11 areas and identified 8 areas as potential or confirmed PFAS release areas.[1] The following potential or confirmed PFAS release areas were recommended for further investigation as part of an SI:

- Former Firefighting Training Area
- Former Fire Station and Spill Response Warehouse (Building 85)
- Test Spray Area (Aboveground Storage Tanks 145 to 149)
- JP-8 truck loading facility (Building 185)
- Fuel Pier
- Polychlorinated Biphenyl (PCB) Disposal Area (Site 302)
- Fuel Pump House (Building 12)
- Vehicle Wash Rack

Seven of the potential or confirmed PFAS release areas are being considered terrestrial and one of the areas, the Fuel Pier, is being considered marine for the purpose of investigation approach development.

The SI objectives are as follows:

- Determine whether PFAS are present in groundwater and soil at potential or confirmed terrestrial PFAS release areas or in surface water and sediment at the confirmed marine PFAS release area at concentrations warranting further investigation.
- Refine the understanding of the hydrogeologic characteristics at potential or confirmed PFAS release areas.

The SI will include installing and collecting samples from new groundwater monitoring wells and collecting soil samples at the terrestrial potential and confirmed PFAS release areas. Monitoring well locations for sample collection were selected based on their proximity to potential PFAS releases identified in the PFAS PA (CH2M, 2021). Soil samples will be collected at a minimum of two depths (at the ground surface and at the top of the capillary fringe in the unsaturated soil) at each new monitoring well location. At locations where monitoring wells are installed deeper than 50 feet below ground surface, in addition to the soil samples collected at the surface

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[1] PFAS release areas were previously referred to as PFAS source areas in the PA (CH2M, 2021).

and above the capillary fringe, a soil sample will be collected from each 50-foot interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). Additional surface soil samples will be collected from other locations to target overland flow/surface water runoff.

The SI will also include collecting surface water and sediment samples at the marine confirmed PFAS release area. Sediment samples will be collected along the piers of the Fuel Pier, and surface water samples will be collected from a subset of the sediment sampling locations.

All samples will be analyzed for the 18 PFAS listed in Method 537.1 via liquid chromatography tandem mass spectrometry compliant with Quality Systems Manual (QSM) Version 5.3 Table B-15 (or the latest version of the QSM for which the laboratory is certified at the time of sampling). The subset of the sediment samples will also be analyzed for total organic carbon and grain size to aid in potential future ecological risk evaluations.

The Navy is taking action on PFAS that have vetted toxicity values (that is, Tier 1, 2, or 3 toxicity values per Department of Defense Instruction [DoDI, 2019]). Currently, these PFAS include perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) (DoD, 2021). Assistant Secretary of Defense policy (DoD, 2021) allows for the use of specified human health toxicity values in calculating screening levels for these three PFAS to determine if further investigation in the remedial investigation phase is warranted. The primary focus of this investigation is, therefore, to determine whether these three PFAS are present in environmental media at concentrations greater than human health screening levels determined in accordance with Assistant Secretary of Defense policy. However, PFAS science and policy are rapidly evolving, and additional sampling and analysis may be necessary to meet future data needs. Such sampling and analysis, should it become necessary, will be presented in a future SAP or SAP addendum along with updated/reevaluated screening levels, as appropriate.

This SAP includes 37 worksheets specific to the scope of work for the MFD SI. Tables are embedded within the worksheets. Figures are included at the end of the document. Field standard operating procedures (SOPs) are included in **Appendix A**. The Laboratory DoD Environmental Laboratory Accreditation Program letters for the supporting laboratories are included in **Appendix B**.

The laboratory information cited in this SAP is specific to Battelle in Norwell, Massachusetts, Pace Analytical - Gulf Coast, and ALS Environmental - Kelso. If additional laboratory services are requested and require modification to the existing SAP, revised SAP worksheets will be submitted to the Navy for approval.

SAP Worksheets

Appendices

Tables

Figures

Acronyms and Abbreviations

°C	degrees Celsius
>	greater than
<	less than
≤	less than or equal to
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µm	micrometer
%	percent
11Cl-pF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid
ADONA	4,8-dioxa-3H-perfluorononanoic acid
AFFF	aqueous film-forming foam
ALS-Kelso	ALS Environmental – Kelso
AM	Activity Manager
amu	atomic mass unit
AQM	Activity Quality Manager
AST	aboveground storage tank
bgs	below ground surface
bss	below sediment surface
CA	corrective action
CASRN	Chemical Abstracts Service Registry Number
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action—Navy
COPC	chemical of potential concern
COR	Contract Officer's Representative
CSM	Conceptual Site Model
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EDS	Environmental Data Services
EIS	Extracted Internal Standard
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
FD	field duplicate
FTA	Firefighting Training Area
FTL	Field Team Leader
g	grams
GPS	Global Positioning System

H&S	health and safety
HDPE	high density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
HHRS	human health risk screening
HI	hazard index
HQ	hazard quotient
HSM	Health and Safety Manager
HSP	health and safety plan
ICAL	initial calibration
ICV	initial calibration verification
ID	identification
IDW	investigation-derived waste
ISC	instrument sensitivity check
LC-MS/MS	liquid chromatography tandem mass spectrometry
LCS	laboratory control sample
LIMS	Laboratory Information Management Systems
LNAPL	light non-aqueous phase liquid
LOD	limit of detection
LOQ	limit of quantitation
MB	Method Blank
MFD	Manchester Fuel Depot
mL	milliliter
mm	millimeters
MPC	measurement performance criteria
MS	matrix spike
MSD	matrix spike duplicate
MWD	Manchester Water District
N/A or NA	not applicable
NAVFAC	Naval Facilities Engineering Systems Command
Navy	Department of the Navy
NC	no criteria
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
ng/L	nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OWS	oil water separator
PA	Preliminary Assessment
PAL	project action limit
PC	Project Chemist
PCB	polychlorinated biphenyl
PCT_P	percent passing
PFAS	per- and polyfluoroalkyl substances

PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFDA	perfluorodecanoic acid
PFDpA	perfluoroheptanoic acid
PFHxA	perfluorohexoanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFPeA	perfluoropentanoic acid
PFTA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnA	perfluoroundecanoic acid
PGC	Pace Analytical - Gulf Coast
PJLA	Perry Johnson Laboratory Accreditation, Inc.
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QSM	Quality Systems Manual
rev.	revised
RI	Remedial Investigation
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	Regional Screening Level
RT	retention time
S/N	signal to noise
SAP	Sampling and Analysis Plan
SCUM	Sediment Cleanup User’s Manuel
SD	standard deviation
SI	Site Inspection
SL	screening level
SME	Subject Matter Expert
SOP	standard operating procedure
SPE	Solid Phase Extraction
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
TBD	to be determined
TDBD	top depth bottom depth
TM	Task Manager
TOC	total organic carbon

USEPA	United States Environmental Protection Agency
v5.3	Version 5.3
VWR	Vehicle Wash Rack
WQP	water quality parameter

SAP Worksheet #2—SAP Identifying Information

Site Name:	Manchester Fuel Depot (MFD), Fleet Logistics Center Puget Sound, Port Orchard, Washington
Operable Unit/Solid Waste Management Unit:	Not applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-16-D-9000
Contract Title:	Comprehensive Long-term Environmental Action—Navy (CLEAN) 9000 Program
Work Assignment Number:	Contract Task Order N4425518F4117

1. **This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the following:**
   - *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
   - *Uniform Federal Policy for Quality Assurance Project Plans* (USEPA, 2005)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
   - *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for Naval Facilities Engineering Systems Command (NAVFAC) Remedial Project Managers* (NAVFAC, 2020)
2. **Identify regulatory program**:
   - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
   - Superfund Amendments and Reauthorization Act (SARA)
3. **This document is a <u>project-specific</u> SAP.**
4. **List dates of scoping sessions that were held:**

Scoping Session	Date
Project Scoping Session NAVFAC Remedial Project Manager (RPM), United States Environmental Protection Agency (USEPA), Suquamish Tribe, Washington State Department of Ecology (Ecology), CH2M	November 4, 2020
Project Scoping Session NAVFAC RPM, Suquamish Tribe, Ecology, CH2M	July 27, 2021

5. **List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.**
   - N/A
6. **List organizational partners (stakeholders) and connection with lead organization:**
   - Suquamish Tribe – Native Sovereign Nation Stakeholder
   - USEPA Region 10 – Federal Regulator
   - Ecology – State Regulator

SAP Worksheet #2—SAP Identifying Information (continued)

7. **Lead organization:**
   - Department of the Navy (Navy) - NAVFAC Northwest
8. **If any required SAP elements or required information are N/A to the project or are provided elsewhere, note the omitted SAP elements and provide an explanation for their exclusion as follows:**
   - The crosswalk table is excluded because all required information is provided in this SAP.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Joy Gryzenia	NAVFAC Northwest RPM	NAVFAC Northwest	(360) 396-1115	joy.t.gryzenia.civ@us.navy.mil
Yorick Wahaus	NAVFAC Northwest Contract Officer's Representative (COR)	NAVFAC Northwest	(360) 396-0022	yorick.o.wahaus.civ@us.navy.mil
Ken Marcy	USEPA RPM	USEPA Region 10	(206) 890-0591	marcy.ken@epa.gov
Mahbub Alam	Ecology RPM	Ecology	(360) 407-6913	mala461@ecy.wa.gov
Denice Taylor	Suquamish Tribe Project Manager (PM)	Suquamish Tribe	(360) 398-8449	dtaylor@suquamish.nsn.us
Dennis Ballam	PM/Activity Manager (AM)	CH2M	(757) 671-6251	dennis.ballam@ch2m.com
Susanne Borchert	Senior Technical Consultant (STC)	CH2M	(630) 309-0450	susanne.borchert@ch2m.com
Alexandra Salter-Blanc	PFAS Subject Matter Expert (SME)	CH2M	(503) 872-4834	alexandra.salter-blanc@ch2m.com
Chris McCarthy	Sediment SME	CH2M	(281) 513-6370	chris.mccarthy@ch2m.com
Peter Lawson	Hydrogeology SME	CH2M	(530) 229-3383	peter.lawson@ch2m.com
Adrienne Jones	Task Manager (TM)	CH2M	(757) 670-6236	adrienne.jones@ch2m.com
Paul Townley	Activity Quality Manager (AQM)	CH2M	(425) 233-3302	paul.townley@ch2m.com
Janna Staszak	CLEAN Program SAP Reviewer	CH2M	(757) 671-6256	janna.staszak@ch2m.com
Anita Dodson	CLEAN Program Chemist/SAP Reviewer	CH2M	(757) 671-6218	anita.dodson@ch2m.com
Juan Acaron	Project Chemist (PC)	CH2M	(352) 214-2814	juan.acaron@ch2m.com
Roni Warren	Human Health Risk Assessor	CH2M	(814) 364-2454	roni.warren@ch2m.com
Dan Lavoie	Ecological Risk Assessor	CH2M	(202) 460-4162	daniel.lavoie@ch2m.com
Loren Kaehn	Health and Safety Manager (HSM)	CH2M	(208) 383-6212	loren.kaehn@ch2m.com

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
To be determined (TBD)	Field Team Leader (FTL)/Site Safety Coordinator (SSC)	CH2M	TBD	TBD
TBD	Field Team Member(s)	CH2M	TBD	TBD
Jonathan Thorn	Laboratory PM	Battelle	(781) 681-5565	thorn@battelle.org
Liz Martin	Laboratory PM	Pace Analytical - Gulf Coast (PGC)	(225) 769-4900	liz.martin@pace.com
Howard Holmes	Laboratory PM	ALS Environmental – Kelso (ALS-Kelso)	(360) 577-7222	howard.holmes@alsglobal.com
Doug Weaver	Data Validator	Environmental Data Services (EDS)	(757) 564-0090	dweaver@env-data.com

SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/Email Receipt	SAP Section Reviewed	Date SAP Read
Dennis Ballam	CH2M/PM, AM	(757) 671-6251			
Adrienne Jones	CH2M/TM	(757) 671-6236			
Susanne Borchert	CH2M/STC	(630) 309-0450			
Alexandra Salter-Blanc	CH2M/PFAS SME	(503) 872-4834			
Anita Dodson	CH2M/CLEAN Program Chemist, SAP Reviewer	(757) 671-6218			
Juan Acaron	CH2M/PC	(352) 214-2814			
TBD	FTL/SSC	TBD			
TBD	Field Team Member(s)	TBD			
Jonathan Thorn	Battelle, Laboratory PM	(781) 681-5565			
Liz Martin	PGC/Laboratory PM	(225) 214-7068			
Howard Holmes	ALS-Kelso/Laboratory PM	(360) 577-7222			
Doug Weaver	EDS, Data Validator PM	(757) 564-0090			

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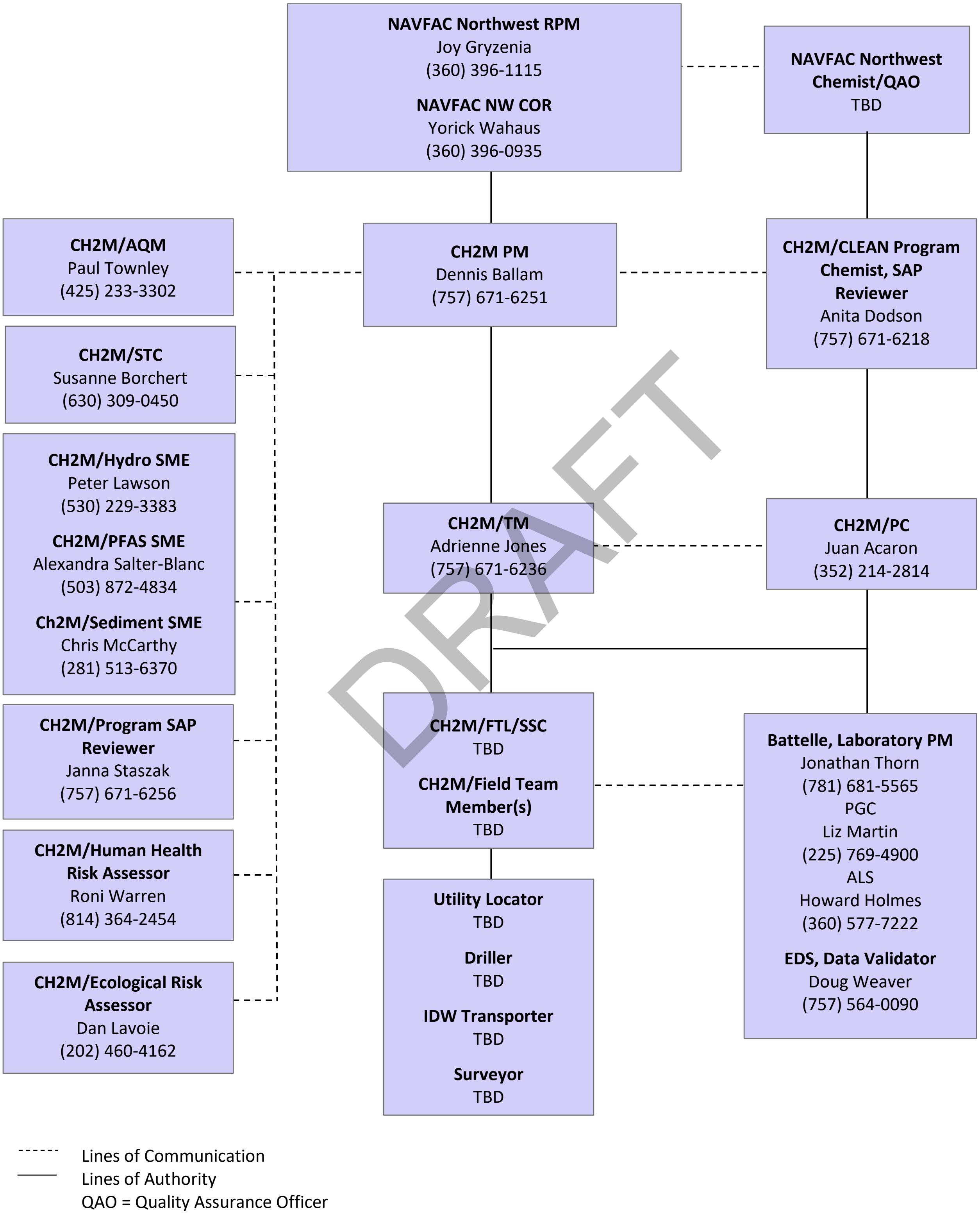
SAP Worksheet #5—Project Organizational Chart



NAVFAC Northwest RPM
Joy Gryzenia
(360) 396-1115

NAVFAC NW COR
Yorick Wahaus
(360) 396-0935

NAVFAC Northwest Chemist/QAO
TBD

CH2M/AQM
Paul Townley
(425) 233-3302

CH2M PM
Dennis Ballam
(757) 671-6251

CH2M/CLEAN Program Chemist, SAP Reviewer
Anita Dodson
(757) 671-6218

CH2M/STC
Susanne Borchert
(630) 309-0450

CH2M/Hydro SME
Peter Lawson
(530) 229-3383

CH2M/PFAS SME
Alexandra Salter-Blanc
(503) 872-4834

Ch2M/Sediment SME
Chris McCarthy
(281) 513-6370

CH2M/TM
Adrienne Jones
(757) 671-6236

CH2M/PC
Juan Acaron
(352) 214-2814

CH2M/Program SAP Reviewer
Janna Staszak
(757) 671-6256

CH2M/FTL/SSC
TBD

CH2M/Field Team Member(s)
TBD

Battelle, Laboratory PM
Jonathan Thorn
(781) 681-5565
PGC
Liz Martin
(225) 769-4900
ALS
Howard Holmes
(360) 577-7222

EDS, Data Validator
Doug Weaver
(757) 564-0090

CH2M/Human Health Risk Assessor
Roni Warren
(814) 364-2454

Utility Locator
TBD

Driller
TBD

IDW Transporter
TBD

Surveyor
TBD

CH2M/Ecological Risk Assessor
Dan Lavoie
(202) 460-4162

- - - - - - Lines of Communication
——— Lines of Authority
QAO = Quality Assurance Officer

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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email Address	Procedure
Communication with Navy (lead agency)	NAVFAC Northwest RPM	Joy Gryzenia	joy.t.gryzenia.civ@us.navy.mil (360) 396-1115	Primary points of contact (POCs) for MFD; coordinates installation-specific logistics; can delegate communication to other internal or external POCs. RPM will have 14 days for work plan review. PM will notify the RPM and NAVFAC Northwest COR by email or telephone call within 24 hours for field changes affecting the scope or implementation of the design.
	NAVFAC Northwest COR	Yorick Wahaus	yorick.o.wahaus.civ@us.navy.mil (360) 396-0935	
SAP reviews	NAVFAC Atlantic Quality Assurance Officer (QAO)	TBD	TBD	Provides review comments to Navy contractor on Pre-draft SAP via the Naval Installation Restoration Information System submittal. Provides overall Navy guidance via direct communication with Navy contractor chemist, as warranted.
Communication with Federal regulator	USEPA	Ken Marcy	marcy.ken@epa.gov (206) 890-0591	Primary POC for USEPA; can delegate communication to other internal or external POCs.
Communication with Community Stakeholder	Suquamish Tribe	Denice Taylor	dtaylor@suquamish.nsn.us (360) 398-8449	Primary POC for Suquamish Tribe; can delegate communication to other internal or external POCs.
Communication with Ecology	Ecology	Mahbub Alam	mala461@ecy.wa.gov (360) 407-6913	Primary POC for Ecology; communicates directly with the Navy as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, Ecology will have opportunity to comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication regarding overall project status and implementation and primary POC with RPM and project team	CH2M AM and PM	Dennis Ballam	dennis.ballam@ch2m.com (757) 671-6251	Oversees project and will be informed of project status by the TM. If field changes occur, AM will work with the Navy RPM and COR to communicate in-field changes to the team by email. All data results will be communicated to the project team following data receipt and review.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email Address	Procedure
Quality issues during and technical communications for project implementation and data interpretation	CH2M AQM	Paul Townley	paul.townley@ch2m.com (425) 233-3302	Contact the AQM regarding quality issues during project implementation. The AQM will report to the PM and the RPM.
Quality issues, and technical communications for project implementation, and data interpretation	CH2M STC	Susanne Borchert	susanne.borchert@ch2m.com (630) 309-0450	Primary contact regarding questions/issues encountered in the field, input on data interpretation, as needed. STC will have 24 hours to respond to technical field questions as necessary. Additionally, STC will review the data as necessary prior to Base and Navy discussions and reporting review.
Communication regarding overall project status and implementation with PM and project team	CH2M TM	Adrienne Jones	adrienne.jones@ch2m.com (757) 671-6236	Inform PM of project status. All data results will be communicated to the project team following data receipt and review.
Quality issues, and technical communications for project implementation, and data interpretation	CH2M Hydrogeology SME	Peter Lawson	peter.lawson@ch2m.com (530) 229-3383	Contact the Hydrogeology SME regarding questions/issues encountered relating to technical oversight for the project, as needed.
Quality issues, and technical communications for project implementation, and data interpretation	CH2M PFAS SME	Alexandra Salter-Blanc	alexandra.salter-blanc@ch2m.com (503) 872-4834	Contact the PFAS SME regarding questions/issues encountered relating to technical oversight for the project, as needed.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email Address	Procedure
Quality issues, and technical communications for project implementation, and data interpretation	CH2M Sediment SME	Chris McCarthy	chris.mccarthy@ch2m.com (281) 513-6370	Contact the Sediment SME regarding questions/issues encountered relating to technical oversight for the project, as needed.
Human Health Risk	CH2M Human Health Risk Assessor	Roni Warren	roni.warren@ch2m.com (814) 364-2454	Contact the Human Health Risk Assessor regarding questions/issues encountered relating to investigative sampling and human health risk screening (HHRS), as needed.
Ecological Risk	CH2M Ecological Risk Assessor	Dan Lavoie	daniel.lavoie@ch2m.com (202) 460 4162	Contact the Ecological Risk Assessor regarding questions/issues encountered relating to investigative sampling and ecological risk screening, as needed.
Health and Safety (H&S)	CH2M HSM	Loren Kaehn	loren.kaehn@ch2m.com (208) 383-6212	Responsible for generation of the health and safety plan (HSP) and approval of the activity hazard analyses prior to the start of fieldwork. The PM or TM will contact the HSM as needed regarding questions/issues encountered in the field.
H&S	CH2M SSC	TBD	TBD	Responsible for the adherence of team members to the site safety requirements described in the HSP. Will report H&S incidents and near losses to PM as soon as possible.
Stop Work Order	CH2M PM	Dennis Ballam	dennis.ballam@ch2m.com (757) 671-6251	Any field member can immediately stop work if an unsafe condition that is immediately threatening to human health is observed. The field staff members, FTL, or SSC should notify the RPM, and the CH2M PM immediately. Ultimately, the FTL and PM can stop work for a period of time. NAVFAC Northwest can stop work at any time.
	CH2M TM	Adrienne Jones	adrienne.jones@ch2m.com (757) 671-6236	
	CH2M Deputy TM	Shannon Bartow	shannon.bartow@ch2m.com (503) 872-4813	
	CH2M FTL	TBD	TBD	

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email Address	Procedure
Work plan changes in field	CH2M FTL	TBD	TBD	Documentation of deviations from the work plan will be captured in the field notes, and the TM and PM will be notified immediately. Deviations will be made only with approval from the PM.
SAP Field changes/field progress reports	CH2M FTL	TBD	TBD	Documentation of field activities in accordance with standard operating procedures (SOPs) (**Appendix A**, **Worksheet #21**) and work plan deviations (made with the approval of STC and/or QAO) in-field notes; provide daily progress reports to TM and PM.
Reporting laboratory data quality issues	Battelle PM	Jonathan Thorn	thorn@battelle.org (781) 681-5565	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported within 2 days to the PC by the laboratory.
	PGC PM	Liz Martin	liz.martin@pace.com (225) 769-4900	
	ALS-Kelso PM	Howard Holmes	howard.holmes@alsglobal.com (360) 577-7222	
Field and analytical corrective actions (CAs)	CH2M Program Chemist	Anita Dodson	anita.dodson@ch2m.com (757) 671-6218	CAs for field and analytical issues will be determined by the PC and reported to the TM and PM within 4 hours.
Communication regarding SAP updates	CH2M Program Chemist	Anita Dodson	anita.dodson@ch2m.com (757) 671-6218	Changes to the project that would prompt a SAP update requiring Navy QAO approval include: the addition of an analytical suite not previously included in the SAP, the addition of an environmental matrix not previously included in the SAP, laboratory accreditation to a new Department of Defense (DoD) Quality Systems Manual (QSM) version, inclusion of a new laboratory, or updates to the conceptual site model (CSM) that prompt new data quality objectives. Updated laboratory limit of quantitation (LOQ), limit of detection (LOD), and detection limit (DL) values will not prompt a SAP update for review by the Navy QAO unless those values negatively impact the ability to meet project action limits (PALs).

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number and/or Email Address	Procedure
Data tracking from field collection to database upload Release of analytical data	CH2M PC	Juan Acaron	juan.acaron@ch2m.com (352) 214-2814	Tracks data from sample collection through database upload daily. Analytical data cannot be released until validation of the data is completed and has been approved by the PC. The PC will review analytical results within 24 hours of receipt for release to the project team. The PC will inform the Navy CLEAN Program Chemist who will notify the Navy QAO of any laboratory issues that would prevent the project from meeting project quality objectives or would cause a significant delay in the project schedule.
Reporting data quality issues	EDS Data Validator	Doug Weaver	dweaver@env-data.com (757) 564-0090	The data validator reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the PC within 28 calendar days.
Field CAs	CH2M FTL and PM	TBD	TBD	Field and analytical issues requiring CA will be determined by the FTL and/or PM on an as-needed basis. The PM will ensure SAP requirements are met by field staff members for the project's duration. The FTL will notify the PM via phone of any need for CA within 4 hours. The PM may notify the RPM of any field issues that would negatively affect schedule or the ability to meet project data quality objectives.
		Dennis Ballam	dennis.ballam@ch2m.com (757) 671-6251	

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SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Joy Gryzenia	RPM	NAVFAC Northwest	Oversees project, provides base-specific information, and coordinates with Base Environmental Manager. Primary Navy POC for MFD.
Yorick Wahaus	COR	NAVFAC Northwest	Oversees project, provides Base-specific information, and coordinates with Base Environmental Manager.
TBD	Chemist/QAO	NAVFAC Atlantic	Reviews and approves the SAP and revisions.
Dennis Ballam	AM/PM	CH2M	Coordinates with COR, RPM, and TM. Provides base-specific information. Oversees and manages project activities.
Adrienne Jones	TM	CH2M	Oversees and manages project activities.
Susanne Borchert	STC	CH2M	Provides senior technical support for project approach and execution. Provides QA oversight.
Janna Staszak	SAP Reviewer	CH2M	Reviews and approves changes or revisions to the SAP.
Paul Townley	AQM	CH2M	Provides support for quality issues during and technical communications for project implementation and data interpretation.
Peter Lawson	Hydrogeology SME	CH2M	Provides subject matter technical support for project approach and execution.
Alexandra Salter-Blanc	PFAS SME	CH2M	Provides subject matter technical support for project approach and execution.
Chris McCarthy	Sediment SME	CH2M	Provides subject matter technical support for project approach and execution.
Roni Warren	Human Health Risk Assessor	CH2M	Provides senior technical support for investigative sampling and HHRS.
Dan Lavoie	Ecological Risk Assessor	CH2M	Provides senior technical support for investigative sampling and ecological risk screening.
Loren Kaehn	HSM	CH2M	Prepares HSP and manages H&S for all field activities.

SAP Worksheet #7—Personnel Responsibilities Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Anita Dodson	Program Chemist	CH2M	Provides SAP project delivery support, reviews and approves SAPs, and performs final data evaluation and QA oversight.
Juan Acaron	PC	CH2M	Manages data, performs data evaluation and QA oversight, POC with laboratory and validator for analytical issues.
TBD	FTL	CH2M	Coordinates all field activities.
TBD	Field Staff Member	CH2M	Conducts field activities.
Jonathan Thorn	Laboratory PM	Battelle	Manages sample tracking and maintains communication with PC.
Liz Martin	Laboratory PM	PGC	
Howard Holmes	Laboratory PM	ALS-Kelso	
Doug Weaver	Data Validator	EDS	Validates laboratory data prior to data use.

SAP Worksheet #8—Special Personnel Training Requirements Table

Specialized training is not required for this project.

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SAP Worksheet #9-1—Project Scoping Session Participants Sheet

Project Name: Site Inspection (SI) for PFAS **Projected Date(s) of Sampling:** September-November 2021 **PM:** Maggie Radford[a]	**Site Name:** MFD **Site Location:** Port Orchard, Washington
Date of Session: November 4, 2020 **Scoping Session Purpose:** Obtain consensus on the SI approach.	

Name	Title/Project Role	Affiliation	Phone Number	Email Address
JoAnn Grady	Meeting Facilitator	Grady and Associates	(907) 321-3213	joanngrady@gmail.com
Denice Taylor	PM	Suquamish Tribe	(360) 398-8449	dtaylor@suquamish.nsn.us
Mahbub Alam	RPM	Ecology	(360) 407-6913	mala461@ecy.wa.gov
Ken Marcy	RPM	USEPA Region 10	(206) 890-0591	marcy.ken@epa.gov
Joy Gryzenia	RPM	NAVFAC Northwest	(360) 396-1115	joy.t.gryzenia.civ@us.navy.mil
Maggie Radford[a]	PM/AM	CH2M	(425) 233-3328	maggie.radford@ch2m.com
Jennifer Madsen[b]	TM	CH2M	(360) 888-0281	jennifer.madsen@ch2m.com

[a] The PM changed to Dennis Ballam after the scoping session.

[b] The TM changed to Adrienne Jones after the scoping session.

Summary of Discussion

The Stakeholder Team agreed to install groundwater monitoring wells and collect groundwater and soil samples at the seven confirmed or potential PFAS release areas recommended for further investigation in the PFAS Preliminary Assessment (PA). The Stakeholder Team discussed the locations of the soil and groundwater samples and agreed to include soil samples in overland drainage directions and pathways in areas where there is suspected surface application. NAVFAC Northwest indicated sampling of surface water and sediment at the areas, including the Fuel Pier, would be considered as part of a phased approach. Ecology expressed concern about using only groundwater and soil results as the triggers for conducting a phased SI for sediment and surface water. Ecology and the Suquamish Tribe noted sediment and surface water sampling should be performed regardless of the results from the groundwater and soil sampling. The Suquamish Tribe expressed concern that the investigation would not result in a clear conclusion on potentially unacceptable risks associated with surface water and sediment. NAVFAC Northwest explained that, if the results of the groundwater and soil sampling do not exceed the groundwater or soil PALs, but the results are not consistent with the CSM, there is a possibility that sediment and surface water sampling could be performed to fill data gaps and update the CSM as part of a phased SI approach.

Summary of Decisions

The following decisions were agreed to for the SI approach:

- Groundwater monitoring wells would be installed and groundwater and soil samples collected at the terrestrial confirmed or potential PFAS release areas recommended for further investigation in the PFAS PA.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet (continued)

- Groundwater and soil samples would be collected from the locations proposed, with soil sample locations added in overland drainage directions and pathways at areas where there is suspected surface application.
- Surface water and sediment samples would be collected at the Fuel Pier during a follow-up SI phase.
- Sampling of surface water and sediment at the terrestrial areas would be considered as part of a phased approach, based on evaluation of the soil and groundwater results.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet

Project Name: SI for PFAS **Projected Date(s) of Sampling:** February 2022 **PM:** Dennis Ballam	**Site Name:** MFD **Site Location:** Port Orchard, Washington

Date of Session: July 27, 2021
Scoping Session Purpose: Obtain consensus on the SI approach for the Fuel Pier.

Name	Title/Project Role	Affiliation	Phone Number	Email Address
JoAnn Grady	Meeting Facilitator	Grady and Associates	(907) 321-3213	joanngrady@gmail.com
Denice Taylor	PM	Suquamish Tribe	(360) 398-8449	dtaylor@suquamish.nsn.us
Andrew Schmeising	PM	Suquamish Tribe	N/A	aschmeising@suquamish.nsn.us
Mahbub Alam	RPM	Ecology	(360) 407-6913	mala461@ecy.wa.gov
Joy Gryzenia	RPM	NAVFAC Northwest	(360) 396-1115	Joy.t.gryzenia.civ@us.navy.mil
Dennis Ballam	PM/AM	CH2M	(757) 671-6251	dennis.ballam@ch2m.com
Adrienne Jones	TM	CH2M	(757) 671-6236	adrienne.jones@ch2m.com
Alexandra Salter-Blanc	PFAS SME	CH2M	(503) 872-4834	alexandra.salter-blanc@ch2m.com
Brittany Prentice	Meeting Support	CH2M	(425) 453-5000	brittany.prentice@ch2m.com

Summary of Discussion

NAVFAC Northwest explained that the scoping session was being conducted because, at the time of the previous SI investigation approach scoping session, sampling at the Fuel Pier was proposed to be conducted during a second phase of the SI and the specifics were not scoped. However, based on input from the Suquamish Tribe and Ecology and evolving Navy guidance, NAVFAC Northwest proposed revising the approach to include sediment and surface water sampling at the Fuel Pier, where a direct release of aqueous film-forming foam (AFFF) to surface water occurred. NAVFAC Northwest clarified that, based on Navy guidance, the initial phase of SI sampling will focus on the media directly impacted by a release or potential release of PFAS, with evaluation of other media and pathways, such as at outfalls, stormwater lines, and drainages where a direct release did not occur, occurring in subsequent phases as warranted. NAVFAC Northwest shared that a flow chart defining Navy guidance on surface water and sediment sampling during PFAS investigations was forthcoming, but not yet available.[2] Ecology raised concerns regarding the differentiation between direct releases to sediment and surface water versus releases via stormwater infrastructure, especially for releases at paved surfaces. Ecology stated the SAP should include a clear pathway showing how, when, and the conditions necessary to move an area forward for additional investigation. NAVFAC Northwest recognized that additional investigation may be warranted to support no further action determinations and proposed that the Stakeholder Team reconvene to determine the path forward in such cases.

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[2] A flow chart detailing the proposed pathways for additional investigation has been included as Figure 11-1.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

The Stakeholder Team discussed the following proposed sampling approach for the Fuel Pier:

- Collection of sediment samples from nine locations – three locations along three transects; one transect along the outside of the of the former pier, one outside of the exiting pier, and one in between the piers.
- Collection of surface sediment and subsurface sediment samples from each location – surface sediment from 0 to 4 inches below sediment surface based on the biologically active zone according to the Sediment Cleanup User's Manual (SCUM) (Ecology, 2019b) and subsurface sediment from 4 to 24 inches below sediment surface.
- Collection of surface water samples from three of the locations where sediment samples are collected.
- Analysis of all of the samples for PFAS and a subset of the sediment samples also for total organic carbon (TOC) and grain size to aid in potential future ecological risk evaluations.

Ecology requested samples extend up to the mean high water level and that the figure that will be included in the SAP indicates this water level. The Suquamish Tribe agreed with Ecology and requested intertidal sediment samples be collected unless there was a reason not to collect them. The Stakeholder Team agreed to include intertidal sediment samples. Ecology stated that if the SI sampling objective is just presence or absence in surface water, the three surface water samples proposed are probably sufficient; however, three samples are not enough to calculate an upper confidence level.

The Stakeholder Team discussed use of tap water screening levels (SLs) generated using the USEPA Regional Screening Level (RSL) calculator as surface water PALs and residential soil SLs generated using the USEPA RSL calculator as sediment PALs, because there are no human health screening values specifically for sediment and surface water. Ecology stated that the PALs are inappropriate, because they do not account for the seafood consumption and bioaccumulation pathways, which would likely require much lower screening values and asked if an SL for seafood consumption should be calculated to ensure data achieves values low enough for future evaluations. NAVFAC Northwest stated that screening values will be revisited in the future as they are finalized and published. The Suquamish Tribe and Ecology stated concerns regarding laboratory limits and the usability of data for future comparisons. Ecology stated the position that the laboratory should be experienced in PFAS analysis, and able to produce low detection limits and high data quality. The Suquamish Tribe questioned the applicability of comparing tap water SLs to surface water as it is not a source of drinking water; but following discussion, concurred with applying these SLs as a conservative screening tool. The Suquamish Tribe expressed that potential exposure pathways should not be excluded at the SI stage. Ecology stated the SI SAP should have a disclaimer that the SI will not consider the seafood consumption pathway; NAVFAC Northwest agreed.

Summary of Discussion

The following decisions were agreed to for the SI approach for the Fuel Pier:

- Sediment samples would be collected from nine locations – three locations along three transects; one transect along the outside of the of the former pier, one outside of the exiting pier, and one in between the piers. One of the samples in each transect would be collected from the intertidal zone.
- Surface sediment and subsurface sediment samples would be collected from each sediment sampling location –surface sediment from 0 to 4 inches below sediment surface and subsurface sediment from 4 to 24 inches below sediment surface.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

- Surface water samples would be collected from three of the locations where sediment samples are collected.
- A subset of the sediment samples would be analyzed for TOC and grain size to aid in potential future ecological risk evaluations.

Action Items

- NAVFAC Northwest/CH2M – Add intertidal sediment sample locations to the Fuel Pier SI sampling approach.
- NAVFAC Northwest – Look into including a provision in the SAP for potential reevaluation of screening values.

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SAP Worksheet #10—Conceptual Site Model

MFD is located on a small peninsula on the eastern edge of the larger Kitsap Peninsula (**Figure 10-1**), which is within Kitsap County, and adjacent to Puget Sound to the east and Clam Bay to the north. MFD is approximately 4.5 miles northeast of the town of Port Orchard, and less than 1 mile north of the census-designated area of Manchester.

MFD is a fuel storage facility whose primary mission is to provide bulk fuel support to area Navy activities. The 234-acre facility encompasses underground and aboveground petroleum storage tanks, associated pipelines, and a fuel pier (**Figure 10-2**). The facility is divided into an eastern side and a western side by Little Clam Bay. The eastern and western sides are connected by a 100-foot-wide causeway (**Figure 10-2**). MFD obtains its drinking water from the local public utility district.

The MFD property was conveyed by the Territory of Washington to the United States War Department in 1898 and subsequently conveyed by the United States War Department to the Navy in 1923 (Perry, 1998). MFD has been a fuel depot for the Navy since the early 1940s (beginning of World War II). Most of the facility currently is used for fuel storage, including underground storage tanks (USTs) (16 through 43, 48 through 50, 141, and 142), aboveground storage tanks (ASTs) used for fuel and other various purposes (primary large fuel tanks 145 through 149), associated pipelines, and a fuel pier (**Figure 10-2**). Fuel products that have been or are currently stored at the fuel depot include Navy Special Fuel (No. 6 fuel oil [also referred to as Bunker C oil]), marine diesel fuel, jet fuel (JP 4, JP-5, JP-8, and F-76), lubricant oil, and aviation gasoline (CH2M, 2020). MFD is the largest single-site fuel depot in the continental United States, holding the operating stock of fuel for all of Navy activities near Puget Sound as well as an emergency stock, if needed. Several areas of the facility have been impacted by past releases of petroleum products (NAVFAC, 2016).

Starting in 1960, the Navy transferred property in the northwest quadrant of the historical boundary of MFD to the General Services Administration (**Figure 10-2**). The Navy does not maintain environmental liability for these transferred properties. This transfer included a portion of the Firefighting Training Area (FTA), which was transferred to National Oceanic and Atmospheric Administration’s (NOAA’s) National Marine Fisheries Service (Disposal Property ID N68436-MAD1). The portion of the FTA that remained within the MFD facility boundary following the transfer, located immediately south of Disposed Property N68436-MAD1, was leased to NOAA March 1, 1968 (Perry, 1998).

A facility-wide PA PFAS was conducted (CH2M, 2021) to identify potential PFAS release areas. The PA identified eight areas as potential or confirmed PFAS release areas (**Figure 10-3**). A release area is considered ‘confirmed’ when there is sufficient historical evidence that indicates PFAS was released directly to the environment through fire suppressant, testing, or firetruck cleaning activities.

A CSM, which includes generalized information on potential fate and transport processes related to PFAS and describes typical human potential receptors for the potential PFAS release areas recommended for further evaluation, is provided in **Table 10-1** and on **Figure 10-4**. Site-specific CSMs for the eight potential and confirmed PFAS release areas are described in **Table 10-2**, which provides background related to the individual potential and confirmed release areas and site condition details regarding potential fate and transport and potential human receptors. The PFAS PA (CH2M, 2021) provides additional background details for each of these potential and confirmed PFAS release areas.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. General CSM for Potential PFAS Releases

Site Name	MFD	
Site Conditions	**Topography and Hydrology**	The topography of MFD is shown on **Figure 10-2**. MFD is bordered by receiving waters to the north, east, and southeast (that is, Clam Bay, Puget Sound, and Little Clam Bay). Surface hydrology on the west side of the facility flows northeast toward Clam Bay. Surface hydrology on the east side of the facility is similar to an island, where surface water is discharged radially to adjacent receiving waters. Approximately 20 to 50 percent of the annual precipitation is available for surface runoff (Hart Crowser, 1988). A perennial stream, Beaver Creek, flows northward through a post-glacial ravine located west of MFD before discharging into Clam Bay through a broad valley located just north of the facility (**Figure 10-1**). Wetlands were identified in the area of the tidal pool and along the borders of the surface water bodies (Franco Pond, Little Clam Bay, Clam Bay, and Puget Sound) per Kitsap County (EDR, 2019) (**Figure 10-2**).
	Geology and Hydrogeology	MFD is located in the Puget Lowland Physiographic Province of western Puget Sound (Battelle, 2017). The local geology consists of glacial and nonglacial deposits overlying volcanic bedrock. Five stratigraphic units, that may or may not be located beneath the installation, are in the area (from youngest to oldest) (URS, 1992): • Holocene Alluvium, consisting of localized thin layers of sand, gravel, silt and peat • Vashon Recessional Outwash, consisting of discontinuous, unconsolidated units of sand, gravel, and silt up to 100 feet thick • Vashon Till, consisting of a dense unit of gravel and cobbles in silt, fine sand and clay forming an aquiclude up to 80 feet thick • Vashon Advance Outwash, consisting of coarse sand and gravel with some silt lenses up to 50 feet thick • Colvos Sand, consisting of well-stratified sand with some lenses of fine gravel and clay typically less than 150 feet thick Surficial deposits above the five stratigraphic units discussed above generally consist of fill material, riprap, and dredged material from the surrounding coastal areas. Tertiary bedrock deposits consisting of marine sedimentary rocks composed of sandstone, siltstone, claystone and conglomerate are also exposed at the surface in the northeastern portion of MFD along the coastline (Hart Crowser, 1988). In the Puget Lowland, the primary source for recharge to the aquifers is local precipitation. Kitsap County receives approximately 42 inches per year, and the majority of the groundwater recharge occurs during the winter and spring seasons and with more intermittent recharge in the summer and fall (Weatherbase, 2019). The precipitation and subsequent infiltration directly recharges the Vashon Advance Outwash aquifer. Groundwater is first encountered at the site within one of the three water-bearing zones: locally perched groundwater, groundwater within recent alluvial or Vashon Recessional Outwash deposits, and groundwater that is confined or semiconfined below or within the Vashon Till in the Vashon Advance Outwash. Groundwater flow direction is generally radial outward from the central portion of the peninsula toward the surface water bodies located to the north, west, and east (Hart Crowser, 1988) (**Figure 10-2**). As such, the groundwater flow direction on the west side of MFD is generally to the northeast toward Clam Bay and Little Clam Bay. On the east side of MFD, there is no evidence of a hydraulically connected sequence of unconsolidated deposits, but more likely perched zones within the Vashon Advance Outwash deposits. In the northeastern portion of MFD where Tertiary bedrock outcrops are present, groundwater movement in the bedrock is primarily through fracture zones (Hart Crowser, 1988). Groundwater on the east side of MFD likely follows topography and flows in a radial direction to either Little Clam Bay to the west or to Puget Sound to the east.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. General CSM for Potential PFAS Releases

Site Conditions (continued)	**Geology and Hydrogeology**	To the extent that perched groundwater is present, this groundwater likely flows radially toward receiving waters to the east, northwest, northeast and west/southwest direction (that is, Puget Sound and Clam Bay, respectively) (**Figure 10-2**). Based on observations during an Ecological Site Assessment conducted at the facility, the approximate depth to groundwater in the perched aquifer is 30 feet below ground surface (bgs) (CH2M, 2018). The depth to groundwater in areas where perched water is not present will vary across the site due to topographic relief. The depth of the uppermost shallow aquifer in these areas may range from 30 to greater than 50 feet based previous drilling in the area. The lower aquifer is generally present below depths of 120 feet bgs, extending to depths greater than 1,000 feet, with artesian conditions common between the depths of approximately 700 and 800 feet (URS, 1992), which are the depths at which the local public supply wells are screened. Due to a limited number of wells screened within the lower aquifer, and the relatively large distance between them, groundwater flow direction in the lower aquifer is unknown. Hydraulic communication between the upper and lower aquifers is unlikely due to the thickness of the silt and clay aquitard (Clover Park Formation).
Chemicals of Potential Concern (COPCs)	Perfluorooctanoic acid (PFOA) Perfluorooctane sulfonate (PFOS) Perfluorobutanesulfonic acid (PFBS) N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA) Perfluorodecanoic acid (PFDA) Perfluorododecanoic acid (PFDoA) Perfluoroheptanoic acid (PFDpA) Perfluorohexanesulfonic acid (PFHxS) Perfluorohexoanoic acid (PFHxA) Perfluorononanoic acid (PFNA) Perfluorotetradecanoic acid (PFTA) Perfluorotridecanoic acid (PFTrDA) Perfluoroundecanoic acid (PFUnA) 4,8-dioxa-3H-perfluorononanoic acid (ADONA) 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS) 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-pF3OUdS) Hexafluoropropylene oxide dimer acid (HFPO-DA)	
Potential Releases and Migration Pathways	As a result of historical use of materials containing certain PFAS, these substances may have been released to the environment. PFAS are a large family of compounds with varying properties. Research into defining the properties of individual PFAS and the impact on their migration in the environment is ongoing. Some PFAS, such as PFOS, PFOA, and PFBS, are not known to degrade under typical environmental conditions; because of this, they persist in the environment. PFAS present in unsaturated soils are subject to downward leaching during precipitation or irrigation events. In general, PFAS are mobile in groundwater but also tend to associate with the organic carbon fraction of soil or sediment. Many PFAS exhibit surfactant properties and preferentially accumulate at interfaces, such as the air-water interface, which may contribute to enhanced retention of PFAS in the vadose zone and capillary fringe where unsaturated conditions provide significant air-water interfacial area. (ITRC, 2020) Potential PFAS releases and migration pathways to be evaluated in the SI include the following: • Direct release of PFAS to surface and/or subsurface soil (for example directly to soil or through cracks in pavement) • Overland flow of stormwater containing PFAS to downgradient areas including soil and drainage ditches • Leaching of PFAS from soil to groundwater • Transport via advection in groundwater • Direct release of PFAS to surface water and intertidal sediment • Partitioning from surface water to sediment	

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. General CSM for Potential PFAS Releases

Potential Releases and Migration Pathways (continued)	The following potential PFAS migration pathways may be evaluated in a second phase of the SI or a Remedial Investigation (RI) if warranted (as described in **Worksheet #11**). If additional investigation is warranted, an updated SI SAP will be considered based on timeframe and/or other laboratory concerns, if the CSM needs to be updated, or if the data quality objectives change. If the project moves to the RI Phase, a new SAP will be created. • Overland flow of stormwater containing PFAS to storm water catch basins • Discharge of groundwater to surface water and sediment • Discharge of stormwater and effluent containing PFAS through stormwater outfalls to surface water • Discharge of stormwater containing PFAS to soil and/or groundwater through degraded stormwater infrastructure • Bioaccumulation of PFAS in biota (plants and animals) • Discharge of PFAS-impacted surface water into underlying groundwater
Potential Human Receptors and Exposure Scenarios	**Soil and Air** Workers, visitors, trespassers, residents, recreators, and tribal fishers and shellfish harvesters within 1 mile of PFAS source areas could potentially be exposed to PFAS in soil through incidental ingestion of and dermal contact with surface and subsurface soil or respiration of soil dust in the air. Because PFAS may bioaccumulate in terrestrial food items (such as plants), upper trophic level receptors (such as birds and mammals) could potentially be indirectly exposed to PFAS in soil through the consumption of terrestrial organisms. Potential recreational hunters could ingest game that had been exposed to PFAS in soil. **Groundwater** In areas where groundwater is within the potential depth of construction activities (within about 10 to 30 feet bgs), construction workers could be exposed to PFAS in groundwater through dermal contact during excavation activities, if a perched or the Vashon Advance Outwash aquifer is encountered. **Sediment** Workers, visitors, trespassers, and residents at and within 1 mile of PFAS source areas could be exposed to PFAS in sediment through incidental ingestion of and dermal contact with sediment. Humans could be indirectly exposed to PFAS in sediment through the consumption of terrestrial or aquatic organisms (plants or animals) if they are growing or living within PFAS-impacted sediment. **Surface Water** Surface water is not used as a drinking water source at MFD or the surrounding area. However, workers, visitors, trespassers, residents, recreators, and tribal fishers and shellfish harvesters within 1 mile of PFAS source areas could be exposed to PFAS in surface water through incidental ingestion of and dermal contact with surface water. Humans could be indirectly exposed to PFAS in surface water through consumption of terrestrial or aquatic organisms (plants or animals) if they are growing or living within or consuming PFAS-impacted surface water.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-1. General CSM for Potential PFAS Releases

Drinking Water Evaluation	**Public Drinking Water Sources**	Drinking water at MFD is currently supplied by the Manchester Water District (MWD), which also supplies potable water for the towns of Port Orchard and Manchester. The MWD obtains its potable water supply from multiple groundwater wells, including deep wells located to the south and upgradient of MFD (Hart Crowser, 1988; MWD, 2008). The wells located nearest to MFD, are approximately 500 feet to the south of the MFD boundary and are the northernmost wells of the MWD water supply. According to the well logs, one of the wells is 277 feet deep and screened at 253.9 to 264.1 feet bgs, with an indicated confining layer of clay from 61 to 125 feet bgs and the other well is 359 feet deep and screened from 329.3 feet to 350.4 feet bgs, with an indicated confining layer of clay from 58 to 140 feet bgs (Ecology, 2019a).Based on the location of MFD and the overall groundwater flow direction on the peninsula, the MWD supply wells are upgradient of MFD (CH2M, 2021). As part of UCMR3, untreated drinking water was tested for PFAS at MWD wells within 1 mile of MFD (USEPA, 2017a, 2019a). MWD wells outside of the 1-mile radius of MFD were also tested. Drinking water was also tested at the point on MFD where it ties-in to MWD. PFAS were not detected in the samples. Drinking water at two on-base buildings were sampled in November 2021 per the ASD policy memo dated July 23, 2020. PFAS were not detected in the samples.
Public Drinking Water Sources	**Private Drinking Water Sources**	A review of well records from Ecology and the Washington State Department of Health indicated that there are private wells within 1 mile of MFD (Ecology, 2019a). However, the exact number of private wells and their locations, current operational status (active or abandoned), depth, and usage are not well documented. Based on the location of MFD and the overall groundwater flow direction on the peninsula, the private wells are upgradient of MFD (CH2M, 2021).Based on limited records available, some of these wells are suspected to be monitoring wells because of depth, location, and Navy contractor affiliation; or abandoned, as multiple public well records confirmed (Ecology, 2019a).

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Former Navy FTA	**10-5**	The Navy operated the FTA in the northwestern area of the facility from 1942 through 1967. A majority of the property on which the Former Navy FTA was located was transferred to the General Services Administration and subsequently to NOAA in 1968 (Perry, 1998). A portion of the land on which the FTA operated is still owned by the Navy and leased to NOAA. This investigation is limited to the Navy-owned portion of the former FTA.	Training included simulated fuel firefighting, although it is uncertain whether AFFF was deployed during these training operations. Limited information is available regarding operations within the current Navy-owned portion of the former FTA, although areas of possible use of AFFF, as identified by the United States Army Corps of Engineers, include the Main Simulator Complex, the Northern Simulator foundation, and other firefighter training infrastructure (Aerostar E&C, 2021) located upgradient of the Navy-owned portion of the former FTA. The following migration pathways are associated with potential releases within the current Navy-owned portion of the former FTA. **Soil:** AFFF could have been directly released to soil in unpaved areas, infiltrated soil through cracks in the paved areas, or runoff with overland flow to the east or south to downgradient soil. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached from the soil into the groundwater of the underlying Vashon Advance Outwash aquifer. **Sediment and surface water:** AFFF in soil could have migrated via overland flow and AFFF in groundwater could have discharged to into the Tidal Pool and Clam Bay.	**Ground cover:** The Former Navy FTA is mostly covered in pavement, with some small areas of grass. **Surface water and overland drainage:** The topography of the Former Navy FTA is relatively flat, sloping gently toward Clam Bay and Tidal Pool, an inlet of Clam Bay. Therefore, overland flow could enter Clam Bay or Tidal Pool and migrate to Clam Bay. **Groundwater flow direction:** Groundwater flow in the area is assumed to generally follow topography in an east-southeast direction toward Tidal Pool and Clam Bay.	Workers and visitors are present at the Former Navy FTA; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Former Fire Station and Spill Response Warehouse (Building 85)	**10-6**	Building 85 is located on the eastern side of MFD. It was built in the early 1940s and was in operation as a fire station through 2005. AFFF deployment equipment was stored in Building 85 when the building was used as a fire station.	AFFF deployment equipment was stored in Building 85 and AFFF was transferred into firefighting equipment at Building 85 in support of test spray activities (described elsewhere in this table). In addition, firefighting trucks were reported to have been washed outside of Building 85 prior to the construction of the VWR (described elsewhere in this table) in 1996. The exact location of where the trucks were washed is unknown, but it is assumed they would have been washed in the driveway located on the northside of the building. While there are no confirmed releases of AFFF, incidental releases may have occurred to the floor of the building during the transfer or to the paved driveway and surrounding area while firetrucks containing AFFF or residues were washed. The following migration pathways are associated with potential releases at Building 85: **Soil:** AFFF could have infiltrated soil through cracks in the paved areas or runoff with overland flow to the northeast, east, or southeast to downgradient soil. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached from the soil into the groundwater of the perched aquifers characteristic of the eastern portion of MFD and been transported downgradient via advection. **Sediment and surface water:** AFFF in soil could have entered the culvert adjacent to the driveway or migrated with overland flow and entered the drainage ditch north of the building and eventually Puget Sound.	**Ground cover:** Building 85 is mostly surrounded by paved surfaces and grass. **Surface water and overland drainage:** The driveway of the building slopes down toward the northeast. A culvert is located in the grassy area at the northeast corner of the driveway. The culvert is connected to a drainage ditch across the road, north of the building. This ditch ultimately discharges into Puget Sound. The overall topography of the ground surface near Building 85 slopes down to the southeast toward Puget Sound. **Groundwater flow direction:** Groundwater flow near Building 85 is generally assumed to mimic the topography and flow to the southeast toward Puget Sound.	Workers and visitors are present at Building 85; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Fuel Pump House (Building 12)	**10-7**	Building 12 was constructed in the 1940s and is located in the eastern portion of MFD. Building 12 is used as a warehouse and houses the emergency generator for MFD, the pumps for transferring fuel between storage tanks, and the manifold equipment where the piping contained in Tunnels B, C, and D and pipes from the USTs 16-21 converge. AFFF has been stored and staged in Building 12 since the mid-1980s. Several fuel spills have occurred nearby, and LNAPL has been observed in the groundwater (NAVFAC, 2016).	AFFF has been stored and staged in Building 12 since the mid-1980s. AFFF was transferred into firefighting equipment at Building 12 in support of test spray activities (described elsewhere in this table). While there are no confirmed releases of AFFF at Building 12, incidental releases are anticipated to have occurred on the floor of the building or on the paved area adjacent to the building during transfer. The following migration pathways are associated with the potential releases at Building 12: **Soil:** AFFF could have infiltrated soil through cracks in the paved areas adjacent to the building or run off from the paved areas and infiltrated soil in the unpaved areas to the west of Building 12. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached into the groundwater of the perched aquifers characteristic of the eastern portion of MFD potentially facilitated by the presence of major utilidors located throughout the site and been transported downgradient via advection. **Sediment and surface water:** AFFF could have been transported to Puget Sound through the migration of soil via overland flow or through the storm drain system or through groundwater discharge.	**Ground cover:** Building 12 is mostly surround by paved surfaces, with some wooded and grassy areas to the north and west. **Surface water and overland drainage:** The topography of the ground surface at Building 12 slopes down to the east-southeast toward Puget Sound. Overland surface flow is generally considered to be captured by the storm drain system or follow topography and be conveyed to Puget Sound. **Groundwater flow direction:** Groundwater flow near Building 12 is generally assumed to mimic the topography and flow to the southeast toward Puget Sound.	Workers and visitors are present at Building 12; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Test Spray Area (ASTs 145 to 149)	**10-8**	The Test Spray Area encompasses the containment basins of ASTs 145 through 149 in the western portion of MFD. The ASTs were installed in 1953 and currently store jet fuel. The tanks rest on a concrete foundation on top of compacted soil. Porous gravel material was historically used as fill material around these ASTs until concrete containment basins were installed in the mid-1990s.	According to interviews with site personnel, an AFFF mixture was test-sprayed in the gravel-lined secondary containment basins surrounding the ASTs. The frequency of spray tests from 1991 to 1999 was semi-annual, and a large nozzle would be used to spray foam along the ASTs to simulate how a large petroleum fire would be extinguished. The nozzle could spray the AFFF mixture at a rate of approximately 2,000 gallons per minute. The following migration pathways are associated with releases within the Test Spray Area: **Soil:** AFFF sprayed onto the gravel surrounding the tanks could have infiltrated through the pore spaces between the gravel and into the underlying soil. After the construction of the containment basins, AFFF releases could have infiltrated the surrounding soil through cracks in the concrete. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached into the groundwater of the underlying Vashon Recessional Outwash Deposits or Vashon Advance Outwash aquifer on the western portion of MFD and been transported downgradient via advection. **Sediment and surface water:** AFFF in soil could have migrated with overland flow to Franco Pond, been released from the OWS directly to Franco Pond, or migrated with overland flow to drainage ditches and subsequently have been conveyed to Little Clam Bay or Clam Bay.	**Ground cover:** The Test Spray Area is mostly surrounded by grass and wooded area. The ASTs rest on large concrete containment pads. **Surface water and overland drainage:** The topography of the Test Spray Area slopes gradually to the northeast-east-southeast toward either Clam Bay or Little Clam Bay. During heavy precipitation, stormwater flows through a series of unpaved ditches and culverts toward Clam Bay and Little Clam Bay. The concrete containment systems of the ASTs have drainage systems that are routed to OWS 6A and discharged into Franco Pond. **Groundwater flow direction:** Groundwater flow near the Test Spray Area is assumed to mimic the topography and flows to the southeast to east direction toward Little Clam Bay or northeast direction toward Clam Bay.	Workers and visitors are present at the Test Spray Areas; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
JP-8 Truck Loading Facility (Building 185)	**10-9**	Building 185 is located in the western portion of MFD. The facility currently consists of a metal canopy, fuel pumps, filtration systems, concrete pad with secondary containment, two loading bays, and a spill drainage system. A petroleum release occurred at UST 50, which is located north of the building (NAVFAC, 2016).	According to former facility personnel, firefighting simulations using AFFF were conducted at least once per year at Building 185 because of its proximity to UST 50, located north of the building. The firefighting simulations consisted of spraying AFFF along the perimeter of the building. The following migration pathways are associated with releases at Building 185: **Soil:** AFFF could have been directly released to soil in unpaved areas adjacent to the building, infiltrated soil through cracks in the paved areas adjacent to the building, or runoff with overland flow to the east to downgradient soil. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached into the groundwater of the underlying Vashon Recessional Outwash Deposits or the Vashon Advance Outwash aquifer on the western portion of MFD and been transported downgradient via advection. However, AFFF released at the facility would likely have been captured by the underground containment tanks. **Sediment and surface water:** AFFF in soil could have migrated with overland flow to Little Clam Bay or entered the stormwater system and ultimately discharged into Little Clam Bay.	**Ground cover:** Building 185 is mostly surrounded by grass and wooded area, along with some paved surfaces. **Surface water and overland drainage:** The topography of the Building 185 area slopes down to the east toward Little Clam Bay. Overland flow could enter Little Clam Bay or be conveyed through drainage ditches located to the east of the building to OWS 7, which discharges into Little Clam Bay. **Groundwater flow direction:** Groundwater flow near Building 185 is generally assumed to mimic the topography and flow to the southeast toward Little Clam Bay. There are two 5,000-gallon concrete underground spill containment tanks at the facility. These tanks would likely capture any releases at the site. Discharge from the tanks goes to OWS 7, which ultimately discharges into Little Clam Bay.	Workers and visitors are present at Building 185; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Fuel Pier	**10-10**	Two fuel piers have existed in the eastern portion of MFD. The former Fuel Pier was constructed during World War II. Between 1990 and 1994, the former Fuel Pier was replaced with the existing Fuel Pier. The existing Fuel Pier is 1,390 feet long and is situated approximately 250 feet northeast of the former Fuel Pier.	Based on an interview with site personnel, firefighting training simulations were conducted at least once a year along the former and existing fuel piers using AFFF. The number of years and total quantity of AFFF used during each spray test is unknown. The following migration pathways are associated with releases at the Fuel Pier: **Sediment and surface water:** PFAS in AFFF is anticipated to have been released directly to surface water within Puget Sound and potentially to intertidal sediments where the pier connects to land. PFAS in surface water may have partitioned to sediment.	**Ground cover:** The majority of the Fuel Pier is located over the Puget Sound with a small portion extending over an area of sand or riprap at the shoreline. **Surface water and overland drainage:** The Fuel Pier is located within Puget Sound. Originally, the existing pier drained directly to Puget Sound. In 2013, the pier drains were routed into containment trenches that flow into OWS system 1B/C/D, which discharges to the sound. Conditions of the former Fuel Pier are unknown. **Groundwater flow direction:** Not applicable.	Workers and visitors are present at the Fuel Pier; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
Polychlorinated Biphenyl (PCB) Disposal Area (Site 302)	**10-11**	Site 302 is located in the western portion of MFD. The site was used as a dump for ship bilge waste, transformer oil, and other petroleum waste from MFD operations and Regional Naval facilities in Puget Sound from 1955 through 1976. Site 302 was classified as a CERCLA site in the early 1990s. As part of the remediation effort in the late 1990s, an excavation was conducted to remove impacted soils, and clean fill was imported to use as clean cover. PFAS impacts were not evaluated at the time of this remediation effort. The site was given closure by Ecology and USEPA in September 2000.	Bilge waste disposed at this location may contain PFAS as a result of AFFF used aboard ships during training or emergency response. The following migration pathways are associated with potential releases at Site 302: **Soil:** PFAS-containing materials disposed of at Site 302 would have been in direct contact with the soil. **Groundwater:** Previous investigations of Site 302 have suggested that the underlying silt layer may act as an aquitard that impedes downward flow into underlying aquifers. PFAS-containing materials deposited at Site 302 are unlikely to have impacted groundwater, based on the suspected depth to groundwater and confining properties of the underlying silt layer. However, if there are areas where the suspected silt layer are not present or it is not competent enough to act as an aquitard, AFFF that was released to soil could have leached into the groundwater of the underlying Vashon Recessional Outwash Deposits or Vashon Advance Outwash aquifer on the western portion of MFD and been transported downgradient via advection. **Sediment and surface water:** AFFF in soil could have migrated with overland flow, eventually entering Little Clam Bay.	**Ground cover:** Site 302 is covered in grassy and wooded areas and surrounded by wooded area. **Surface water and overland drainage:** Site 302 is located on a topographic high spot with the surrounding area sloping downward radially from the west to the north and east. Flow is conveyed through ditches and streams on or adjacent to Site 302. This flow can ultimately enter Little Clam Bay. **Groundwater flow direction:** Groundwater flow near Site 302 is assumed to mimic topography and flow to either the north, northwest, northeast, and east (depending on the location within Site 302) toward Little Clam Bay located to the east of Site 302.	Workers and visitors are present at Site 302; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 10-2. Conceptual Site Models for Potential or Confirmed PFAS Release Areas at Manchester Fuel Depot

Area Name	Associated Figure	Description and Operational History	Potential/Confirmed PFAS Releases and Potential Migration Pathways	Area Conditions	Potential Human Receptors
VWR	**10-12**	The VWR is located near the south-southeastern corner of Building 194 and was constructed in 1996 to wash Base vehicles and various equipment.	According to the current Regional Fuel Manager/Deputy Director, staff members are instructed to wash fire trucks at the VWR. Current staff members could not corroborate this practice, but it may have occurred in the past. Because the VWR is a designated location for firetruck washing, and because of the history and AFFF transfer and test spraying at MFD, the PA conservatively recommended the VWR for SI. The following migration pathways are associated with potential releases at the VWR: **Soil:** AFFF could have infiltrated soil through cracks in the paved surface or infiltrated soil in the grassy area to the east of the VWR via overspray. **Groundwater:** AFFF that was released to soil or migrated to soil could have leached into the groundwater and entered perched aquifers characteristic of the eastern portion of MFD. **Sediment and surface water:** AFFF could have migrated with overland flow, eventually entering Puget Sound.	**Ground cover:** The VWR is paved and is primarily surround by paved surfaces with a wooded area to the east. **Surface water and overland drainage:** The topography of the ground surface surrounding the VWR slopes gradually down to the east and then to Puget Sound. Overland surface flow is generally captured by the storm drain system and conveyed to OWS 2, which discharges to the sanitary sewer system, or flows topographically, resulting in discharge into Puget Sound. **Groundwater flow direction:** Groundwater flow near the VWR is generally assumed to mimic the topography and flow to the southeast toward the Puget Sound.	Workers and visitors are present at the VWR; workers, visitors, and residents are present within a 1-mile radius of the area. Shellfish harvesting and fishing could occur within a 1-mile radius of MFD.

LNAPL = light non-aqueous phase liquid

OWS = oil water separator

VWR = Vehicle Wash Rack

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SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Problem Statement and Objectives

The objectives, environmental questions, investigation approach, and project quality objectives are presented in **Table 11-1. Figure 11-1** shows the decision logic associated with **Table 11-1.**

Table 11-1. Problem Definitions/Objectives, Environmental Questions, and Project Quality Objectives

Problem Definition/Objective	Environmental Question	General Investigation Approach	Project Quality Objectives
Terrestrial Potential or Confirmed PFAS Release Areas			
It is unknown whether a release of PFAS at terrestrial potential or confirmed PFAS release areas identified in the PFAS PA has resulted in the presence of PFAS in soil and groundwater at concentrations warranting further investigation. Determine whether PFAS[a] are present in groundwater and soil at concentrations warranting further investigation at terrestrial areas identified during the PFAS PA.	Are PFAS[a] present in onsite groundwater at concentrations that warrant further investigation?	Groundwater monitoring wells will be installed at or near each of the potential or confirmed terrestrial release areas. Groundwater samples will be collected from the surficial aquifer at the newly installed monitoring wells (**Worksheet #17**). Samples will be analyzed for the 18 PFAS listed in EPA Method 537.1 in accordance with **Worksheet #18**. **Figures 10-5** through **10-12** present the sample locations. The samples and rationale are outlined in **Worksheet #17**.	The soil and groundwater data will be evaluated to determine whether further investigation is warranted (including collection of surface water and/or sediment samples under an SAP Addendum) (**Figure 11-1**).
	Are PFAS[a] present in onsite soil at concentrations that warrant further investigation?	Soil samples will be collected during installation of the monitoring wells at the potential or confirmed terrestrial release areas. Soil samples will be collected at a minimum of two depths from each boring (at the surface and at the top of the capillary fringe in the unsaturated soil) at each monitoring well during installation of the wells. At locations where monitoring wells are installed deeper than 50 feet bgs, in addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each vertical 50-foot interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted toward zones with higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. Additional surface soil samples will be collected downgradient from the potential or confirmed release area, where surface water runoff is expected. Samples will be analyzed for the 18 PFAS listed in EPA Method 537.1 in accordance with **Worksheet #18**. **Figures 10-5** through **10-12** present the sample locations. The samples and rationale are outlined in **Worksheet #17**.	

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Table 11-1. Problem Definitions/Objectives, Environmental Questions, and Project Quality Objectives

Problem Definition/Objective	Environmental Question	General Investigation Approach	Project Quality Objectives
The hydrogeologic characteristics are not well known at the terrestrial potential or confirmed PFAS source areas identified during the PFAS PA. Refine the understanding of the hydrogeologic characteristics at terrestrial potential or confirmed PFAS release areas.	What are the groundwater flow directions at terrestrial potential or confirmed PFAS source areas?	Prior to groundwater sampling, monitoring wells will be gauged to determine depth to groundwater at each location and these data will be used to estimate local groundwater flow directions in the areas where monitoring wells were installed. If additional wells are identified in the field, these may be gauged to determine depth to groundwater as well, and these data will also be incorporated into the analysis of groundwater flow directions at the site. Groundwater levels from at least three monitoring wells at each area will be measured so that groundwater flow direction can be verified to assess potential PFAS migration directions within groundwater. Additionally, transducers will be deployed in newly installed monitoring wells at two of the potential release areas near the shore (the Former Navy FTA and Building 12) for 1 week prior to sampling to monitor potential tidal influence.	This information will be used to refine the CSM for groundwater flow at potential or confirmed PFAS release areas prior to conducting any additional sampling (which would be done under a SAP Addendum or new SAP).
Marine Confirmed PFAS Release Area			
It is unknown whether past activities at the marine confirmed PFAS release area, which likely resulted in direct release(s) of AFFF to surface water and intertidal sediment, have impacted nearby surface water and sediment at concentrations warranting further investigation. Determine whether PFAS are present in surface water and sediment at concentrations warranting further investigation at the marine confirmed PFAS release area identified for SI during the PFAS PA.	Are PFAS present in surface water and sediment at concentrations that warrant further investigation?	Sediment samples will be collected along three transects adjacent to the former and existing Fuel Pier. Sediment samples will be collected at two depths at each location. Surface water samples will be collected at three of the locations where sediment samples are collected. The samples will be analyzed for the 18 PFAS listed in EPA Method 537.1 and a subset of the sediment samples will be analyzed for TOC and grain size in accordance with **Worksheet #18**. **Figure 10-10** presents the sample locations. The samples and rationale are outlined in **Worksheet #17**.	The surface water and sediment data will be evaluated to determine whether further investigation is warranted (**Figure 11-1**).

[a] The focus of this SI is PFOA, PFOS, and PFBS. Data for remaining compounds will be reported in an appendix to the SI report for future use if appropriate PALs become available.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

What are the Project Action Limits?

The determination of whether further investigation is warranted will be made using the PALs described as follows and listed in **Worksheet #15**, which are based on human health exposure scenarios. Risk to ecological and human receptors will be evaluated using approved state-of-the-science toxicological information available at that time; a human health risk screening may be conducted during the SI in accordance with **Figure 11-1**, an ecological risk screening will not be conducted as part of the SI.

Groundwater

Groundwater data will be screened against residential scenario SLs for tap water based on an HQ of 0.1 and consistent with DoD technical guidance (DoD, 2021). Tap water SLs for PFOA and PFOS based on an HQ of 0.1 were generated using the USEPA RSL calculator as described in DoD, 2021. The PFBS tap water SL is presented in the November 2021 RSL Table (USEPA, 2021).

There are no PALs for other PFAS analytes.

Soil

Soil data will be screened against residential scenario SLs for soil based on an HQ of 0.1 and consistent with DoD technical guidance (DoD, 2021). Residential soil SLs for PFOS and PFOA based on an HQ of 0.1 were generated using the USEPA RSL calculator as described in DoD, 2021. The PFBS residential soil SL is presented in the November 2021 RSL Table (USEPA, 2021).

There are no PALs for other PFAS analytes.

Sediment

Sediment data will be screened against residential scenario SLs for soil based on an HQ of 0.1. Residential scenario SLs for soil will be used in the absence of EPA toxicity values for sediment. The residential scenario soil SLs will be applied as initial SLs but are not fully applicable to the potential exposure scenarios at the site. Use of the soil SLs is conservative; exposure to sediment is typically much lower than exposure to soil. Residential soil SLs for PFOS and PFOA based on an HQ of 0.1 were generated using the USEPA RSL calculator as described in DoD, 2021. The residential soil SL for PFBS is presented in the November 2021 RSL Table (USEPA, 2021).

There are no PALs for other PFAS analytes.

Surface water

Surface water data will be screened against residential scenario SLs for tap water based on an HQ of 0.1. Residential tap water SLs will be used in the absence of EPA toxicity values for surface water. The tapwater SLs will be applied as initial screening levels but are not fully applicable to the potential exposure scenarios at the site.

Use of the tap water SLs is conservative; exposure to surface water not used as a drinking water supply is typically much lower than exposure to groundwater. Tap water SLs for PFOA and PFOS based on an HQ of 0.1 were generated using the USEPA RSL calculator as described in DoD, 2021. The tap water SL for PFBS is presented in the November 2021 RSL Table (USEPA, 2021).

There are no PALs for other PFAS analytes.

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

For what will the data be used?

The data will be used to answer the environmental questions (**Table 11-1**).

What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

The data to be collected during this investigation will include the following:

- Soil boring logs that describe lithology generated during the monitoring well installations.
- Laboratory analytical results for PFAS in groundwater, soil, surface water, and sediment samples. The specific target analytes and PALs are included in **Worksheet #15**.
- Laboratory analytical results for TOC and grain size in sediment samples.
- Water quality parameters (WQPs), including pH, conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), temperature, and turbidity collected during groundwater sample collection.
- Surveyed coordinates for sample locations.
- Groundwater elevation data collected prior to groundwater sample collection.
- Transducer data collected to monitor potential tidal influence.

Are there any special data quality needs, field or laboratory, to support environmental decisions?

There are no special data quality needs.

Where, when, and how should the data be collected/generated?

- All sampling locations are shown on **Figure 10-5** through **Figure 10-12** and are based on the rationale presented in **Worksheet #17** and in accordance with the project schedule outlined in **Worksheet #16**.
- The data will be collected following the methodologies in **Worksheet #14** and the SOPs presented in **Worksheet #21**.

SAP Worksheet #12-1—Field Quality Control Samples

Matrix: Groundwater, Surface Water

Analytical Group: PFAS

Analytical Method: Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS) Compliant with QSM Version 5.3 (v5.3)[a] Table B-15

QC Sample	Analytical Group	Frequency[b]	DQIs	MPC
Field duplicate	PFAS	Once per 10 normal field samples	Precision	RPD < 25% for waters
Equipment blank		One per day for decontaminated equipment; one per event for disposable equipment	Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Field blank		One per investigation area	Bias/Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Temperature blank		One per cooler	Representativeness	≤ 10 °C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen

[a] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

[b] QC will be collected separately for each matrix.

°C = degrees Celsius
> = greater than
< = less than
≤ = less than or equal to
% = percent
DQI = data quality indicator
MPC = measurement performance criteria
RPD = relative percent difference

SAP Worksheet #12-2—Field Quality Control Samples

Matrix: Surface Soil, Subsurface Soil, and Sediment

Analytical Group: PFAS

Analytical Method: LC-MS/MS Compliant with QSM v5.3[a] Table B-15

QC Sample	Analytical Group	Frequency[b]	DQIs	MPC
Field duplicate	PFAS	Once per 10 normal field samples	Precision	RPD < 35% for soils
Equipment blank		One per day for decontaminated equipment; one per event for disposable equipment	Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Field blank		One per investigation area	Bias/Contamination	No analytes detected > 1/2 LOQ or > 1/10 sample concentration, whichever is greater
Temperature blank		One per cooler	Representativeness	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen

[a] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

[b] QC will be collected separately for each matrix (surface soil and subsurface soil are considered the same matrix).

SAP Worksheet #12-3—Field Quality Control Samples

Matrix: Sediment

Analytical Group: WCHEM (TOC)

Concentration Level: Low (SW-846 9060A)

QC Sample	Analytical Group	Frequency	DQIs	MPC
Temperature blank	WCHEM	One per cooler	Accuracy/Representativeness	2 to 6°C

SAP Worksheet #12-4—Measurement Performance Criteria Table – Field Quality Control Samples

Matrix: Sediment

Analytical Group: GRAINSIZE

Concentration Level: Low (ASTM D 422)

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
N/A: Field QC samples are not planned for grain size (sieve) analysis.					

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary data criteria is not available for this project.

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SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities is detailed herein. The SOPs tabulated on **Worksheet #21** and provided in **Appendix A** address the protocols to be used for the SI. Any modification to the work approach will be documented in the field notes.

Fieldwork Preparation

- Subcontractor procurement
  - Analytical laboratory
  - Data validator
  - Utility locator
  - Driller
  - Marine vessel operator
  - Surveyor
  - Investigation-derived waste (IDW) transportation and disposal contractor
- Equipment procurement
- Fieldwork scheduling

Fieldwork

- Mobilization for the field effort includes initial transport to the site. Equipment and supplies will be brought to the site when the CH2M field team mobilizes for field activities. Field notes will be captured each day on loose-leaf notebook paper and forms. A location for the placement of IDW will be determined, and IDW will be stored in a manner consistent with the SOP presented in **Appendix A** and the Waste Management Plan and Environmental Protection Plan before beginning any phase of work. CH2M and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the HSP.
- In general, work will be performed in Level D personal protective equipment (PPE), which includes a hard hat, safety glasses, safety-toed boots, and hearing protection. Teflon, Viton, or other PFAS-containing materials will not be used during sampling tasks.
- Field activities will take place during normal daylight working hours.

Utility Clearance

Utilities will be cleared before beginning intrusive activities in accordance with the SOP listed in **Worksheet #21** and provided in **Appendix A**. CH2M will coordinate utility clearance. A third-party utility clearance subcontractor will be procured by CH2M to clearly mark subsurface utilities near the proposed monitoring well and soil sample locations. Proposed monitoring well locations within 6 feet of utility locations will be relocated to avoid impact to utilities. If a monitoring well location needs to be relocated, the field team will use its best judgment in relocating the well and will notify the CH2M PM and Navy RPM of the new location.

Monitoring Well Installation

Monitoring wells will be installed using a rotosonic drilling method. Continuous soil cores will be collected in plastic sleeves and logged. The wells will be constructed using 2-inch-inner-diameter Schedule 40 polyvinyl chloride (PVC) and 0.020-inch PVC screens. Each monitoring well will be constructed with up to a 10-foot-long screen. Monitoring wells will be screened within the surficial aquifer, with a small portion of screen above the

SAP Worksheet #14—Summary of Project Tasks (continued)

water table but the majority beneath the water table. Final well construction details will be determined in the field based on subsurface conditions encountered during drilling. The annual space around the well screens will be backfilled with a well-graded, fine to medium silica sand filter pack consisting of a thoroughly washed, round, durable, siliceous material containing less than 5 percent calcareous particles. The filter pack will extend from the bottom of the boring to 2 feet above the top of screen. A 2-foot-thick bentonite layer will be placed above the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space.

Teflon, Viton, or other PFAS-containing drilling materials will not be used during drilling or well installation. Drilling greases will be vegetable-based formulations, such as Biolube. Bentonite materials will be PFAS-free. Polymer-coated bentonite formulations will not be used unless shown to be free of PFAS.

Monitoring Well Development

Upon completion of installation, each monitoring well will be developed using a combination of surging and pumping throughout the well screen. During monitoring well development, the CH2M field crew will measure WQPs, including pH, temperature, conductivity, and turbidity. Development will continue until turbidity is below 10 nephelometric turbidity units (NTUs) or at least three well volumes removed. Under ideal conditions, discharge is as clear as possible and parameters are stabilized (temperature, DO, and specific conductance within +/- 10 percent, pH within +/- 0.5 units, oxidation/reduction potential within 10 millivolts). Monitoring wells will be developed using a submersible pump (or equivalent) and surge block without Teflon, Viton, or other PFAS-containing components.

Development information, including turbidity, pH, specific conductivity, temperature, and gallons of water removed, will be recorded as field notes on loose-leaf notebook paper. The water quality meter will be calibrated daily (at a minimum), and the calibration will be documented in the field notes.

Wells will be developed in accordance with SOP listed in **Worksheet #21** and provided in **Appendix A**.

Tidal Influence Monitoring

Following monitoring well installation and development, transducers will be deployed in each well at two of the potential release areas near the shore (the Former Navy FTA and Building 12) to monitor tidal influence for a duration of 1 week. Transducers will be deployed in accordance with the SOPs listed in **Worksheet #21** and provided in **Appendix A.**

Groundwater Level Monitoring

Before groundwater sampling, and at least 24 hours after well installation and development has been completed, the depth to groundwater, to the nearest 0.01 foot, will be measured from all monitoring wells in accordance with the SOP listed in **Worksheet #21** and provided in **Appendix A**. Measurements will be made from the top of the PVC riser, which will be marked. If during the locking well cap removal, the well demonstrates signs of being under pressure (such as escaping air sounds or cap being pushed off by pressure), the depth to water in that well will be measured repeatedly over a period of several minutes to determine whether the water level is still changing. If over several minutes the water level continues to change, the water level in that well will not be measured for a period of 1 hour to allow the water level to equilibrate. Depth to water and time measured will be recorded in the field notes.

SAP Worksheet #14—Summary of Project Tasks (continued)

Groundwater Sampling

Groundwater samples will be collected from newly installed monitoring wells in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A.** Groundwater samples will be collected under low-flow/low-stress conditions, the peristaltic pump intake will be placed at the middle of the well screen interval. Depth-to-water readings and WQPs will be measured and recorded (approximately every 5 minutes) before sampling using a depth-to-water meter and water quality meter, calibrated daily (at a minimum). The pump intake will be placed in the middle of well screen, due to extremely limited saturated thickness. If excessive drawdown occurs at very low-flow rates, the well will be purged dry and sampled once recovered to the extent where a sample can be obtained. Sampling will begin when three well volumes have been purged or when minimal water-level drawdown requirements are met and WQPs have stabilized for three consecutive readings, in accordance with the SOPs listed in **Worksheet #21** and located in **Appendix A**, as follows:

- Temperature within 3 percent
- pH within 0.1 pH units
- Conductivity within 3 percent
- DO within 10 percent for values greater than 0.5 milligram per liter (mg/L), if 3 DO values are less than 0.5 mg/L, consider the values stabilized
- ORP within 10 millivolts
- Turbidity measurements are less than 5 NTU; if three turbidity values are less than 5 NTU, consider the values as stabilized

Depth-to-water, WQPs, and total well depth measurements will be recorded on Groundwater Sampling Data Sheets. Following completion of the sampling, each area will be restored to its original condition.

Groundwater Sampling Beneath LNAPL-Groundwater Interface

Standard groundwater sampling methods are inadequate for sample collection beneath LNAPL plumes, because sampling equipment becomes coated as it passes through LNAPL (GZA, 2012). Excess LNAPL product within a groundwater sample may damage field instrumentation, such as the probe membranes of DO meters. Due to the potential for LNAPL to be preset in groundwater at the facility due to the primary mission of the facility, this alternative groundwater sampling method will be used in the event LNAPL is encountered. To prevent groundwater samples from becoming compromised with LNAPL product, a direct ice-coating method will be used during the collection of the groundwater samples. Ice will be used as a temporary barrier to protect sampling equipment. PFAS-free tubing will be coated with an approximately 0.1- to 0.3-inch-thick layer of ice (laboratory-grade distilled water), using simple molds fabricated from 1-inch recut ends of silicone tubing in individual ice trays (GZA, 2012). The sample tubing with attached ice plug will be lowered through the measured LNAPL interval to the midpoint of the water column. The ice will then be allowed to melt and sampling will be conducted. Groundwater sampling using the ice-coating method will be conducted in accordance with the modified low-flow sampling guidance SOP provided in **Appendix A**.

SAP Worksheet #14—Summary of Project Tasks (continued)

Soil Sampling

Soil samples will be collected at the surface (0 to 1 feet bgs or in the 1-foot interval immediately below pavement if present) and top of the capillary fringe in the unsaturated soil (to be determined in the field) at each new monitoring well location (that is at, or adjacent to, potential or confirmed PFAS release areas) and at the surface at stand-alone samples locations. At locations where monitoring wells are installed deeper than 50 feet bgs, in addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted toward zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist.

The surface soil samples will be collected using a hand auger. The soil samples collected from the capillary fringe will be collected using a sampling tool advanced to the desired sampling depth. Following completion of the sampling, each area will be restored to its original condition. Soil samples will be collected in accordance with the soil sampling SOPs listed in **Worksheet #21** and located in **Appendix A**.

Surface Water and Sediment Sampling

Prior to collection, in-situ parameters (pH, conductivity, turbidity, DO, temperature, salinity, and ORP) will be measured with a Horiba U-52 or similar water quality meter(s). Measurements from a Seabird Conductivity-Temperature-Depth profiler with optical back scatter (turbidity), pH, and DO sensors may also be used. The depth to the surface water/sediment interface will be measured before sampling.

The surface water samples will be collected by PFAS-free tubing and a peristaltic pump with the open end of tubing placed directly below the water surface. Careful attention will be made to keep the tubing below the surface as a means to avoid collecting any potential foam(s) that can form at the surface water-air interface. Surface water samples will be collected prior to any sediment sampling (intertidal or subtidal) to avoid cross contamination. The surface water samples will be collected into laboratory-provided sample bottles and packed on ice for overnight shipment to the laboratory. Surface water samples will be collected in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.

The sediment samples will be collected from 0 to 4 inches and 4 to 24 inches bgs. For subtidal sediment samples, one sediment core will be collected from each sampling location using a vibratory coring technique. Sleeves for the core barrel will include materials appropriate for PFAS sampling (for example, fluorine free, high density polyethylene [HDPE]). The cores will be split into 0- to 4-inch and 4- to 24-inch segments. Sediment from each segment will be homogenized before filling laboratory-provided sample jars for analysis of PFAS, TOC, and grain size. For the 0- to 4-inch segment, if mass of sediment collected is insufficient to meet laboratory requirements, only the PFAS and TOC samples will be collected from the core. As needed, a Box Corer, Ponar, Shipek, Van Veen, or Eckman sampling device will be used to collect additional sediment for grain size analysis for the 0- to 4-inch samples. Each of these devices works in a similar fashion where the device is lowered to the bottom from a boat and the sediment is enclosed by force. The specific device will be selected based upon the sediment type encountered, which can be determined from observing the core retrieved by vibratory methods. For intertidal sediments, samples will be collected with core tubes with “egg-shell” core catchers as needed. Cross contamination of PFAS analytes in accordance with the SOP will be considered during sampling. Sediment samples will be packed on ice for overnight shipment to the laboratory. Sediment samples will be collected in accordance with **Worksheet #18** and with the SOPs listed in **Worksheet #21** and provided in **Appendix A**.

SAP Worksheet #14—Summary of Project Tasks (continued)

Equipment Decontamination

All nondisposable sampling equipment will be decontaminated immediately after each use in accordance with the SOP listed in **Worksheet #21** and provided in **Appendix A**. Nondisposable equipment will be decontaminated using the following solutions in this order:

1. Distilled water (laboratory-certified PFAS-free) and Liquinox solution
2. Distilled water (laboratory-certified PFAS-free) rinse 10 percent isopropanol and distilled water solution (laboratory-certified PFAS-free) and air-dried
3. Laboratory-grade deionized water (laboratory-certified PFAS-free)

Decontamination fluids will be contained in a tank or 55-gallon drum and disposed of offsite as described as follows.

Surveying

Newly installed permanent monitoring well locations will be horizontally and vertically located by a Washington licensed surveyor in accordance with SOPs listed in **Worksheet #21** and provided in **Appendix A**. The surveyor will provide coordinates of all horizontal points X, Y, to the nearest 0.1 foot and vertical point Z (top of casing) to the nearest 0.01 foot. The ground surface elevations will be surveyed to the nearest 0.01 foot for asphalt and concrete surfaces and to 0.01 foot for unpaved ground surfaces.

Investigation-derived Waste Management

IDW is expected to consist of drill cuttings from the soil borings generated during monitoring well installations, purge water from well development and groundwater sampling, excess sediment generated during sediment sampling, and decontamination fluids. Aqueous IDW and solid IDW will be stored in separate rolloff containers, portable containers, or drums. IDW will be managed in accordance with the Interim PFAS Site Guidance for NAVFAC RPMs, November 2020 Update (NAVFAC, 2020), the SOP referenced in **Worksheet #21** and included in **Appendix A** and the Environmental Protection Plan and Waste Management Plan. Efforts will be made to segregate release area IDW from that generated in downgradient areas where concentrations are likely to be lower to minimize the volume of aqueous IDW requiring treatment. Disposable equipment, including PPE, will be disposed of with normal facility trash.

Sample Shipment

Analytical samples and equipment will be shipped by FedEx. Samples will be shipped in accordance with the SOP referenced in **Worksheet #21** and included in **Appendix A**.

Demobilization

Full demobilization will occur when the project is complete, and appropriate QA/QC checks have been performed. Personnel no longer needed during the course of field operations may be demobilized before the final project completion date. The following will occur before demobilization:

- Chain-of-custody records will be reviewed to verify that all samples were collected as planned and submitted for appropriate analyses.

SAP Worksheet #14—Summary of Project Tasks (continued)

- Restoration of the site to an appropriate level (for example, repair of deep ruts from drilling equipment) will be verified by the CH2M FTL.
- All equipment will be inspected, packaged, and shipped to the appropriate location.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24** and **#25**). The laboratory will analyze samples for PFAS as shown on **Worksheets # 15** and **#18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23** and will be provided upon request.

Analyses will be conducted by Battelle as listed in **Worksheet #30**.

Data Validation, Review, and Management

Data from all samples will be validated. The PC is responsible for data tracking and storage. Definitive analytical laboratory data will be reported as a Stage 4 data package and 10 percent of the data will undergo Stage 4 validation before use by the Navy. All WQP data will be checked by the PC before use. The FTL is responsible for ensuring the WQP meter is calibrated prior to sample collection. Refer to **Worksheet #36** for more information. All analytical data will be loaded into the Naval Installation Restoration Information Solution database.

Procedures for Recording and Correcting Data

- Field data will be recorded on loose-leaf notebook paper.
- Project Assessment/Audit: **Worksheets #31** and **#32**
- Data Validation: **Worksheets #35** and **#36**
- Data Usability Assessment: **Worksheet #37**

Analytical and Validation Tasks

The analytical laboratory will process and prepare samples for analyses and will analyze all samples per **Worksheets #19** and **#23**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23**.

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. Refer to **Worksheets #24** and **#25**.
- The laboratory will process and prepare samples for analysis.
- All analytical data to be used for chemical characterization of the site, excluding IDW characterization, will be validated. Refer to **Worksheet #36** for more details.
- A data usability assessment will be performed on the SI data. Refer to **Worksheet #37** for more details.

Reporting

A summary of the field activities, results, HHRS, conclusions, and recommendations will be presented in an SI report, according to the anticipated schedule outlined in **Worksheet #16**. The focus of the SI is PFOA, PFOS, and PFBS. Data for remaining compounds will be reported in an appendix to the SI report for future use if appropriate PALs become available.

SAP Worksheet #14—Summary of Project Tasks (continued)

An HHRS will be conducted if the initial results are inconclusive and do not point to an obvious CERCLA-type release (**Figure 11-1**). The HHRS evaluation will be performed using the validated data. The HHRS, performed individually for each of the potential or confirmed PFAS release areas, will provide a preliminary indication of potential human health risks from exposure to PFAS at each of the potential or confirmed PFAS release area based on the most conservative site use scenario, future residential use. The HHRS will be limited to PFOA, PFOS, and PFBS, which are currently the only PFAS with toxicity values and human health SLs.

The HHRS will be performed separately for each of the potential or confirmed PFAS release areas using the following two step process:

- Step 1: Comparison of maximum detected concentrations to SLs.
  - Groundwater and surface water data will be compared to the SLs identified in **Worksheet #15-1**, the tap water SLs, which are based on residential potable water use.
  - Surface soil, subsurface soil, and sediment data will be compared to the SLs identified in **Worksheet #15-2**, the residential soil SLs.
  - If the maximum detected concentration in a medium (groundwater, surface water, surface soil, subsurface soil, surface sediment, or subsurface sediment) exceeds the SL, the PFAS that exceed a SL will be identified as a COPC and the HHRS will move to Step 2. If there are no exceedances of any SLs, it is assumed there would be no unacceptable human health risks associated with exposure to PFAS.
- Step 2: Calculation of risk levels for COPCs identified in Step 1.
  - For carcinogenic endpoints, carcinogenic risk will be calculated using the following equation

$$\text{Carcinogenic risk} = \frac{\text{MDC x target risk level of calculated SL}}{\text{Calculated SL}}$$

Where:

MDC = Maximum detected concentration (micrograms per kilogram [µg/kg] for soil and sediment or nanograms per liter [ng/L] for groundwater and surface water)
target risk level of calculated SL = $1\text{x}10^{-6}$ (unitless)
Calculated SL = calculated SL based on carcinogenic risk of $1\text{x}10^{-6}$ (µg/kg for soil and sediment or ng/L for groundwater and surface water)

  - For noncarcinogenic endpoints, a hazard index (HI) will be calculated using the following equation

$$\text{HI} = \frac{\text{MDC x target HI of SL}}{\underline{\text{Calculated SL}}}$$

Where:

MDC = Maximum detected concentration (µg/kg for soil and sediment or ng/L for groundwater and surface water)
target HI of calculated SL = 1 (unitless)
Calculated SL = calculated SL based on HI of 1 (µg/kg for soil and sediment or ng/L for groundwater and surface water)

SAP Worksheet #14—Summary of Project Tasks (continued)

The carcinogenic risk and noncarcinogenic HI are calculated for Step 1 COPCs that act through carcinogenic and noncarcinogenic effects. The carcinogenic risks for each chemical in a medium within an area are summed to calculate the cumulative carcinogenic risk and the HIs are summed to calculate the cumulative HI. A cumulative HI is also calculated for each target organ/effect. If the cumulative noncarcinogenic HI for a target organ/effect is greater than 0.5, or the cumulative carcinogenic risk is greater than 5×10^{-5}, the compounds contributing to these values are identified as Step 2 COPCs. A conservative benchmark (HI=0.5, cancer risk $5\text{x}10^{-5}$) is being applied as the HHRS does not sum the HIs or risks across media and therefore, will not have a cumulative site risk from soil and groundwater, if both are present. However, if sufficient data and information is available for the HHRS, it may be possible to use the CERCLA threshold levels of HI = 1 and carcinogenic risk = $1 \text{ x } 10^{-4}$. Identification (ID) of a Step 2 COPC is considered an indicator of potential unacceptable human health risk associated with PFAS.

SAP Worksheet #15-1—Reference Limits and Evaluation Table

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.3[a] Table B-15)

Matrix: Groundwater and Surface Water

Analyte	CASRN	PAL (µg/L)	PAL Reference	Laboratory-specific Limits (µg/L)			Accuracy Control Limit (%R)[b]		Precision Control Limit (% RPD)
				LOQs	LODs	DLs			
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.04	Tap Water SL HQ = 0.1[c]	0.005	0.0010	0.00044	40	144	30
Perfluorooctanoic acid (PFOA)	335-67-1	0.04	Tap Water SL HQ = 0.1[c]	0.005	0.0015	0.00051	49	141	30
Perfluorobutanesulfonic acid (PFBS)	375-73-5	0.6	Tap Water RSL HQ = 0.1[d]	0.005	0.0005	0.00014	56	134	30
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NC[e]	NC[e]	0.005	0.0010	0.00050	51	131	30
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NC[e]	NC[e]	0.005	0.0010	0.00035	50	146	30
Perfluorodecanoic acid (PFDA)	335-76-2	NC[e]	NC[e]	0.005	0.0005	0.00014	59	135	30
Perfluorododecanoic acid (PFDoA)	307-55-1	NC[e]	NC[e]	0.005	0.0005	0.00019	75	131	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	NC[e]	NC[e]	0.005	0.0010	0.00026	48	136	30
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NC[e]	NC[e]	0.005	0.0004	0.00011	52	128	30
Perfluorohexanoic acid (PFHxA)	307-24-4	NC[e]	NC[e]	0.005	0.0015	0.00053	51	137	30
Perfluorononanoic acid (PFNA)	375-95-1	NC[e]	NC[e]	0.005	0.0010	0.00031	58	122	30
Perfluorotetradecanoic acid (PFTA)	376-06-7	NC[e]	NC[e]	0.005	0.0020	0.00073	42	158	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	NC[e]	NC[e]	0.005	0.0005	0.00015	42	148	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NC[e]	NC[e]	0.005	0.0005	0.00022	64	134	30
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	NC[e]	NC[e]	0.005	0.0005	0.00025	70[f]	130[f]	30

SAP Worksheet #15-1—Reference Limits and Evaluation Table (continued)

Analyte	CASRN	PAL (µg/L)	PAL Reference	Laboratory-specific Limits (µg/L)			Accuracy Control Limit (%R)[b]		Precision Control Limit (% RPD)
				LOQs	LODs	DLs			
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NC[e]	NC[e]	0.005	0.0010	0.00027	70[f]	130[f]	30
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NC[e]	NC[e]	0.005	0.0005	0.00023	70[f]	130[f]	30
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NC[e]	NC[e]	0.005	0.0010	0.00027	70[f]	130[f]	30

[a] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

[b] DoD QSM v5.3 is the basis for laboratory control sample and matrix spike (MS)/matrix spike duplicate (MSD) limits.

[c] The PAL is the Tap Water SL based on an HQ of 0.1 and was generated using the USEPA RSL calculator as described in DoD, 2021.

[d] The PAL is the Tap Water RSL based on an HQ of 0.1 presented in the November 2021 RSL Table (USEPA, 2021).

[e] NC: No Criteria (no SL for this compound)

[f] DoD QSM v5.3 does not provide limits for this compound. In-house limits used.

µg/L = micrograms per liter

CASRN = Chemical Abstracts Service Registry Number

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Analytical Group: PFAS (LC-MS/MS Compliant with QSM v5.3[a] Table B-15)

Matrix: Surface Soil, Subsurface Soil, and Sediment

Analyte	CASRN	PAL (µg/kg)	PAL Reference	Laboratory-specific Limits (µg/kg)			Accuracy Control Limit (%R)[b]		Precision Control Limit (% RPD)
				LOQs	LODs	DLs			
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	130	Residential Soil SL HQ = 0.1[c]	5.0	2.0	0.69	40	144	30
Perfluorooctanoic acid (PFOA)	335-67-1	130	Residential Soil SL HQ = 0.1[c]	5.0	2.0	0.61	49	141	30
Perfluorobutanesulfonic acid (PFBS)	375-73-5	1,900	Residential Soil RSL HQ = 0.1[d]	5.0	1.0	0.35	56	134	30
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NC[e]	NC[e]	5.0	2.0	0.75	51	131	30
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NC[e]	NC[e]	5.0	2.5	1.02	50	146	30
Perfluorodecanoic acid (PFDA)	335-76-2	NC[e]	NC[e]	5.0	1.0	0.46	59	135	30
Perfluorododecanoic acid (PFDoA)	307-55-1	NC[e]	NC[e]	5.0	2.0	0.61	75	131	30
Perfluoroheptanoic acid (PFHpA)	375-85-9	NC[e]	NC[e]	5.0	1.5	0.51	48	136	30
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NC[e]	NC[e]	5.0	2.0	0.81	52	128	30
Perfluorohexanoic acid (PFHxA)	307-24-4	NC[e]	NC[e]	5.0	2.0	0.71	51	137	30
Perfluorononanoic acid (PFNA)	375-95-1	NC[e]	NC[e]	5.0	1.0	0.49	58	122	30
Perfluorotetradecanoic acid (PFTA)	376-06-7	NC[e]	NC[e]	5.0	2.5	1.08	42	158	30
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	NC[e]	NC[e]	5.0	1.0	0.28	42	148	30
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NC[e]	NC[e]	5.0	1.0	0.46	64	134	30
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	NC[e]	NC[e]	5.0	2.0	0.64	70[f]	130[f]	30

SAP Worksheet #15-2—Reference Limits and Evaluation Table (continued)

Analyte	**CASRN**	**PAL (µg/kg)**	**PAL Reference**	**Laboratory-specific Limits (µg/kg)**			**Accuracy Control Limit (%R)[b]**		**Precision Control Limit (% RPD)**
				LOQs	**LODs**	**DLs**			
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	NC[e]	NC[e]	5.0	2.0	0.83	70[f]	130[f]	30
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	NC[e]	NC[e]	5.0	1.5	0.52	70[f]	130[f]	30
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	756426-58-1	NC[e]	NC[e]	5.0	1.0	0.48	70[f]	130[f]	30

[a] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

[b] DoD QSM v5.3 is the basis for laboratory control sample and MS/MSD limits.

[c] The PAL is the residential soil SL based on an HQ of 0.1 and was generated using the USEPA RSL calculator as described in DoD, 2021.

[d] The PAL is the residential soil RSL based on an HQ of 0.1 presented in the November 2021 RSL Table (USEPA, 2021).

[e] NC: No Criteria (no SL for this compound)

[f] DoD QSM v5.3 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-3—Reference Limits and Evaluation Table

Analytical Group: WCHEM (SW-846 9060A[a])

Matrix: Sediment

Units are milligrams per kilogram (unless otherwise specified).

Analyte	CASRN[b]	Laboratory-specific Limits			Accuracy Control Limit (%R)		Precision Control Limit (% RPD)
		LOQ	LOD	DL			
TOC	TOC	250	200	153	69	128	25

[a] The Laboratory SOP is the basis for laboratory control sample and MS/MSD limits.

[b] This value is contractor-specific.

SAP Worksheet #15-4—Reference Limits and Evaluation Table

Analytical Group: GRAINSIZE
Matrix: Sediment

Analyte[a]	CASRN[b]	Report Units[c]
GS09 Sieve 0.5" (12.5 mm)	SIEVE12.5	PCT_P
GS10 Sieve 0.375" (9.5 mm)	SIEVE9.5	PCT_P
Sieve No. 004 (4.75 mm)	SIEVE4.75	PCT_P
Sieve No. 010 (2.00 mm)	SIEVE2.0	PCT_P
Sieve No. 020 (850 µm)	SIEVE850	PCT_P
Sieve No. 040 (425 µm)	SIEVE425	PCT_P
Sieve No. 060 (250 µm)	SIEVE250	PCT_P
Sieve No. 100 (150 µm)	SIEVE150	PCT_P
Sieve No. 200 (75 µm)	SIEVE75	PCT_P
Gravel (%)	GRAVEL	PCT_P
Sand (%)	14808-60-7	PCT_P
Coarse sand (%)	COARSESAND	PCT_P
Medium sand (%)	MEDIUMSAND	PCT_P
Fine sand (%)	FINESAND	PCT_P
Fines (%)	FINES	PCT_P

[a] This is a typical sieve set. A similar sieve set is also acceptable.
- Sieve No. 010 marks the gravel to coarse sand line.
- Sieve No. 030 (interpolated) marks the coarse sand to medium sand line.
- Sieve No. 040 marks the medium sand to fine sand line.
- Sieve No. 200 marks the fine sand to silt line.
- Sand (%) is the sum percentage of coarse sand, medium sand, and fine sand.
- Fines (%) is that which is not retained by Sieve No. 200; typically, this is the sum of silt and clay.

[b] Some numbers are contractor-specific.

[c] PCT_P: Percent Passing

µm = micrometer
mm = millimeters

SAP Worksheet #16—Project Schedule/Timeline Table

Activities	**Organization**	**Dates (Month/Year)**		**Deliverable**
		Anticipated Date(s) of Initiation	**Anticipated Date of Completion**	
SAP Schedule				
Navy RPM and technical support review and comment resolution	NAVFAC Northwest, NAVFAC Atlantic/CH2M	November 2021	December 2021	Comments/response to comments
Navy QAO review and comment resolution	NAVFAC Atlantic/CH2M	December 2021	February 2022	Comments/response to comments
Stakeholder review and comment resolution	USEPA, Ecology, and Suquamish Tribe/CH2M	April 2022	June 2022	Comments/response to comments/redlined Draft Final SAP
Final SAP	CH2M	June 2022	July 2022	Final SAP
Fieldwork Schedule				
Fieldwork preparation, subcontracting	CH2M	September 2021	July 2022	N/A
Fieldwork	CH2M, drilling subcontractor	August 2022	September 2022	N/A
Data management	CH2M	August 2022	November 2022	N/A
Data analysis	Battelle PGC ALS-Kelso	August 2022	October 2022	Electronic data deliverables (EDDs) and data hard copies
Data validation	EDS	October 2022	October 2022	Data validation reports
Reporting Schedule				
Reporting	CH2M	October 2022	September 2023	Draft and final SI reports

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SAP Worksheet #17—Sampling Design and Rationale

Groundwater, soil, surface water, and sediment samples will be collected as detailed in **Table 17-1**. PFAS are generally water-soluble and relatively mobile through soils to groundwater. Therefore, if a historical release occurred at a terrestrial potential or confirmed PFAS release area, it is likely to be detected within groundwater at the release area and/or downgradient of the release area. Groundwater and soil sample locations are based on this rationale and access considerations. The samples will be analyzed for PFAS by LC-MS/MS compliant with QSM v5.3 Table B-15 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
Former Navy FTA	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-5**.	Co-located groundwater and soil samples will be collected from three locations near potential release location(s) within the current Navy-owned portion of the Former Navy FTA or downgradient of potential releases on NOAA-owned property. The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions, the depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. One additional surface soil sample will be collected on the eastern side of the site to evaluate a potential release directly to unpaved soil present in that area of the site.
	Soil	Surface (0 to 1 foot bgs)	4		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
Former Fire Station and Spill Response Warehouse (Building 85)	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-6**.	Co-located groundwater and soil samples will be collected from one location (MW03) adjacent to a suspected release location (the driveway on the north side of the building) and two locations downgradient of potential release locations along assumed surface or groundwater flow paths. Locations were selected with consideration of considerable underground utilities in the area and significant ongoing construction projects south and southeast of the building. The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions, the depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist.
	Soil	Surface (0 to 1 foot bgs)	3		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
Test Spray Areas (ASTs 145 to 149)	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	5	Refer to **Figure 10-8**.	Co-located groundwater and soil samples will be collected from five locations as close as possible to the release locations (MW01, MW04, and MW05) or downgradient of the release locations along assumed surface or groundwater flow paths and migration of stormwater through the OWS (MW02 and MW03). The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions, the depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. Two additional surface soil samples will be collected near the inlet to Franco Pond to evaluate potential overland migration to the soil in the area. One additional surface soil sample will be collected downgradient of proposed monitoring well MW01 to evaluate potential overland migration to the soil in the area.
	Soil	Surface (0 to 1 foot bgs)	8		
		Subsurface (top of the capillary fringe in the unsaturated soil)	10		
JP-8 Truck Loading Facility (Building 185)	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-9**.	Co-located groundwater and soil samples will be collected from three locations near the suspected release location(s) or downgradient of the release locations, along assumed surface water or groundwater flow paths. The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions, the depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist.
	Soil	Surface (0 to 1 foot bgs)	3		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
Fuel Pier	Surface Water	Directly below the water surface	3	Refer to **Figure 10-10**.	Sediment samples will be collected in three transects along the length of the former and current piers: one to the west of the former pier, one between the former and current piers, and one to the east of the current pier. Sediment samples will be collected from three locations along each of the transects; one of the samples in each of the transects will be collected in the intertidal zone. Surface and subsurface sediment samples will be collected at each location; the surface sediment samples will be collected from 0 to 4 inches below sediment surface based on the biologically active zone defined in Ecology's SCUM guidance (Ecology, 2019b). A surface water sample will be collected at one of the sediment locations along each of the transects. Three of the sediment samples will be analyzed for TOC and grain size, in addition to PFAS in order to support future potential ecological risk evaluation.
	Sediment	0 to 4 inches below sediment surface (bss)	9		
		4 to 24 inches bss	9		
PCB Disposal Area (Site 302)	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-11**.	Co-located groundwater and soil samples will be collected from three locations near the suspected release location or downgradient of the release location, along assumed surface water or groundwater flow paths. The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions, the depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. Two additional surface soil samples will be collected on the eastern side of the area to evaluate potential overland migration in the area.
	Soil	Surface (0 to 1 foot bgs)	5		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
Fuel Pump House (Building 12)	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-7**.	Co-located groundwater and soil samples will be collected from three locations near the suspected release location(s) or downgradient of the release location, along assumed surface water or groundwater flow paths. Locations were selected with consideration of considerable underground utilities near the building. The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions that depth could range from 30 to 75 feet bgs. The current monitoring wells installed at the site are too shallow to provide this information, which is critical to identifying potential PFAS migration pathways from site sources to nearby downgradient surface water receptors. Soil samples will be collected from two depths (the surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. One additional surface soil sample will be collected in the unpaved area east of the building to evaluate potential overland migration to the area.
	Soil	Surface (0 to 1 foot bgs)	4		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #17—Sampling Design and Rationale (continued)

Table 17-1. Sampling Design and Rationale

Area Name	Matrix	Sample Depth	Number of Samples	Sampling Locations	Rationale
VWR	Groundwater	Mid-screen (will be determined at the time of well construction based on lithology)	3	Refer to **Figure 10-12**.	Co-located groundwater and soil samples will be collected from three locations near the suspected release location(s). The monitoring wells will be installed at the depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer; depending on the site-specific conditions that depth could range from 30 to 75 feet bgs. Soil samples will be collected from two depths (surface and top of the capillary fringe in the unsaturated soil) within each monitoring well boring. In addition to the soil samples collected at the surface and above the capillary fringe, a soil sample will be collected from each 50-foot vertical interval (with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist. Two additional surface soil samples will be collected where overspray from washing vehicles may have occurred.
	Soil	Surface (0 to 1 foot bgs)	5		
		Subsurface (top of the capillary fringe in the unsaturated soil)	6		

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
Former Navy FTA						
MFD-FTA-MW01	MFD-FTA-GW01-MMYY	Groundwater	TBD	PFAS	2 (FD)	Refer to **Worksheet #21**.
	MFD-FTA-GW01P-MMYY					
	MFD-FTA-SS01-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-FTA-SB01-TDBD	Subsurface Soil	TBD	PFAS	2 (FD)	
	MFD-FTA-SB01P-TDBD					
	MFD-FTA-SB01-TDBD				1	
MFD-FTA-MW02	MFD-FTA-GW02-MMYY	Groundwater	TBD	PFAS	3 (MS/MSD)	
	MFD-FTA-GW02-MMYY-MS					
	MFD-FTA-GW02-MMYY-MSD					
	MFD-FTA-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-FTA-SB02-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-FTA-SB02-TDBD				1	
MFD-FTA-MW03	MFD-FTA-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-FTA-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-FTA-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-FTA-SB03-TDBD				1	
MFD-FTA-SS04	MFD-FTA-SS04-0001	Surface Soil	0 to 1 foot	PFAS	1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	**Sample ID**[a]	**Matrix**	**Depth (inches or feet bgs/bss)**[b]	**Analytical Group**	**Number of Samples (identify field duplicates)**	**Sampling SOP Reference**
Former Fire Station and Spill Response Warehouse (Building 85)						
MFD-B85-MW01	MFD-B85-GW01-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-B85-SS01-0001	Surface Soil	0 to 1 foot	PFAS	2 (FD)	
	MFD-B85-SS01P-0001					
	MFD-B85-SB01-TDBD	Subsurface Soil	TBD	PFAS	2 (FD)	
	MFD-B85-SB01P-TDBD					
	MFD-B85-SB01-TDBD				1	
MFD-B85-MW02	MFD-B85-GW02-MMYY	Groundwater	TBD	PFAS	1	
	MFD-B85-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B85-SB02-TDBD	Subsurface Soil	TBD	PFAS	3 (MS/MSD)	
	MFD-B85-SB02-TDBD-MS					
	MFD-B85-SB02-TDBD-MSD					
	MFD-B85-SB02-TDBD				1	
MFD-B85-MW03	MFD-B85-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-B85-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B85-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B85-SB03-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	**Sample ID[a]**	**Matrix**	**Depth (inches or feet bgs/bss)[b]**	**Analytical Group**	**Number of Samples (identify field duplicates)**	**Sampling SOP Reference**
Test Spray Areas (ASTs 145 to 149)						
MFD-AST-MW01	MFD-AST-GW01-MMYY	Groundwater	TBD	PFAS	2 (FD)	Refer to **Worksheet #21**.
	MFD-AST-GW01P-MMYY					
	MFD-AST-SS01-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-AST-SB01-TDBD	Subsurface Soil	TBD	PFAS	2 (FD)	
	MFD-AST-SB01P-TDBD					
	MFD-AST-SB01-TDBD				1	
MFD-AST-MW02	MFD-AST-GW02-MMYY	Groundwater	TBD	PFAS	1	
	MFD-AST-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-AST-SB02-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-AST-SB02-TDBD				1	
MFD-AST-MW03	MFD-AST-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-AST-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-AST-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-AST-SB03-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-AST-MW04	MFD-AST-GW04-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-AST-SS04-0001	Surface Soil	0 to 1 foot	PFAS	2 (FD)	
	MFD-AST-SS04P-0001					
	MFD-AST-SB04-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-AST-SB04-TDBD				1	
MFD-AST-MW05	MFD-AST-GW05-MMYY	Groundwater	TBD	PFAS	1	
	MFD-AST-SS05-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-AST-SB05-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-AST-SB05-TDBD				1	
MFD-AST-SS06	MFD-AST-SS06-0001	Surface Soil	0 to 1 foot	PFAS	1	
MFD-AST-SS07	MFD-AST-SS07-0001	Surface Soil	0 to 1 foot	PFAS	1	
MFD-AST-SS08	MFD-AST-SS08-0001	Surface Soil	0 to 1 foot	PFAS	1	
JP-8 Truck Loading Facility (Building 185)						
MFD-B185-MW01	MFD-B185-GW01-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-B185-SS01-0001	Surface Soil	0 to 1 foot	PFAS	3 (MS/MSD)	
	MFD-B185-SS01-0001-MS					
	MFD-B185-SS01-0001-MSD					
	MFD-B185-SB01-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B185-SB01-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-B185-MW02	MFD-B185-GW02-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-B185-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B185-SB02-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B185-SB02-TDBD				1	
MFD-B185-MW03	MFD-B185-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-B185-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B185-SB03-TDBD	Subsurface Soil	TBD	PFAS	2 (FD)	
	MFD-B185-SB03P-TDBD					
	MFD-B185-SB03-TDBD				1	
Fuel Pier						
MFD-FP-SWSD01	MFD-FP-SW01-MMYY	Surface Water	--	PFAS	4 (FD/MS/MSD)	Refer to **Worksheet #21**.
	MFD-FP-SW01P-MMYY					
	MFD-FP-SW01-MMYY-MS					
	MFD-FP-SW01-MMYY-MSD					
	MFD-PF-SD01-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD01-0424	Sediment	4 to 24 inches	PFAS	1	
				WCHEM (TOC)	1	
				GRAINSIZE	1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-FP-SWSD02	MFD-FP-SW02-MMYY	Surface Water	--	PFAS	1	Refer to **Worksheet #21**.
	MFD-PF-SD02-0004	Sediment	0 to 4 inches	PFAS	2 (FD)	
	MFD-PF-SD02P-0004					
	MFD-PF-SD02-0424	Sediment	4 to 24 inches	PFAS	1	
MFD-FP-SWSD03	MFD-FP-SW03-MMYY	Surface Water	--	PFAS	1	
	MFD-PF-SD03-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD03-0424	Sediment	4 to 24 inches	PFAS	3 (MS/MSD)	
	MFD-PF-SD03-0424-MS					
	MFD-PF-SD03-0424-MSD					
MFD-FP-SD04	MFD-PF-SD04-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD04-0424	Sediment	4 to 24 inches	PFAS	1	
MFD-FP-SD05	MFD-PF-SD05-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD05-0424	Sediment	4 to 24 inches	PFAS	1	
				WCHEM (TOC)	1	
				GRAINSIZE	1	
MFD-FP-SD06	MFD-PF-SD06-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD06-0424	Sediment	4 to 24 inches	PFAS	1	
MFD-FP-SD07	MFD-PF-SD07-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD07-0424	Sediment	4 to 24 inches	PFAS	1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-FP-SD08	MFD-PF-SD08-0004	Sediment	0 to 4 inches	PFAS	1	Refer to **Worksheet #21**.
	MFD-PF-SD08-0424	Sediment	4 to 24 inches	PFAS	2 (FD)	
	MFD-PF-SD08P-0424					
MFD-FP-SD09	MFD-PF-SD09-0004	Sediment	0 to 4 inches	PFAS	1	
	MFD-PF-SD09-0424	Sediment	4 to 24 inches	PFAS	1	
				WCHEM (TOC)	1	
				GRAINSIZE	1	
PCB Disposal Area (Site 302)						
MFD-S302-MW01	MFD-S302-GW01-MMYY	Groundwater	TBD	PFAS	2 (FD)	Refer to **Worksheet #21**.
	MFD-S302-GW01P-MMYY					
	MFD-S302-SS01-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-S302-SB01-TDBD	Subsurface Soil	TBD	PFAS	3 (MS/MSD)	
	MFD-S302-SB01-TDBD-MS					
	MFD-S302-SB01-TDBD-MSD					
	MFD-S302-SB01-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	**Sample ID**[a]	**Matrix**	**Depth (inches or feet bgs/bss)**[b]	**Analytical Group**	**Number of Samples (identify field duplicates)**	**Sampling SOP Reference**
MFD-S302-MW02	MFD-S302-GW02-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-S302-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-S302-SB02-TDBD	Subsurface Soil	TBD	PFAS	2 (FD)	
	MFD-S302-SB02P-TDBD					
	MFD-S302-SB02-TDBD				1	
MFD-S302-MW03	MFD-S302-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-S302-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-S302-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-S302-SB03-TDBD				1	
MFD-S302-SS04	MFD-S302-SS04-0001	Surface Soil	0 to 1 foot	PFAS	1	
MFD-S302-SS05	MFD-S302-SS05-0001	Surface Soil	0 to 1 foot	PFAS	2 (FD)	
	MFD-S302-SS05P-0001	Surface Soil	0 to 1 foot	PFAS		
Fuel Pump House (Building 12)						
MFD-B12-MW01	MFD-B12-GW01-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-B12-SS01-0001	Surface Soil	0 to 1 foot	PFAS	3 (MS/MSD)	
	MFD-B12-SS01-0001-MS					
	MFD-B12-SS01-0001-MSD					
	MFD-B12-SB01-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B12-SB01-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-B12-MW02	MFD-B12-GW02-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-B12-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B12-SB02-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B12-SB02-TDBD				1	
MFD-B12-MW03	MFD-B12-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-B12-SS03-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-B12-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-B12-SB03-TDBD				1	
MFD-B12-SS04	MFD-B12-SS04-0001	Surface Soil	0 to 1 foot	PFAS	1	
VWR						
MFD-VWR-MW01	MFD-VWR-GW01-MMYY	Groundwater	TBD	PFAS	3 (MS/MSD)	Refer to **Worksheet #21**.
	MFD-VWR-GW01-MMYY-MS					
	MFD-VWR-GW01-MMYY-MSD					
	MFD-VWR-SS01-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-VWR-SB01-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-VWR-SB01-TDBD				1	

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location	Sample ID[a]	Matrix	Depth (inches or feet bgs/bss)[b]	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
MFD-VWR-MW02	MFD-VWR-GW02-MMYY	Groundwater	TBD	PFAS	1	Refer to **Worksheet #21**.
	MFD-VWR-SS02-0001	Surface Soil	0 to 1 foot	PFAS	1	
	MFD-VWR-SB02-TDBD	Subsurface Soil	TBD	PFAS	3 (MS/MSD)	
	MFD-VWR-SB02-TDBD-MS					
	MFD-VWR-SB02-TDBD-MSD					
	MFD-VWR-SB02-TDBD				1	
MFD-VWR-MW03	MFD-VWR-GW03-MMYY	Groundwater	TBD	PFAS	1	
	MFD-VWR-SS03-0001	Surface Soil	0 to 1 foot	PFAS	2 (FD)	
	MFD-VWR-SS03P-0001					
	MFD-VWR-SB03-TDBD	Subsurface Soil	TBD	PFAS	1	
	MFD-VWR-SB03-TDBD				1	
MFD-VWR-SS04	MFD-VWR-SS04-0001	Surface Soil	0 to 1 foot	PFAS	1	
MFD-VWR-SS05	MFD-VWR-SS05-0001	Surface Soil	0 to 1 foot	PFAS	1	

[a] Top depth and bottom depth (TDBD) of the sampled interval.

[b] Groundwater samples will be collected at a depth where groundwater is first encountered and the aquifer has sufficient permeability and vertical extent to be considered a significant aquifer. At each monitoring well installation location, a subsurface soil sample will be collected at the top of the capillary fringe in the unsaturated soil. Additionally, a subsurface soil sample will be collected from each 50-foot vertical interval (starting with the 50 to 100-foot interval) with the sample collected at the surface accounting for the sample collected within the first 50-foot interval). These additional subsurface soil samples will be targeted towards zones with a higher moisture content, organic content, or lithologic change, at the discretion of the field geologist.

FD = field duplicate

SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference[a]	Containers (number, size, and type)	Sample Volume[b] (units)	Preservation Requirements (chemical, temperature, light-protected)	Maximum Holding Time[c] (preparation/analysis)
Groundwater Surface Water	PFAS	LC-MS/MS compliant with QSM v5.3[d] Table B-15/SOP 5-370-11, SOP 5-369-08	Two of 250 mL HDPE	250 mL	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen	14 days, 28 days
Surface Soil Subsurface Soil Sediment	PFAS	LC-MS/MS compliant with QSM v5.3[d] Table B-15/SOP 5-370-11, SOP 5-369-08	One of 8 oz HDPE jar	30 g	≤ 10°C at laboratory receipt, storage in the laboratory ≤ 6°C, but not frozen	14 days, 28 days
Sediment	WCHEM (TOC)	SW-846 9060A/ENV-SOP-BTRO-0044	One of 4 oz amber glass	20 g	Cool to 0 to 6°C	As soon as possible
	GRAINSIZE	ASTM D 422M/SOIL-PSP	16-oz glass or poly	100 to 150 g	N/A	N/A

[a] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

[b] Provide the minimum sample volume or mass requirement if it differs from the container volume.

[c] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

[d] QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling.

g = grams
ML = milliliters
Oz = ounces

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSDs[a]	Number of Field Blanks[a]	Number of Equipment Blanks[a]	Total Number of Samples to Laboratory
Groundwater	PFAS	23	3	2/2	7	7	44
Surface Soil	PFAS	32	4	2/2	7	7	54
Subsurface Soil	PFAS	46	5	3/3	0	7	64
Surface Water	PFAS	3	1	1/1	1	1	8
Sediment	PFAS	18	2	1/1	1	4	27
	WCHEM (TOC)	3	0	0	0	0	3
	GRAINSIZE	3	0	0	0	0	3

[a] The number of field QC samples to be collected is dependent on the number of parent samples and the number of days of the sampling event. Field QC will be sampled at the frequency specified on **Worksheet #12** and summarized as follows:

- Field duplicates are collected at a frequency of 1 per 10 field samples per matrix.
- MS/MSD pairs are collected at a frequency of 1 per 20 samples per matrix sent to the laboratory (including duplicates).
- Equipment blanks for decontaminated equipment are collected once per day of sampling, per type of equipment. Equipment Blanks for disposable equipment are collected once per lot.
- Field blanks will be collected one per investigation area per matrix.

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number (CH2M/NAVFAC Northwest)	Title, Revision Date and/or Number (CH2M/NAVFAC Northwest)	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-001/NA	Chain-of-Custody, revised (rev.) 02/2021	CH2M	Chain-of-custody form	No	None
SOP-002/NA	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using a WQP meter with Flow-through Cell, rev 02/2021	CH2M	Water quality meter with flow-through cell	No	None
SOP-003/I-D-05	Water-Level Measurements, rev. 02/2021 Water Level Measurements, rev. 03/2015	CH2M NAVFAC Northwest	Water-level meter	No	No Teflon components
SOP-004/NA	Equipment Blank and Field Blank Preparation, rev. 02/2021	CH2M	Laboratory-provided blank liquid and sample bottles	No	None
SOP-005/NA	Groundwater Sampling for Per- and Polyfluoroalkyl Substances, rev. 01/2021	CH2M	Teflon-free tubing, Teflon-free bailer (if using bailer), PFAS-free pump, sample bottles HDPE bottle with HDPE screw cap), laboratory pre-filled HDPE bottles containing field reagent blank water and Trizma preservative, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	No	No Teflon components, PFAS-free shipping materials

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number (CH2M/NAVFAC Northwest)	Title, Revision Date and/or Number (CH2M/NAVFAC Northwest)	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-006/NA	Soil Sampling for Per- and Polyfluoroalkyl Substances, rev. 01/2021	CH2M	Sample jars (HDPE bottle with HDPE screw cap and Trizma preservative), laboratory pre-filled HDPE bottles containing field reagent blank water and Trizma preservative, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves	No	No Teflon components, PFAS-free shipping materials
SOP-007/NA	Homogenization of Soil and Sediment Samples, rev. 02/2021	CH2M	Teflon-free equipment	No	None
SOP-008/NA	Packaging and Shipping Procedures for Low Concentration Samples, rev. 02/2021	CH2M	Plastic bags, ice, tape	No	No Teflon supplies
SOP-009/NA	Decontamination of Personnel and Equipment, rev. 0/2021	CH2M	For cleaning reusable equipment	No	None
SOP-010/NA	Disposal of Waste Fluids and Solids, rev. 02/2021	CH2M	Drum, tank, rolloff	No	None
SOP-011/NA	Management of Liquid Waste containing Per- and Polyfluoroalkyl Substances, rev. 01/2021	CH2M	Drum, tank, HDPE sample bottles	No	No Teflon components, PFAS-free shipping materials
SOP-012/NA	Sampling Contents of Tanks and Drums, rev. 02/2021	CH2M	HDPE sample bottles	No	No Teflon components, PFAS-free shipping materials

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number (CH2M/NAVFAC Northwest)	Title, Revision Date and/or Number (CH2M/NAVFAC Northwest)	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-013/NA	Locating and Clearing Underground Utilities, rev. 02/2021	CH2M	None	No	None
SOP-014/NA	General Guidance for Monitoring Well Installation, rev. 02/2021	CH2M	Drill rig	No	Sampling rods and retractable stainless-steel without Teflon components. Polyethylene sampling tubing (not Teflon-lined) and stainless-steel foot valve. Biolube is acceptable substitute to drilling lube containing polytetrafluoroethylene or fluorine-containing substance.
SOP-015/NA	Installation of Monitoring Wells by Sonic Drilling, rev. 02/2021	CH2M	Sonic drill rig, well materials	No	
SOP-016/NA	Decontamination of Drilling Rigs and Equipment, rev 02/2021	CH2M	Drill rig	No	
SOP-017/NA	Civil Surveying, rev. 02/2021	CH2M	Surveying equipment	No	None
SOP-018/NA	Global Positioning System, rev. 2/2021	CH2M	Hand-held Global Positioning System (GPS) unit	No	None
SOP-019/NA	Sediment Sampling for Per- and Polyfluoroalkyl Substances, rev. 01/2021	CH2M	Sample collection device (hand corer, scoop, dredge, grab sampler), stainless-steel spoon or spatula or fluorine free plastic disposable scoop, sample jars (HDPE with HDPE screw cap), laboratory prepare deionized laboratory-certified PFAS-free water for field blank, measuring tape, GPS unit, PFAS-free labels, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves, material for classifying soils	No	No Teflon components, PFAS-free shipping materials

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number (CH2M/NAVFAC Northwest)	Title, Revision Date and/or Number (CH2M/NAVFAC Northwest)	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-020/NA	Surface Water Sampling for Per- and Polyfluoroalkyl Substances, rev. 01/2021	CH2M	Open tube sampler, dip sampler, weighted bottle sampler, hand pump without Teflon components, Van Dorn sampler, depth-integrating sampler, peristaltic pump and PFAS-free tubing, sample containers (HDPE with HDPE screw cap), PFAS-free labels, loose leaf paper without waterproof coating, clip board, pen (not Sharpie), nitrile or latex gloves, material for classifying soils	No	No Teflon components, PFAS-free shipping materials
SOP-021/NA	Preparing Field Log Books, rev. 02/2021	CH2M	Log book	No	None
SOP-022/NA	Soil Boring Drilling and Abandonment, rev. 09/2021	CH2M	Drill rig and equipment, cement, bentonite	No	None
SOP-023/NA	Logging of Soil Borings, rev. 09/2021	CH2M	Tape measure or ruler, grain size chart, hand lens, USCS index charts, Munsell chart, spatula, log book/sheets, pens	No	None
SOP-024/NA	Shallow Soil Sampling, rev. 02/2021	CH2M	Sample jars, hand auger, spatula/scoop, pin flags or unpainted wooden stakes, GPS unit	No	None
SOP-025/NA	Soil Sampling	CH2M	Trowel or scoop, hand auger, soil boring samplers, drill rig, stainless-steel pan/bowl or disposable sealable bags, sample bottles	No	None
SOP-026/NA	Sediment Sampling	CH2M	Core tubes, core tube end caps, “egg shell” core catchers, stainless-steel spoon or spatula or plastic disposable scoop, measuring tape, log book, materials for classifying soils, sample jars	No	None

SAP Worksheet #21—Project Sampling SOP References Table (continued)

Reference Number (CH2M/NAVFAC Northwest)	Title, Revision Date and/or Number (CH2M/NAVFAC Northwest)	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
SOP-027/NA	Vibracore Sediment Sampling	CH2M	Fathometer and bar gauge or equivalent, vibratory core barrel, core cutter and sample retainer assemblers, core cutting and sample processing equipment, tape measure, sample bottles, log book	No	None
SOP-028/NA	Surface Water Grab Sampling	CH2M	Peristaltic pump, PFAS-free tubing, sample bottles, water quality meter	No	None

NA – not applicable

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SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity[a]	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[b]	Comments
Water quality meter[c]	Calibrate probe using Auto-calibration Standard Solution	Daily and as needed	pH reads 4.0 +/- 3% Conductivity reads 4.49 +/- 3% Turbidity reads 0 +/- 3% DO and temperatures probes consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP-002	**Appendix A**
Turbidimeter	Calibrate probe using Auto-calibration Standard Solution	Daily and as needed	Parameter specific per model/instruction manual	Contact manufacturer technical support for calibration errors.	FTL	SOP-002	**Appendix A**
Hand-held GPS unit	Self-calibration	When unit is turned on	The unit antenna will receive signal from satellites (a minimum of three satellites is necessary for signal and data collection/operation)	Contact manufacturer technical support for calibration errors.	FTL	SOP-019	**Appendix A**

[a] Activities may include calibration, verification, testing, and maintenance.

[b] Reference number from the Project Sampling SOP References table (**Worksheet #21**).

[c] It is assumed that a Horiba multi-probe meter will be used; however, if a different water quality meter is used, calibration and maintenance will be complete per the model and instruction manual.

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Revisited, if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work? (Yes/No)
5-369-08	PFAS Analytical; October 2019; Revision 8	June 2021	Definitive	Groundwater, surface soil, subsurface soil, sediment, surface water/PFAS	LC-MS/MS	Battelle	None	No
5-370-12	PFAS Sample Preparation; April 2021; Revision 12	N/A	Definitive	Groundwater, surface soil, subsurface soil, sediment, surface water/PFAS	N/A	Battelle	None	No
6-010-19	Sample Receipt, Custody, and Handling; October 2018; Revision 19	December 2020	N/A	N/A	N/A	Battelle	None	No
5-114-11	The Storage and Disposal of Regulated and Non-Regulated Waste; February 2021; Revision 11	N/A	N/A	N/A	N/A	Battelle	None	No
SOIL-PSP	Particle Size Determination, Revision 11, 11/18/2020	January 2021	Screening	Sediment/ Grain size	Analytical Balance	ALS-Kelso	None	No
SMO-DISP	Sample Disposal, Revision 16, 10/19/2021	N/A	N/A	N/A	N/A	ALS-Kelso	None	No
SMO-GEN	Sample Receiving, Revision 39, 10/19/2021	N/A	N/A	N/A	N/A	ALS-Kelso	None	No
ENV-SOP-BTRO-0017	Waste Collection, Storage, and Disposal, Revision 02, 03/10/21	N/A	N/A	N/A	N/A	PGC	None	No

SAP Worksheet #23—Analytical SOP References Table (continued)

Lab SOP Number	Title, Revision Date, and/or Number	Date Last Revisited, if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM	Modified for Project Work? (Yes/No)
ENV-SOP-BTRO-0044	Total Organic Carbon (TOC) in Soil, Revision 02, 09/30/21	N/A	Screening	Sediment/ WCHEM	TOC Analyzer	PGC	None	No
ENV-SOP-BTRO-0118	Sample Receiving and LIMS Log-In, Revision 30, 03/24/21	N/A	N/A	N/A	N/A	PGC	None	No
ENV-SOP-BTRO-0119	Sample Chain of Custody and Sample Integrity, Revision 01, 03/24/21	N/A	NA	NA	NA	PGC	None	No

SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument[a]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA[b]	SOP Reference[c]
LC-MS/MS (for PFAS)	Initial Calibration (ICAL)	At instrument setup and after ICV or CCV failure, prior to sample analysis. Calibration can be linear (minimum of 5 standards) or quadratic (minimum of 6 standards); weighting is allowed.	The isotopically labeled analog of an analyte [Extracted Internal Standard Analyte (EIS)] must be used for quantitation if commercially available (Isotope Dilution Quantitation). Commercial PFAS standards available as salts are acceptable providing the measured mass is corrected to the neutral acid concentration. Results shall be reported as the neutral acid with appropriate CASRN. If a labeled analog is not commercially available, the EIS analyte with the closest retention time to the analyte must be used for quantitation. (Internal Standard Quantitation) Analytes must be within 70 to 130 percent of their true value for each calibration standard. ICAL must meet one of the following two options: Option 1: The relative standard deviation (RSD) of the response factors for all analytes must be ≤ 20 percent. Option 2: Linear or nonlinear calibrations must have $r^2 \geq 0.99$ for each analyte. Isotope Dilution is required for all analytes. External Calibration is not allowed for any analyte.	Correct problem then repeat ICAL. Flagging is not appropriate. Samples shall not be analyzed until ICAL has passed.	Analyst	5-369-08
	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	Analyte concentrations must be within ±30 percent of their true value. Samples shall not be analyzed until calibration has been verified.	Correct problem, rerun ICV. If problem persists, repeat ICAL. Flagging is not appropriate.		
	Continuing Calibration Verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analytical sequence.	Concentration of analytes must range from the LOQ to the mid-level calibration concentration. Analyte concentrations must be within ±30 percent of their true value. Instrument sensitivity check (ISC) can serve as a bracketing CCV.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform CA(s) and repeat CCV and all associated samples since last successful CCV. Alternatively, recalibrate if necessary; then reanalyze all associated samples since last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Results may not be reported without valid CCVs.		
	Tune Check	When the masses fall outside of the ±0.5 atomic mass unit (amu) of the true value (as determined by the product ion formulas).	Mass assignments of tuning standard within 0.5 amu of true value.	Retune instrument and verify. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate. Samples shall not be analyzed without a valid tune.		
	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. Mass calibration is verified after each mass calibration, prior to ICAL.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Mass calibration range must bracket the ion masses of interest. The most recent mass calibration must be used for every acquisition in an analytical run. Mass calibration must be verified to be ±0.5 amu of the true value, by acquiring a full scan continuum mass spectrum of a PFAS stock standard. Problem must be corrected. Samples may not be analyzed under a failing mass calibration. The mass calibration is updated as needed (for example, QC failures, ion masses fall outside of the ±0.5 amu of the true value, major instrument maintenance is performed, or the instrument is moved).	If the mass calibration fails, recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. Flagging is not appropriate.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument[a]	**Calibration Procedure**	**Frequency of Calibration**	**Acceptance Criteria**	**CA**	**Person Responsible for CA[b]**	**SOP Reference[c]**
LC-MS/MS (for PFAS)	Mass Spectural Acquisition Rate	Each analyte, EIS analyte, and injection internal standard analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	Flagging is not appropriate.	Analyst	5-369-08
	Calibration, Calibration Verification, and Spiking Standards	All analytes.	Standards containing both branched and linear isomers must be used when commercially available. PFAS method analytes may consist of both branched and linear isomers, but quantitative standards that contain the linear and branched isomers do not exist for all method analytes. For PFAS that do not have a quantitative branched and linear standard, identify the branched isomers by analyzing a qualitative standard that includes both linear and branched isomers and determine retention times, transitions and transition ion ratios. Quantitate samples by integrating the total response (that is, accounting for peaks that are identified as linear and branched isomers) and relying on the ICAL that uses the linear isomer quantitative standard. Standards containing both branched and linear isomers are to be used during method validation to ensure the total response is quantitated for that analyte. Technical grade standards cannot be used for quantitative analysis.	Flagging is not appropriate.		
	Ion Transitions (Parent -> Product)	Prior to method implementation.	In order to avoid biasing results high due to known interferences for some transitions, the following transitions must be used for the quantification of the following analytes: PFOA: 413 → 369 PFOS: 499 → 80 PFHxS: 399 → 80 PFBS: 299 → 80 4:2 FTS: 327 → 307 6:2 FTS: 427 → 407 8:2 FTS: 527 → 507 NEtFOSAA: 584 → 419 NMeFOSAA: 570 → 419 If these transitions are not used, the reason must be technically justified and documented (for example, alternate transition was used due to observed interferences).	Flagging is not appropriate.		
	Retention Time (RT) Window Position Establishment	Once per ICAL and at the beginning of the analytical sequence.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used. Calculated for each analyte and EIS.	N/A		
	RT Window Width	Every field sample, standard, blank, and QC sample.	RT of each analyte and EIS analyte must fall within 0.4 minutes of the predicted retention times from the daily calibration verification or, on days when ICAL is performed, from the midpoint standard of the ICAL. Analytes must elute within 0.1 minute of the associated EIS. This criterion applies only to analyte and labeled analog pairs. Calculated for each analyte and EIS.	Correct problem and reanalyze samples.		
	ISC	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at LOQ; concentrations must be within ±30 percent of their true values. Samples shall not be analyzed until ISC has met acceptance criteria. ISC can serve as the initial daily CCV.	Correct problem, rerun ISC. If problem persists, repeat ICAL. Flagging is not appropriate.		

SAP Worksheet #24—Analytical Instrument Calibration Table (continued)

Instrument[a]	**Calibration Procedure**	**Frequency of Calibration**	**Acceptance Criteria**	**CA**	**Person Responsible for CA**[b]	**SOP Reference**[c]
TOC Analyzer	ICAL	Analyzed and evaluated before any result can be quantitated.	The correlation coefficient must be 0.995 or greater.	Correct problem; recalibrate instrument; new calibration verified.	Analyst, Supervisor	ENV-SOP-BTRO-0044
	ICV	Immediately following the ICAL.	±10% (90 to 110% of true value).	Instrument maintenance. Reanalysis of ICV or ICAL or repreparation of the standards.		
	CCV	Each day that an ICAL is not performed a CCV must be performed before sample analysis. Also analyze every 10 samples and at the end of the analytical batch.	±10% (90 to 110% of true value).	Instrument maintenance. Reanalysis of ICV or ICAL or repreparation of the standards.		
	Continuing Calibration Blank	Analyzed after every 10 samples or more frequently and at the end of the analytical batch.	Concentration must be less than the LOQ.	Correct problem; recalibrate instrument.		
Analytical Balance	Calibrate against National Institute of Standards and Technology standards	Daily or prior to analyzing samples.	In accordance with unit model and manufacturer's recommendation or laboratory SOP.	Terminate analysis, recalibrate, and verify before analyzing samples.	Analyst, Supervisor	SOIL-PSP

[a] DoD QSM v5.3 is the basis for specifications on this table.

[b] Name or title of responsible person may be used.

[c] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

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SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Person Responsible for CA[a]	SOP Reference[b]
LC-MS/MS	Clean curtain plate	PFAS	Visually inspect curtain plate for residue.	As needed when curtain plate has visible residue present	No visible residue on curtain plate	Remove and clean the instrument curtain plate.	Analyst	5-369-08
	Preventative maintenance	PFAS	Visually inspect for instrument performance degradation.	Every 6 months or when instrument performance deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards recovery within acceptance criteria on **Worksheet #28**	Service provider performs preventative maintenance and mass calibration. Run tune check. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		
	Replace analytical column	PFAS	Review peak shape, retention times, and peak separation on ICAL, ICC, and CCV samples.	When chromatography performance deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards recovery within acceptance criteria on **Worksheet #28**	Replace analytical column. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.		
Balance	Verification	Weight	--	Daily	+/- 0.02 g or +/- 0.1% of calibration weight used, whichever is greater	Refer to manufacturer’s instruction manual.	Analyst	5-369-08
	Calibration		--	Annually	Per manufacturer	Remove from service, repair, replace.		

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Person Responsible for CA[a]	SOP Reference[b]
Pipette	Verification	Volume	--	Daily	+/- 2% difference from true value, < 1% RSD (n=3)	Remove from service, repair, replace.	Analyst	5-369-08
	Calibration		--	Quarterly	Per manufacturer	Remove from service, repair, replace.		
TOC Analyzer	Change injection needle, change catalyst	TOC	Monitor instrument performance via Continuing Calibration Verification.	As needed or replace as necessary, loss of sensitivity or failing resolutions, erratic response	Maintenance is not required as long as instrument QC meets criteria	Perform instrument maintenance, clean injection needle, change catalyst.	Analyst, Supervisor, QA manager	ENV-SOP-BTRO-0044
Analytical Balance	Check digital LCD display and ensure a flat base for the Instrument	Grain size	Visually inspect for wear or damage and indicator from computer controls.	Daily and annual maintenance from manufacturer	Refer to manufacturer's recommendation	Return to manufacturer for recalibration or call for maintenance service.	Analyst or certified instrument technician	SOIL-PSP

[a] Name or title of responsible person may be used.

[b] Specify the appropriate reference letter or number from the Analytical SOP References table (**Worksheet #23**).

SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FTL (TBD)/CH2M
Sample Packaging (Personnel/Organization): Sample Processor or Field Team Member (TBD)/CH2M
Coordination of Shipment (Personnel/Organization): Sample Processor or Field Team Member (TBD)/CH2M
Type of Shipment/Carrier: Overnight/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Receipt Personnel/Battelle, PGC, ALS-Kelso
Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/Battelle, PGC, ALS-Kelso
Sample Preparation (Personnel/Organization): Extractions Personnel/Battelle, PGC, ALS-Kelso
Sample Determinative Analysis (Personnel/Organization): Analyst/Battelle, PGC, ALS-Kelso
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Extracts may be disposed of 90 days after extraction.
Biological Sample Storage (No. of days from sample collection): N/A
SAMPLE DISPOSAL
Personnel/Organization: Environmental H&S Office/Battelle, PGC, ALS-Kelso
Number of Days from Analysis: Samples may be disposed of 90 days after report mail date.

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SAP Worksheet #27—Sample Custody Requirements Table

Sample Labeling

Sample labels will include, at a minimum, client name, area name, sample ID, date/time collected, analysis group or method, and sampler's initials. Labels will be applied to the jar using a PFAS-free tape to ensure that they do not separate.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory)

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled, as outlined in the Sample Labeling section. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples ≤10°C (storage in the laboratory will be ≤ 6°C) but not frozen until they are received by the laboratory. The chain-of-custody will also be placed into the cooler. Coolers will be shipped to the laboratory via methods described in **Worksheet #21**, with the airbill number indicated on the chain-of-custody (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples. Battelle will receive the PFAS samples while TOC will be shipped directly to PGC, and grain size will be shipped to ALS-Kelso.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal)

Refer to the laboratories' sample handling SOPs: Sampling Receiving and Laboratory Information Management Systems (LIMS) Log-in; Waste Collection, Storage, and Disposal; and Sample Disposal for details on sample handling.

Sample Identification Procedures

Upon opening the cooler, the receiving clerk signs the chain-of-custody, and then takes the temperature using the temperature blank (if absent, a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's chain-of-custody and any discrepancies or breakage is noted on the chain-of-custody. The clerk will deliver the chain-of-custody (and any other paperwork; for example, temperature or pH QA notice) to the PM for LIMS entry and client contact (if needed).

The field notes will identify the sample ID with the location, depth, date/time collected, and the parameters

requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain-of-custody.

The laboratory will send sample log-in forms to PC to check sample IDs and parameters are correct.

Chain-of-Custody Procedures

Chain-of-custodies will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, analysis method, and comments. The chain-of-custody will also have the sampler's name and signature. The chain-of-custody will link the location of the sample from the field notes to the laboratory receipt of the sample.

The laboratory will use the sample information to populate the LIMS database for each sample.

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SAP Worksheet #28-1—Laboratory Quality Control Samples Table

Matrix: Groundwater and Surface Water

Analytical Group: PFAS

Analytical Method/SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15/SOP 5-369-08

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Aqueous Sample Preparation	Each sample and associated batch QC samples	Solid Phase Extraction (SPE) must be used unless samples are known to contain high PFAS concentrations (for example, AFFF formulations). Inline SPE is acceptable. Entire sample plus bottle rinsate must be extracted using SPE. Known high PFAS concentration samples require serial dilution be performed in duplicate. Documented project approval is needed for samples prepared by serial dilution as opposed to SPE. Samples with > 1 percent solids may require centrifugation prior to SPE extraction. Pre-screening of separate aliquots of aqueous samples is recommended.	N/A	Analyst	N/A	Same as Method/ SOP QC Acceptance Limits
Sample Cleanup Procedure	Each sample and associated batch QC samples Not applicable to AFFF formulation samples	ENVI-Carb or equivalent must be used on each sample and batch QC sample. Cleanup should reduce bias from matrix interferences.	Flagging is not appropriate.		N/A	

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Sample PFAS ID	All analytes detected in a sample	The chemical derivation of the ion transitions must be documented. A minimum of two ion transitions (Precursor → quant ion and precursor → confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist PFBA and PFPeA. Documentation of the primary and confirmation transitions and the ion ratio is required. In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 50 to 150 percent. Signal to noise (S/N) ratio must be ≥ 10 for all ions used for quantification and must be ≥ 3 for all ions used for confirmation. Quant ion and confirmation ion must be present and must maximize simultaneously (±2 seconds). For example: Ion ratio = (quant ion abundance/confirm ion abundance) Calculate the average ratio (A) and standard deviation (SD) using the ICAL standards. An acceptance range of ratio could be within A ±3 SD for confirmation of detection.	PFAS identified with ion ratios that fail acceptance criteria must be flagged. Any quantitation ion peak that does not meet the maximization criteria shall be included in the summed integration and the resulting data flagged as “estimated, biased high”.	Analyst	Accuracy/Bias	Same as Method/ SOP QC Acceptance Limits

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis	Concentration of each analyte must be ≤ 1/2 the LOQ. Instrument blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (> 1/2 LOQ), they must be reanalyzed. Samples shall not be analyzed until instrument blank has met acceptance criteria. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. When the highest standard analyzed is not part of the calibration curve, it cannot be used to extend out the calibration range, it is used only to document a higher concentration at which carryover still does not occur. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left.	Analyst	Precision/Accuracy/ Bias	Same as Method/ SOP QC Acceptance Limits

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
EIS Analytes	Every field sample, standard, blank, and QC sample	Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. EIS analyte recoveries must be within 50 to 150 percent of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	Correct problem. If required, reextract and reanalyze associated field and QC samples. If recoveries are acceptable for QC samples, but not field samples, the field samples must be reextracted and analyzed (greater dilution may be needed). Samples may be extracted and analyzed outside of hold times, as necessary for CA associated with QC failure. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative. EIS should be 96 percent (or greater) purity. When the impurity consists of the unlabeled analyte, the EIS can result in a background artifact in every sample, standard and blank, if the EIS is fortified at excessive concentrations.	Analyst	Precision/Accuracy/ Bias	Same as Method/ SOP QC Acceptance Limits

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank (MB)	One per preparatory batch	No analytes detected > 1/2 LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, repreparation and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Bias/Contamination	Same as Method/ SOP QC Acceptance Limits

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Laboratory Control Sample (LCS)	One per preparatory batch	Refer to **Worksheet #15-1**.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Precision/Accuracy/ Bias	Same as Method/ SOP QC Acceptance Limits
MS	Once per batch maximum of 20 samples		Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (that is, matrix effect or analytical error).		Accuracy	

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
MSD	Once per batch maximum of 20 samples	Refer to **Worksheet #15-1**.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. The data shall be evaluated to determine the source of difference.	Analyst	Accuracy/Precision	Same as Method/ SOP QC Acceptance Limits
Post Spike Sample	Only applies to aqueous samples prepared by serial dilution instead of SPE that have reported value of "<LOQ" for analyte(s).	Spike aliquot(s) of sample at the final dilution(s) reported for sample with all analytes that have reported value of "<LOQ" in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the "<LOQ" value). When analyte concentrations are calculated as "<LOQ," the spike must recover within 70 to 130 percent of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70 to 130 percent acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met. Flagging is not appropriate. When analyte concentrations are calculated as "<LOQ," results may not be reported without acceptable post spike recoveries.		Accuracy/Precision	

SAP Worksheet #28-1—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
LOD Verification	Quarterly for every analyte	Spike a quality system matrix at concentration 2-4x the DL. Must meet 3:1 S/N ratio, or for data systems that do not measure noise, results must be at least 3 SDs greater than the mean MB concentration.	If verification fails, the DL determination must be repeated and a LOD verification. Alternatively pass two consecutive LOD verification at a higher spike and set the LOD at the higher concentration.	Analyst	Accuracy	Same as Method/ SOP QC Acceptance Limits
LOQ Verification	Quarterly for every analyte	Spike a quality system matrix at a concentration equal to or greater than the low point of the calibration curve.	Must meet laboratory specified precision and bias limits. If LOQ fails, repeat at a higher level until limits are met.		Precision/Bias	
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Non-detect results are reported as U-Values at the LOD.	N/A		Accuracy	

[a] DoD QSM v5.3 is the basis for specifications on this table.

PFBA = perfluorobutanoic acid

PFPeA = perfluoropentanoic acid

SAP Worksheet #28-2—Laboratory Quality Control Samples Table

Matrix: Surface Soil, Subsurface Soil, and Sediment
Analytical Group: PFAS
Analytical Method/SOP Reference: LC-MS/MS Compliant with QSM v5.3 Table B-15/SOP 5-369-08

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Solid Sample Preparation	Each sample and associated batch QC samples	Entire sample received by the laboratory must be homogenized prior to subsampling.	NA	Analyst	N/A	Same as Method/ SOP QC Acceptance Limits.
Sample Cleanup Procedure	Each sample and associated batch QC samples Not applicable to AFFF formulation samples	ENVI-Carb or equivalent must be used on each sample and batch QC sample. Cleanup should reduce bias from matrix interferences.	Flagging is not appropriate.		N/A	
Sample PFAS ID	All analytes detected in a sample	The chemical derivation of the ion transitions must be documented. A minimum of two ion transitions (Precursor → quant ion and precursor → confirmation ion) and the ion transitions ratio per analyte are required for confirmation. Exception is made for analytes where two transitions do not exist PFBA and PFPeA. Documentation of the primary and confirmation transitions and the ion ratio is required. In-house acceptance criteria for evaluation of ion ratios must be used and must not exceed 50 to150 percent. S/N ratio must be ≥ 10 for all ions used for quantification and must be ≥ 3 for all ions used for confirmation. Quant ion and confirmation ion must be present and must maximize simultaneously (±2 seconds). For example: Ion Ratio = (quant ion abundance/confirm ion abundance) Calculate the average ratio (A) and SD using the ICAL standards. An acceptance range of ratio could be within A ±3 SD for confirmation of detection.	PFAS identified with Ion ratios that fail acceptance criteria must be flagged. Any quantitation ion peak that does not meet the maximization criteria shall be included in the summed integration and the resulting data flagged as "estimated, biased high."		Accuracy/ Bias	

SAP Worksheet #28-2—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Instrument Blanks	Immediately following the highest standard analyzed and daily prior to sample analysis	Concentration of each analyte must be ≤ 1/2 the LOQ. Instrument blank must contain EIS to enable quantitation of contamination.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower concentration for the highest standard until acceptance criteria is met. If sample concentrations exceed the highest allowed standard and the sample(s) following exceed this acceptance criteria (>1/2 LOQ), they must be reanalyzed. Samples shall not be analyzed until instrument blank has met acceptance criteria. Note: Successful analysis following the highest standard analyzed determines the highest concentration that carryover does not occur. When the highest standard analyzed is not part of the calibration curve, it cannot be used to extend out the calibration range, it is used only to document a higher concentration at which carryover still does not occur. Flagging is only appropriate in cases when the sample cannot be reanalyzed and when there is no more sample left.	Analyst	Precision/ Accuracy/ Bias	Same as Method/ SOP QC Acceptance Limits.

SAP Worksheet #28-2—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
EIS Analytes	Every field sample, standard, blank, and QC sample	Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. EIS analyte recoveries must be within 50 to 150 percent of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	Correct problem. If required, reextract and reanalyze associated field and QC samples. If recoveries are acceptable for QC samples, but not field samples, the field samples must be reextracted and analyzed (greater dilution may be needed). Samples may be extracted and analyzed outside of hold times, as necessary for CA associated with QC failure. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner. Failing analytes shall be thoroughly documented in the Case Narrative. EIS should be 96 percent (or greater) purity. When the impurity consists of the unlabeled analyte, the EIS can result in a background artifact in every sample, standard and blank, if the EIS is fortified at excessive concentrations.	Analyst	Precision/ Accuracy/ Bias	Same as Method/ SOP QC Acceptance Limits

SAP Worksheet #28-2—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
MB	One per preparatory batch	No analytes detected > 1/2 LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, repreparation and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply B-Flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid MB. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Bias/ Contamination	Same as Method/ SOP QC Acceptance Limits.
LCS	One per preparatory batch	Refer to **Worksheet #15-2**.	Correct problem, then reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		Precision/ Accuracy/ Bias	

SAP Worksheet #28-2—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
MS	Once per batch maximum of 20 samples	Refer to **Worksheet #15-2**.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. For matrix evaluation only. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference (that is, matrix effect or analytical error).	Analyst	Accuracy	Same as Method/ SOP QC Acceptance Limits
MSD	Once per batch maximum of 20 samples	Refer to **Worksheet #15-2**.	Examine the project-specific requirements. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the Case Narrative. The data shall be evaluated to determine the source of difference.		Accuracy/ Precision	
Post Spike Sample	Only applies to aqueous samples prepared by serial dilution instead of SPE that have reported value of "<LOQ" for analyte(s)	Spike aliquot(s) of sample at the final dilution(s) reported for sample with all analytes that have reported value of "<LOQ" in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the "<LOQ" value). When analyte concentrations are calculated as "<LOQ," the spike must recover within 70 to 130 percent of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70 to 130 percent acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met. Flagging is not appropriate. When analyte concentrations are calculated as "<LOQ," results may not be reported without acceptable post spike recoveries.		Accuracy/ Precision	

SAP Worksheet #28-2—Laboratory Quality Control Samples Table (continued)

QC Sample[a]	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
LOD Verification	Quarterly for every analyte	Spike a quality system matrix at concentration 2 to 4 times the DL. Must meet 3:1 S/N ratio, or for data systems that do not measure noise, results must be at least 3 SDs greater than the mean MB concentration.	If verification fails, the DL determination must be repeated and a LOD verification. Alternatively pass two consecutive LOD verification at a higher spike and set the LOD at the higher concentration.	Analyst	Accuracy	Same as Method/ SOP QC Acceptance Limits
LOQ Verification	Quarterly for every analyte	Spike a quality system matrix at a concentration equal to or greater than the low point of the calibration curve.	Must meet laboratory specified precision and bias limits. If LOQ fails, repeat at a higher level until limits are met.		Precision/ Bias	
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ. Non-detect results are reported as U-Values at the LOD.	N/A		Accuracy	

[a] DoD QSM v5.3 is the basis for specifications on this table.

SAP Worksheet #28-3—Laboratory Quality Control Samples Table

Matrix: Sediment

Analytical Group: WCHEM (TOC)

Analytical Method/SOP Reference: SW-846 9060A/ENV-SOP-BTRO-0044

QC Sample[a]	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
MB	Once per batch, maximum of 20 samples	Concentration shall not be > 1/2 the LOQ or 1/10 the amount measured in any sample (whichever is greater)	The source of contamination should be investigated, and samples should be reanalyzed. If additional sample is not available, report in a narrative.	Analyst, Supervisor, QA Manager	Bias/Contamination	Same as Method/ SOP QC Acceptance Limits.
LCS	Once per batch, maximum of 20 samples	Refer to **Worksheet #15-3**.	If LCS fails to meet laboratory criteria, the source of inaccuracy should be investigated, and samples reanalyzed. If additional sample is not available, report in a narrative.		Accuracy/Bias	
MS	One pair per batch (assuming sufficient volume exists) or as specified by client request		If the recovery is outside of the control limits and a laboratory error suspected, repeat the MS determination. If the LCS is within control limits, matrix interference is indicated, analyze a post-digestion spike and report results with a narrative		Accuracy/Bias	
MSD	One pair per batch (assuming sufficient volume exists) or as specified by client request		Investigate the source of the precision error. A source of precision error in the duplicate or MS/MSD may be homogenous nature of the sample. If laboratory error is suspected, repeat analysis. If matrix issue is indicated, report the results with a narrative.		Precision	

[a] The Laboratory SOP is the basis for specifications on this table.

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field notebooks • Chain-of-custody records • Air bills • Custody seals • CA forms • EDDs • ID of QC samples • Meteorological data from field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes, drilling logs, and field forms • Sample receipt, chain of custody, and tracking records • Standard traceability logs • Equipment calibration logs • Sample preparation logs • Run logs • Equipment maintenance, testing, and inspection logs • Reported field sample results • Reported result for standards, QC checks, and QC samples • Instrument printouts (raw data) for field samples, standards, QC checks, and QC samples • Data package completeness checklists • Sample disposal records • Extraction/cleanup records • Raw data (archived per CLEAN contract) • Data validation reports	• Field data deliverables, such as logbooks entries, chains-of-custody, airbills, EDDs, and so forth, will be kept on CH2M's network server. • Field parameter data will be loaded with the analytical data into the Navy database. • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server and archived in accordance with the CLEAN contract. • Electronic data from the laboratory as well as field data will be reviewed and loaded simultaneously into Navy database. • Following project completion, hardcopy deliverables such as logbooks, chains-of-custody, and so forth will be archived at Iron Mountain. These files are stored for a minimum of 7 years in accordance with CLEAN contract requirements: Iron Mountain Headquarters 745 Atlantic Avenue Boston, Massachusetts 02111 (800) 899-IRON • Following project completion, hardcopy deliverables including chains-of-custody and raw data will be archived at the Washington National Records Center. Files stored here are maintained for 50 years: Washington National Records Center 4205 Suitland Road Suitland, Maryland 20746-8001 301-778-1550

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/Organization (name and address, contact person, and telephone number)	Backup Laboratory/ Organization[a] (name and address, contact person, and telephone number)
Groundwater Surface Soil Subsurface Soil Sediment Surface Water	PFAS	Refer to **Worksheet #18**.	PFAS by LC-MS/MS compliant with QSM v5.3[b] Table B-15	28 calendar-day turnaround time	Battelle 141 Longwater Drive Suite 202 Norwell, Massachusetts 02061 Jonathan Thorn (781) 681-5565	Vista Analytical Laboratory Attn: Sample Receiving 1104 Windfield Way El Dorado Hills, California 95762 Martha Maier (916) 673-1520
Sediment	WCHEM (TOC)		TOC (SW-846 9060A)		PGC 7979 Innovation Park Drive Baton Rouge, Louisiana 70820 Liz Martin (225) 769-4900	TBD
	GRAINSIZE		Grain size (ASTM D 422)		ALS-Kelso 960 West LeVoy Drive Kelso, Washington 98626 Howard Holmes (360) 801-0932	

[a] Should it be necessary to use the backup laboratory for sample analysis, the laboratory SAP worksheets will be submitted to the Navy Chemist/QAO for review prior to sample analysis.

[b] DoD QSM v5.3 or the latest version of the QSM for which the laboratory is certified at the time of sampling

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing CAs (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Field Performance Audit	In accordance with CLEAN program requirements	Internal	CH2M	TBD FTL/CH2M	Dennis Ballam PM/CH2M	Dennis Ballam PM/CH2M	Paul Townley AQM/CH2M
Offsite Laboratory Technical Systems Audit	Laboratories must have current DoD Environmental Laboratory Accreditation Program (ELAP) accreditation, which will identify the period of performance	External	Perry Johnson Laboratory Accreditation, Inc. (PJLA)	Tracy Szerszen President and Operations Manager/PJLA	Zachary Willenberg Laboratory Quality Systems Manager/Battelle	Zachary Willenberg Laboratory Quality Systems Manager/Battelle	Tracy Szerszen President and Operations Manager/PJLA
					Jacqueline Bendolph Laboratory Quality Systems Manager/PGC	Jacqueline Bendolph Laboratory Quality Systems Manager/PGC	
					Carl Degner Laboratory Quality Systems Manager/ALS-Kelso	Carl Degner Laboratory Quality Systems Manager/ALS-Kelso	

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (Name, Title, Organization)	Time Frame for Response
Field Performance Audit	Checklist and Written Audit Report	Dennis Ballam PM/CH2M	Within 1 week of audit	Memorandum	TBD FTL/CH2M Paul Townley AQM/CH2M	Within 1 week of receipt of CA Form
Laboratory Performance and Systems Audits	Written Laboratory CA Form	Juan Acaron PC/CH2M	Within 3 days of ID of issue	Memorandum	Juan Acaron PC/CH2M	Within 1 week of receipt of initial notification

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SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating corrective action (CA) ______________________________ Date ______________

Description of problem and when identified: ______________________________

____

____

____

Cause of problem, if known or suspected: ______________________________

____

____

____

<u>Sequence of CA:</u> (including date implemented, action planned, and personnel/data affected) ______________

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CA implemented by: ______________________ Date: ______________

CA initially approved by: ______________________ Date: ______________

Follow-up date: ______________________________

Final CA approved by: ______________________ Date: ______________

Information copies to:

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SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.:______________________________ Date: ______________________________

Project Location:___________________________ Signature: ___________________________

Team Members:

Yes _ No _ 1) Is the approved work plan being followed?

Comments ____

____

Yes _ No _ 2) Was a briefing held for project participants?

Comments ____

____

Yes _ No _ 3) Were additional instructions given to project participants?

Comments ____

____

Sample Collection

Yes _ No _ 1) Is there a written list of sampling locations and descriptions?

Comments ____

____

Yes _ No _ 2) Are samples collected as stated in the Master SOPs?

Comments ____

____

Yes _ No _ 3) Are samples collected in the type of containers specified in the work plan?

Comments ____

____

Yes _ No _ 4) Are samples preserved as specified in the work plan?

Comments ____

____

Yes _ No _ 5) Are the number, frequency, and type of samples collected as specified in the work plan?

Comments ____

____

SAP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes _ No _ 6) Are QA checks performed as specified in the work plan?

Comments ____

____

Yes _ No _ 7) Are photographs taken and documented?

Comments ____

____

Document Control

Yes _ No _ 1) Have any accountable documents been lost?

Comments ____

____

Yes _ No _ 2) Have any accountable documents been voided?

Comments ____

____

Yes _ No _ 3) Have any accountable documents been disposed of?

Comments ____

____

Yes _ No _ 4) Are the samples identified with sample tags?

Comments ____

____

Yes _ No _ 5) Are blank and duplicate samples properly identified?

Comments ____

____

Yes _ No _ 6) Are samples listed on a chain-of-custody record?

Comments ____

____

Yes _ No _ 7) Is chain-of-custody documented and maintained?

Comments ____

____

SAP Worksheet #33—Quality Assurance Management Reports Table

Report Type	Frequency (daily, weekly monthly, quarterly, annually, and similar)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Performance CA Memorandum	After field audit (if conducted)	1 week after audit, if necessary	FTL: TBD/CH2M	Will be posted in project file
Data Usability Assessment	Once results have been assessed for data usability	To be submitted with SI report	CH2M	Will be posted in project file

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SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Verification Input[a]	Description	Step I / IIa / IIb	Internal/ External[b]	Responsible for Verification (Name, Organization)
Field notes	Field notes will be reviewed internally and placed into the project file for archival at project closeout.	Step I	Internal	FTL (TBD)/CH2M
Chain-of-custodies and shipping forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain of custody will be initialed by the reviewer, a copy of the chain of custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.		Internal/ External	FTL (TBD)/CH2M PC: Juan Acaron/CH2M
Sample condition upon receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.		External	PC: Juan Acaron/CH2M
Documentation of laboratory method deviations	Laboratory method deviations not included in the laboratory SOP and therefore not included in the DoD ELAP accreditation letter are not allowed for this project. All laboratory deviations must be approved by the DoD ELAP accrediting body and be incorporated into the DoD accreditation letter.		Internal/ External	PC: Juan Acaron/CH2M
Electronic data deliverables	EDDs will be compared against hardcopy laboratory results (10 percent check). If errors are found, the laboratory must correct the errors and resubmit the electronic data deliverable. The PC will check to make sure the errors have been addressed and a 10 percent check will be performed. The process will be repeated if additional errors are found.		External	PC: Juan Acaron/CH2M
Case narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and are applicable to the data packages.		External	Data Validator: Doug Weaver/EDS
Laboratory data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.		Internal	Laboratory QAO (Battelle, PGC, and ALS-Kelso)
Laboratory data	The data will be verified for completeness by the PC. In order to ensure completeness, EDDs will be compared to the SAP. This is a verification that all samples were included in the laboratory data and that correct analyte lists were reported.		External	PC: Juan Acaron/CH2M

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Verification Input[a]	Description	Step(s)	Internal/ External[b]	Responsible for Verification (Name, Organization)
Audit reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	Step I	Internal	AM: Dennis Ballam/CH2M
CA reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.		External	AM: Dennis Ballam/CH2M
				PC: Juan Acaron/CH2M
Laboratory methods	During the pre-validation check, ensure the laboratory analyzed samples using the correct methods specified in the SAP. If methods other than those specified in the SAP were used, the reason will be determined and documented.	Step IIa	External	PC: Juan Acaron/CH2M
Target compound list	Ensure the laboratory reported all analytes from each analysis group as described in **Worksheet #15**. If the target compound list is not correct, then it must be corrected prior to sending the data for validation. Once the checks are complete, the PM is notified via email.		External	PC: Juan Acaron/CH2M
Reporting limits (DL, LOD, and LOQ)	Ensure the laboratory met the project-designated reporting limits as described in **Worksheet #15**. If reporting limits were not met, the reason will be identified and documented. Oftentimes the cause for minor laboratory reporting limit deviation from those presented in the SAP is attributable to the quarterly update of the laboratory LOD.		External	PC: Juan Acaron/CH2M
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed. Any such discrepancies will be discussed first in the data validation narrative and will be included in the associated project report.		External	Data Validator: Doug Weaver/EDS
Sample chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Step IIb	External	Data Validator: Doug Weaver/EDS

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Verification Input[a]	Description	Step(s)	Internal/ External[b]	Responsible for Verification (Name, Organization)
Raw data	10 percent Stage 4 review of raw data to confirm laboratory calculations and manual integrations. For a recalculated result, the data validation attempts to recreate the reported numerical value. The laboratory is asked for clarification if a discrepancy is identified which cannot reasonably be attributed to rounding. In general, this is outside 5 percent difference. The remaining 90 percent of data will receive Stage 2B review.	Step IIb	External	Data Validator: Doug Weaver/EDS
Onsite screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.		Internal	FTL (TBD)/CH2M
Documentation of method QC results	Establish that all required QC samples were run and met limits.		External	Data Validator: Doug Weaver/EDS
Documentation of field QC sample results	Establish that all required SAP QC samples were run and met limits.		Internal	PC: Juan Acaron/CH2M Data Validator: Doug Weaver/EDS
PFAS[c]	Analytical methods and laboratory SOPs will be evaluated against QA/QC criteria to ensure compliance, as presented in this SAP. QA/QC criteria for field QC samples are presented in **Worksheet #12**. LOQs, LODs, and DLs are presented in **Worksheet #15**. QA/QC criteria for calibrations are presented in laboratory SOPs (referenced in **Worksheet #23**). Analytical instrument calibration criteria are presented in **Worksheet #24**. QA/QC criteria for laboratory QC samples are presented in **Worksheet #28**. Data may be qualified if QA/QC exceedances have occurred. Guidance and qualifiers from DoD "General Data Validation Guidelines" (DoD, 2019) and "Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15" (DoD, 2020) will be applied as appropriate. The data validator may adapt the guidance from "USEPA National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.4)" (540-R-2017-002; USEPA, 2017b) and the "EPA Technical BRIEF for Per- and Polyfluoroalkyl Substances (PFAS): Reviewing Analytical Methods Data for Environmental Samples" (USEPA, 2019b) as needed. Although there are no samples being analyzed by EPA Method 537.1, the data validator may reference "EPA Data Review and Validation Guidelines for Perfluoroalkyl Substances (PFAS) Analyzed Using EPA Method 537" (USEPA, 2018) as needed.	Step IIa and IIb	External	Data Validator: Doug Weaver/EDS

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

Verification Input[a]	Description	Step(s)	Internal/ External[b]	Responsible for Verification (Name, Organization)
WCHEM (TOC), GRAINSIZE	WCHEM and GRAINSIZE are subject to the verification and validation procedures specified in these worksheets. The case narratives will be read, any issues will be investigated, and the impact (if any) on data quality or data usability will be discussed with the project team.	Step IIa and IIb	External	PC: Juan Acaron/CH2M

Notes:

[a] Verification (Step I) is a completeness check that is performed before the data review process continues to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated is in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against MPC in the SAP (both sampling and analytical).

[b] Internal or external is in relation to the data generator.

[c] Manual validation is planned, and qualifiers are then applied to the electronic data deliverable. Validation will be 90 percent Stage 2B and 10 percent Stage 4.

Should CH2M find discrepancies during the verification or validation procedures above, an email documenting the issue will be circulated to the internal project team, and a Corrections to File Memo will be prepared identifying the issues and the CA needed. This memo will be sent to the laboratory, or applicable party, and maintained in the project file.

SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Non-detected site contaminants will be evaluated to ensure that PAL in **Worksheet #15** were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, J+, J-, or UJ. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an X qualifier as recommended for rejection. The project team will review the project quality objectives and data validation narrative will decide to replace the X qualifier with the R qualifier (in most cases the data would not be considered usable for project decisions) or other appropriate qualifier. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the investigation report.
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - J+ = Analyte present. Reported value is estimated and may be biased high.
  - J- = Analyte present. Reported value is estimated and may be biased low.
  - UJ = Analyte not detected. Associated non-detect value may be inaccurate or imprecise.
  - X = Result recommended for rejection by the data validator. Result not reliable.
  - R = Rejected result, team decision. Result not reliable.
- If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to the sample DL and evaluations will be performed using the USEPA's ProUCL software. For duplicate sample results, the most conservative value will be used for project decisions.
- Additional qualifiers that may be given by the data validation are:
  - N = Tentative ID. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
  - NJ = Qualitative ID questionable due to poor resolution. Presumptively present at approximate quantity.
  - U = Not Detected.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. The checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- Evaluative procedures used to assess overall measurement error associated with the project will be described.
- To assess whether a sufficient quantity of acceptable data is available for decision making, the data will be compared to the 95 percent completeness goal and reconciled with MPC following validation and review of DQIs.

SAP Worksheet #37—Usability Assessment (continued)

- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site.

If significant deviations are noted between laboratory and field precision, the cause will be further evaluated to assess impact on decision making.

Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

- Data tables will be produced to reflect detected and non-detected analytes. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation will be provided as part of the SI report.
- The SI report will identify any data usability limitations and make recommendations for CA, if necessary.

Identify the personnel responsible for performing the usability assessment.

The CH2M Team, including the PM and PC, will review the data and present to the Navy and Base for review and approval of usability.

References

Aerostar Environmental and Construction LLC (Aerostar E&C). 2021. *Manchester Annex Per- and Polyfluoroalkyl Substances (PFAS) Site Inspection, Old Navy Dump/Manchester Annex Site Manchester, Washington*. May.

Battelle. 2017. *Phase I Environmental Site Assessment Report Proposed MILCON and Decommissioning Project, Fleet Logistics Center Puget Sound Manchester Fuel Depot, Manchester, Washington*. April 4.

CH2M HILL, Inc. (CH2M). 2018. *Phase II Environmental Site Assessment Report in Support of MILCON P-856, Manchester Fuel Depot, Manchester, Washington.* March.

CH2M. 2020. *Preliminary Assessment for Per- and Polyfluoroalkyl Substances (PFAS), Manchester Fuel Depot, Kitsap County, Washington.* November.

GZA GeoEnvironmental Inc. (GZA). 2012. Schaffner, I. R., Wieck, J. M., Asselin, M. B. & Lamb, S. R. *Collection of groundwater samples from beneath an LNAPL: An ice-coating method*.

Environmental Data Resources Inc. (EDR). 2019. *National Environmental Policy Act Search Map Report. Manchester, Washington.* February.

Hart Crowser. 1988. Current Situation Report, PCB and TEL Sites, Naval Supply Center Puget Sound Fuel Department, Manchester, Washington. April.

Manchester Water District (MWD). 2008. *Manchester Water District Comprehensive Water System Plan*, Figure 202 Existing System Hydraulic Profile.

Naval Facilities Engineering Systems Command (NAVFAC). 2016. *Land Use Control Plan for Sites 302, 303, 304, and Tank 50*. Naval Base Kitsap Manchester. December.

NAVFAC. 2020. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for Naval Facilities Engineering Systems Command (NAVFAC) Remedial Project Managers*. November 24.

Perry. 1998. *Manchester: 100 Years of Stewardship, 1898-1998*.

Department of Defense (DoD). 2019. United States Department of Defense General Data Validation Guidelines. September.

DoD. 2020. United States Department of Defense Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis for QSM Table B-15. May.

DoD. 2021. Memorandum, Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. August.

Department of Defense Instruction (DoDI). 2019. Emerging Chemicals (ECS) Of Environmental Concern. Office of the Under Secretary of Defense for Acquisition and Sustainment. September 4.

Interstate Technology Regulatory Council (ITRC). 2020. Fate and Transport of Per- and Polyfluoroalkyl Substances (PFAS). August.

United States Environmental Protection Agency (USEPA). 2002. *Guidance for Quality Assurance Project Plans, USEPA QA/G-5.* EPA/240/R-02/009. December.

USEPA. 2005. *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs - Part 1: UFP-QAPP Manual.* Intergovernmental Data Quality Task Force. EPA-505-B-04-900A. Final Version 1. March.

USEPA. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4.* EPA/240/B-06/001. February.

USEPA. 2017a. The Third Unregulated Contaminant Monitoring Rule (UCMR 3) Data Summary. January.

USEPA. 2017b. National Functional Guidelines for Superfund Organic Data Review. January.

USEPA. 2018. Data Review and Validation Guidelines for Perfluoroalkyl Substances (PFASs) Analyzed Using EPA Method 537. EPA-910-R-18-001. November.

USEPA. 2019a. *EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan*. EPA 823R18004. February

USEPA. 2019b. *EPA Technical BRIEF for Per- and Polyfluoroalkyl Substances (PFAS): Reviewing Analytical Methods Data for Environmental Samples.*

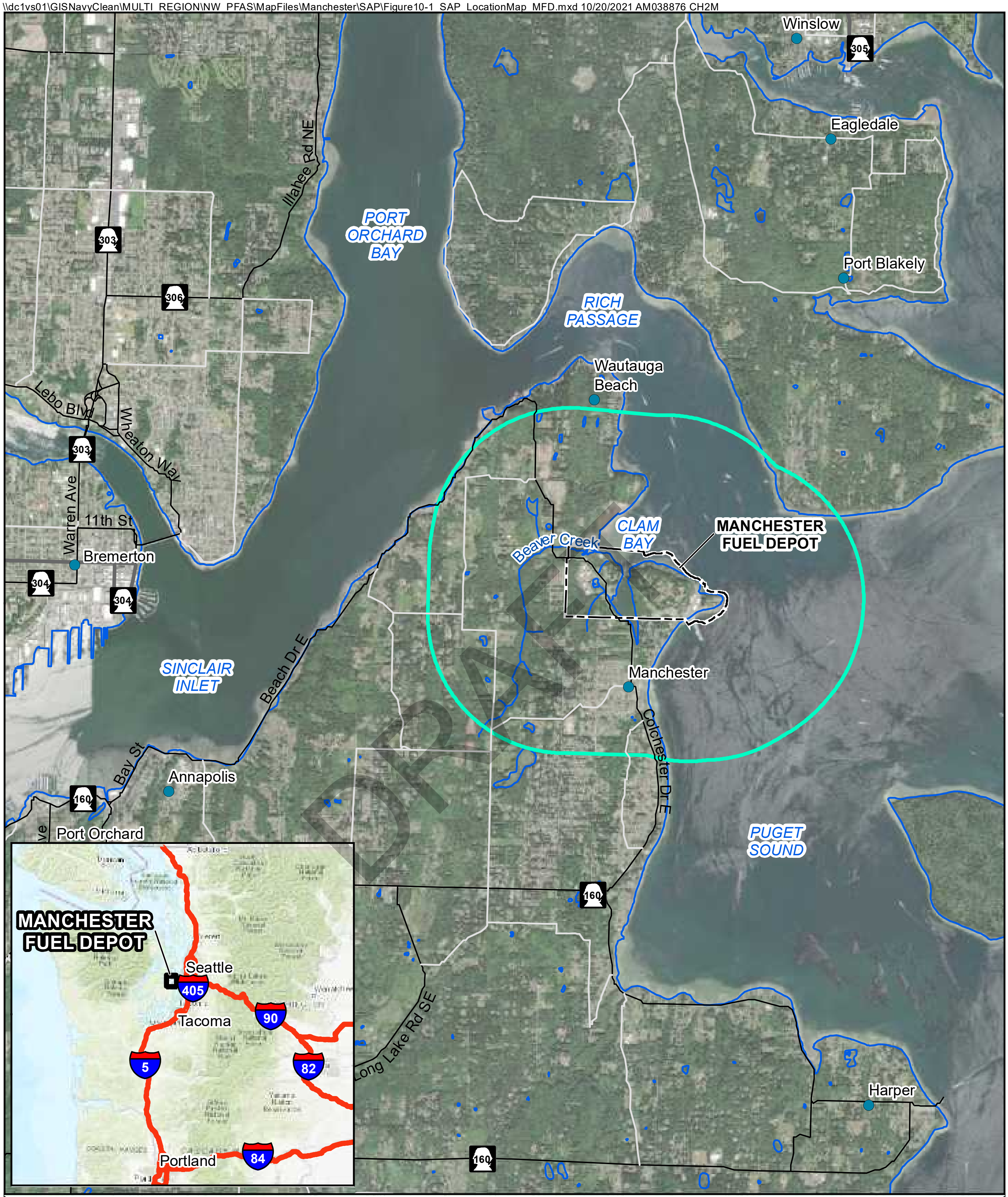
Washington Department of Ecology (Ecology). 2019a. Well Report Viewer. https://fortress.wa.gov/ecy/wellconstruction/map/wclswebMap/default.aspx. Accessed February 14.

Ecology. 2019b. *Sediment Cleanup User's Manuel.* Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC. Publication No. 12-09-057. Second Revision. December.

Weatherbase. 2019. Manchester Weather Summary. http://www.weatherbase.com/weather/weather-summary. Accessed January 26, 2021.

Figures

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-1_SAP_LocationMap_MFD.mxd 10/20/2021 AM038876 CH2M



LEGEND

● City

Hydrology

Secondary Road

Local Connecting Road

Important Local Road

Installation Boundary

1 Mile Installation Boundary Buffer

NOTE:
MFD = Manchester Fuel Depot

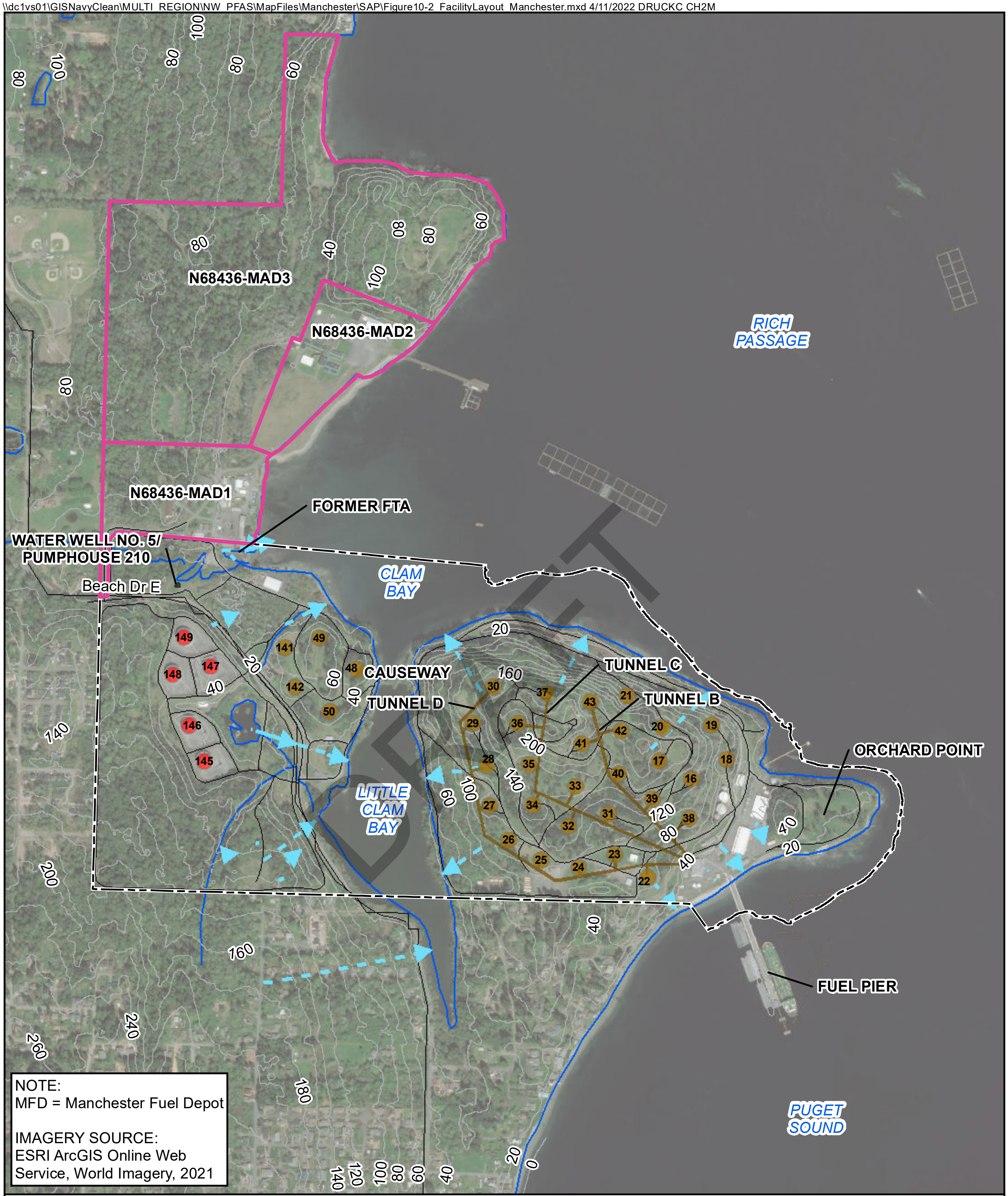
IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery, 2020

Figure 10-1
Manchester Fuel Depot Location
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

0 0.5 1
Miles
1 inch = 1 mile

N

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-2_FacilityLayout_Manchester.mxd 4/11/2022 DRUCKC CH2M



NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

LEGEND

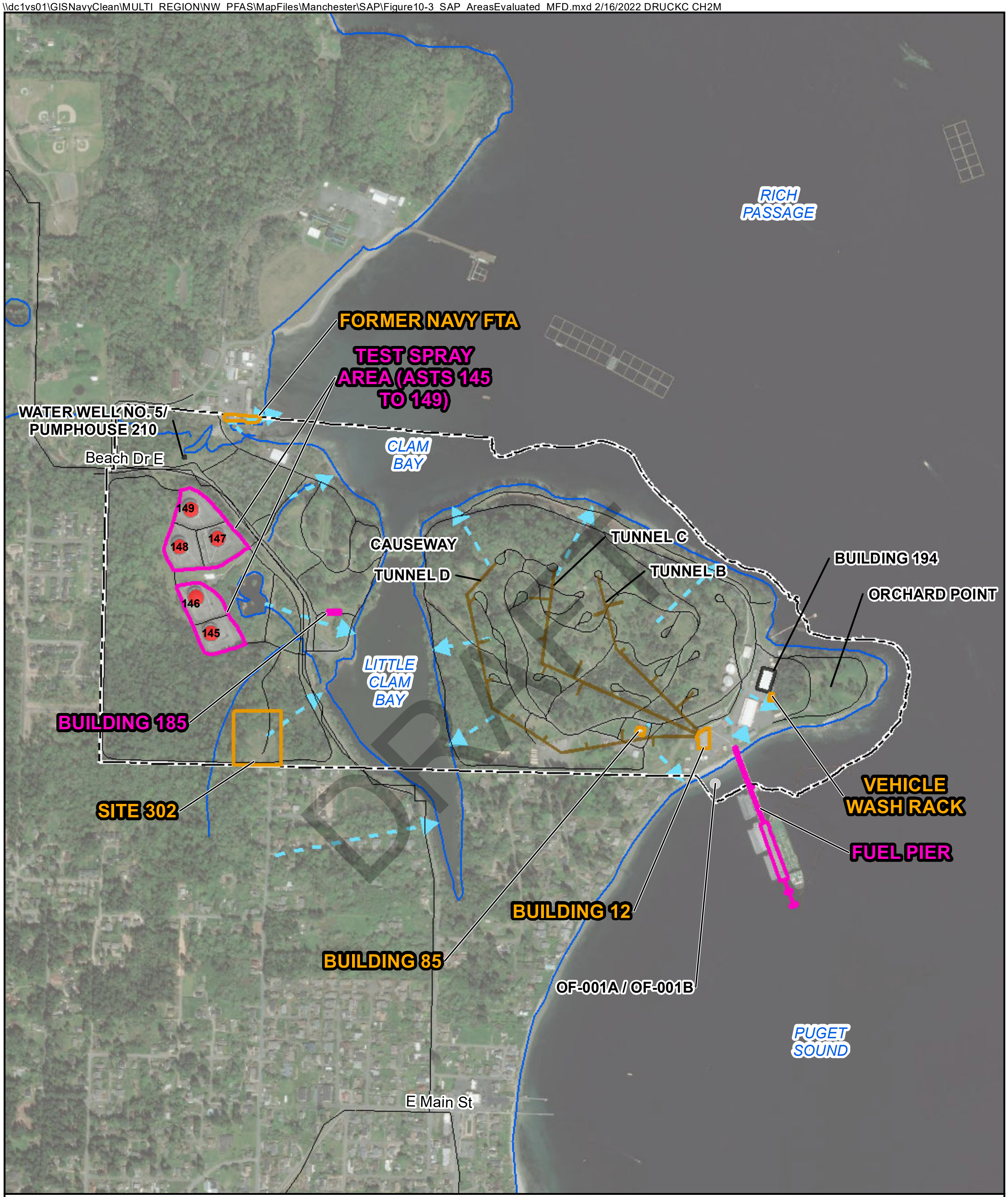
- Roads
- 20' Topographic Contour
- Hydrology
- Tunnel
- Anticipated Groundwater Flow Direction
- 🟥 Aboveground Storage Tank
- 🟫 Underground Storage Tank
- Historical Installation Boundary
- Installation Boundary

0 0.1 0.2 Miles

1 inch = 0.2 mile

N

Figure 10-2
Manchester Fuel Depot Layout
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington



LEGEND

- ● Discharge
- Roads
- Hydrology
- Anticipated Groundwater Flow Direction
- Tunnel
- 🟥 Aboveground Storage Tank
- ▢ Potential PFAS Release Area
- ▢ Confirmed PFAS Release Area
- ▢ Installation Boundary
- ▢ Building

NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

0 0.1 0.2 Miles

1 inch = 0.2 mile

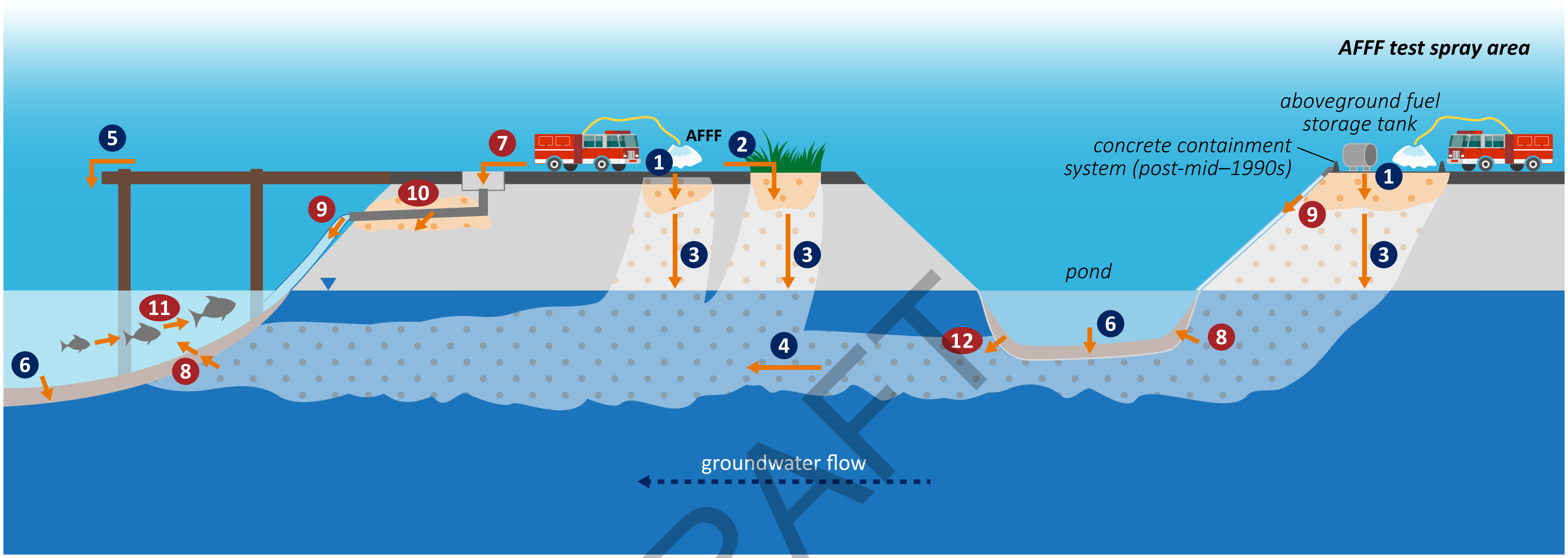
N

Figure 10-3

Potential and Confirmed PFAS Release Areas

PFAS SI Sampling and Analysis Plan

Manchester Fuel Depot, Kitsap County, Washington



To be evaluated during the SI:

1 Direct release of PFAS to surface and/or subsurface soil (e.g., through direct release to surface soil or through cracks in pavement)
2 Overland flow of stormwater and effluent containing PFAS to downgradient soil
3 Leaching of PFAS from soil to groundwater
4 Transport via advection in groundwater
5 Direct release of PFAS to surface water and intertidal sediment
6 Partitioning from surface water to sediment

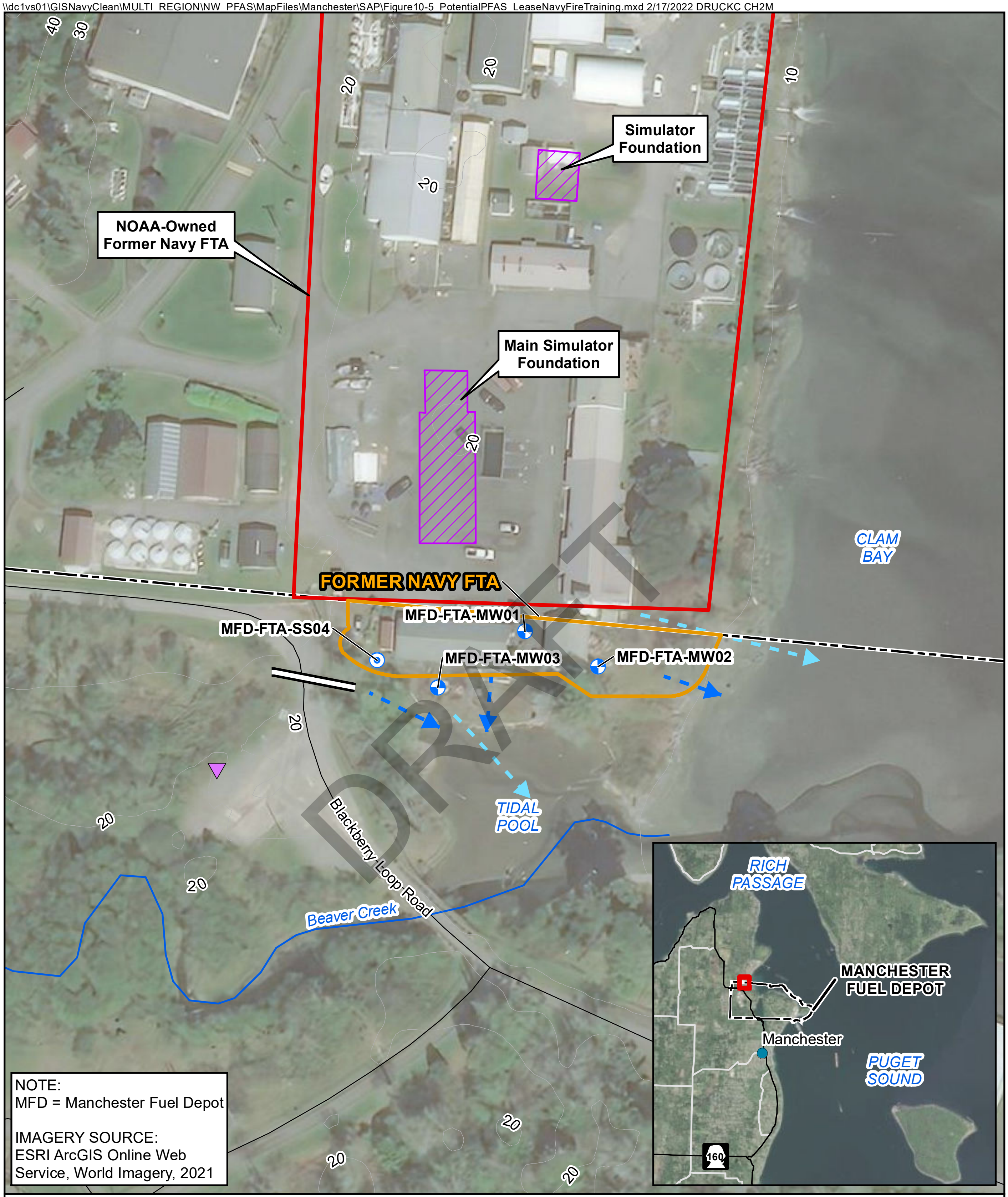
To potentially be considered during a second phase of the SI or the RI:

7 Overland flow of stormwater containing PFAS to stormwater catch basins
8 Discharge of groundwater to surface water and sediment
9 Discharge of stormwater and effluent containing PFAS through stormwater outfalls to surface water
10 Discharge of stormwater containing PFAS to soil and/or groundwater through degraded stormwater infrastructure
11 Bioaccumulation of PFAS in biota (plants and animals)
12 Discharge of PFAS-impacted surface water into underlying groundwater

Figure 10-4.
PFAS Migration Pathway Conceptual Site Model
Site Inspection Sampling and Analysis Plan
Manchester Fuel Depot
Manchester, Washington

Note: Figure shows migration pathways only (not exposure pathways).

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-5_PotentialPFAS_LeaseNavyFireTraining.mxd 2/17/2022 DRUCKC CH2M



NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

LEGEND

- Proposed Monitoring Well/Soil Boring Location
- Proposed Surface Soil Location
- ▼ Inlet
- Culvert Pipe
- Road
- Hydrology
- 10' Topographic Contour
- Anticipated Overland Drainage Direction
- Anticipated Groundwater Flow Direction
- Potential PFAS Release Area
- Former Fire Training Area (FFTA) Investigation Area
- ▨ Simulator Foundation
- Installation Boundary

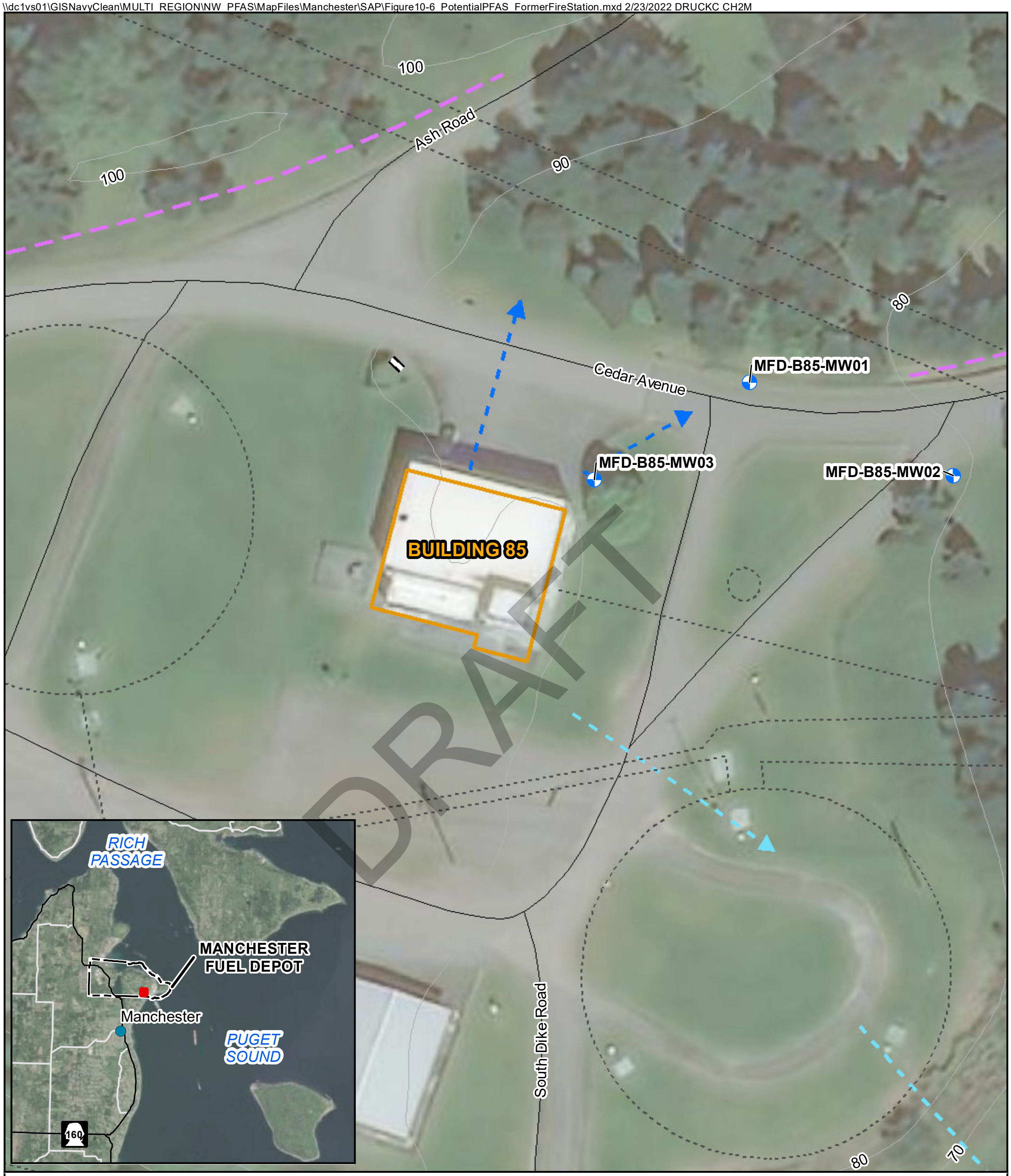
0 50 100 Feet

1 inch = 100 feet

N

Figure 10-5
Former Navy Firefighting Training Area
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-6_PotentialPFAS_FormerFireStation.mxd 2/23/2022 DRUCKC CH2M



LEGEND

- ◐ Proposed Monitoring Well/Soil Boring Location
- - - - Stormwater Main Line
- ▬ ▬ Unpaved Ditch
- ═ Culvert Pipe
- — Road
- — 10' Topographic Contour
- ➤ Anticipated Surface Water Drainage Direction
- ➤ Anticipated Groundwater Flow Direction
- ▭ Potential PFAS Release Area
- ⬚ Installation Boundary

Figure 10-6
Former Fire Station (Building 85)
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web
Service, World Imagery, 2021

0 25 50 Feet
1 inch = 50 feet
N

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-7_PotentialPFAS_FuelPumpHouse.mxd 3/17/2022 DRUCKC CH2M

LEGEND

- ◐ Proposed Monitoring Well/Soil Boring Location
- ⊙ Proposed Surface Soil Location
- ▼ Inlet
- ● Discharge
- ■ Oily Water Separator
- - - - Stormwater Main Line
- - - - Unpaved Ditch
- —— Road
- 10' Topographic Contour
- ➤ Anticipated Groundwater Flow Direction
- ☐ Potential PFAS Release Area
- ☐ Installation Boundary

Figure 10-7

Fuel Pump House (Building 12)

PFAS SI Sampling and Analysis Plan

Manchester Fuel Depot, Kitsap County, Washington

NOTE:
MFD = Manchester Fuel Depot

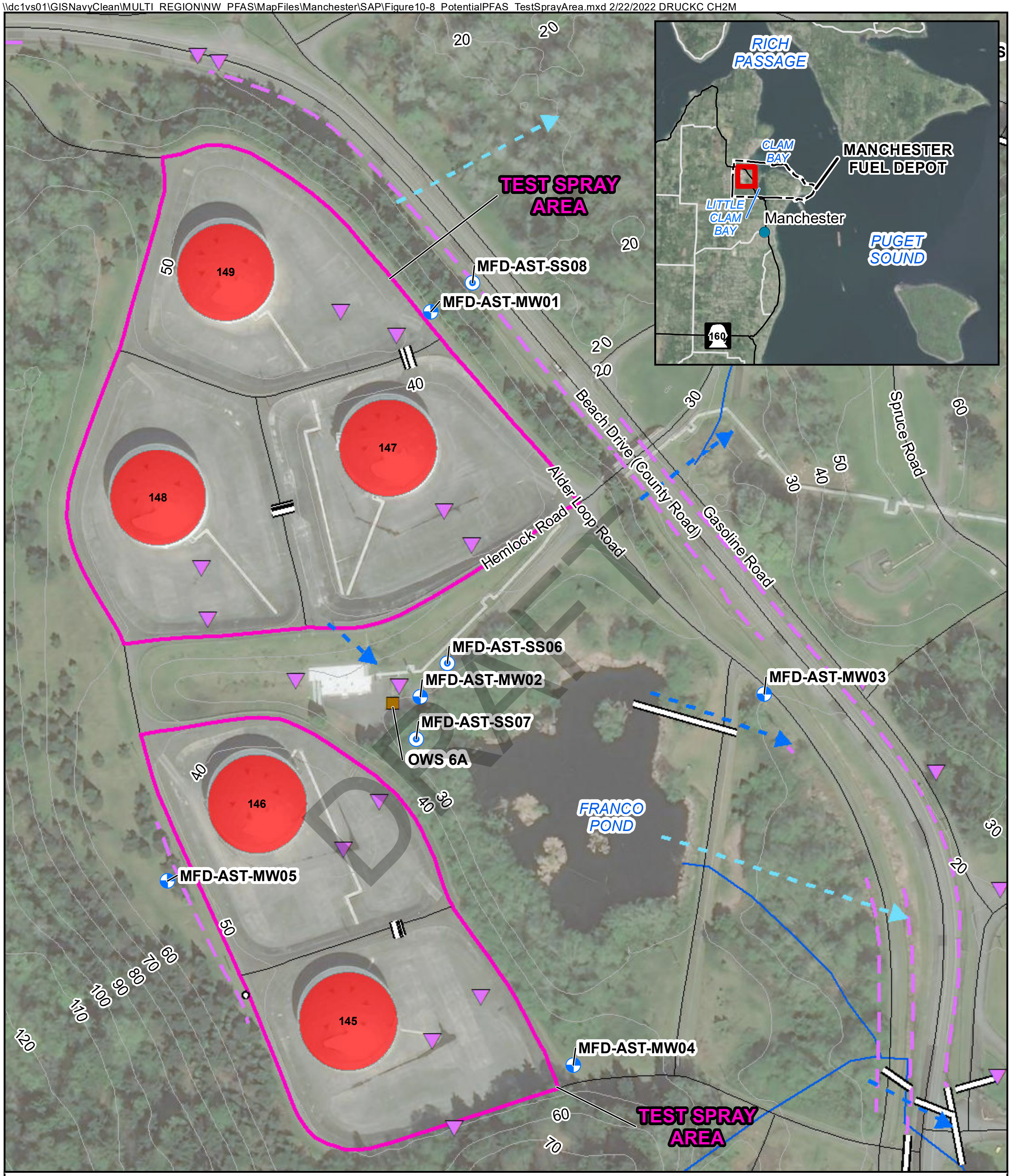
IMAGERY SOURCE:
ESRI ArcGIS Online Web
Service, World Imagery, 2021

0 35 70
Feet

1 inch = 70 feet

N

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-8_PotentialPFAS_TestSprayArea.mxd 2/22/2022 DRUCKC CH2M



LEGEND

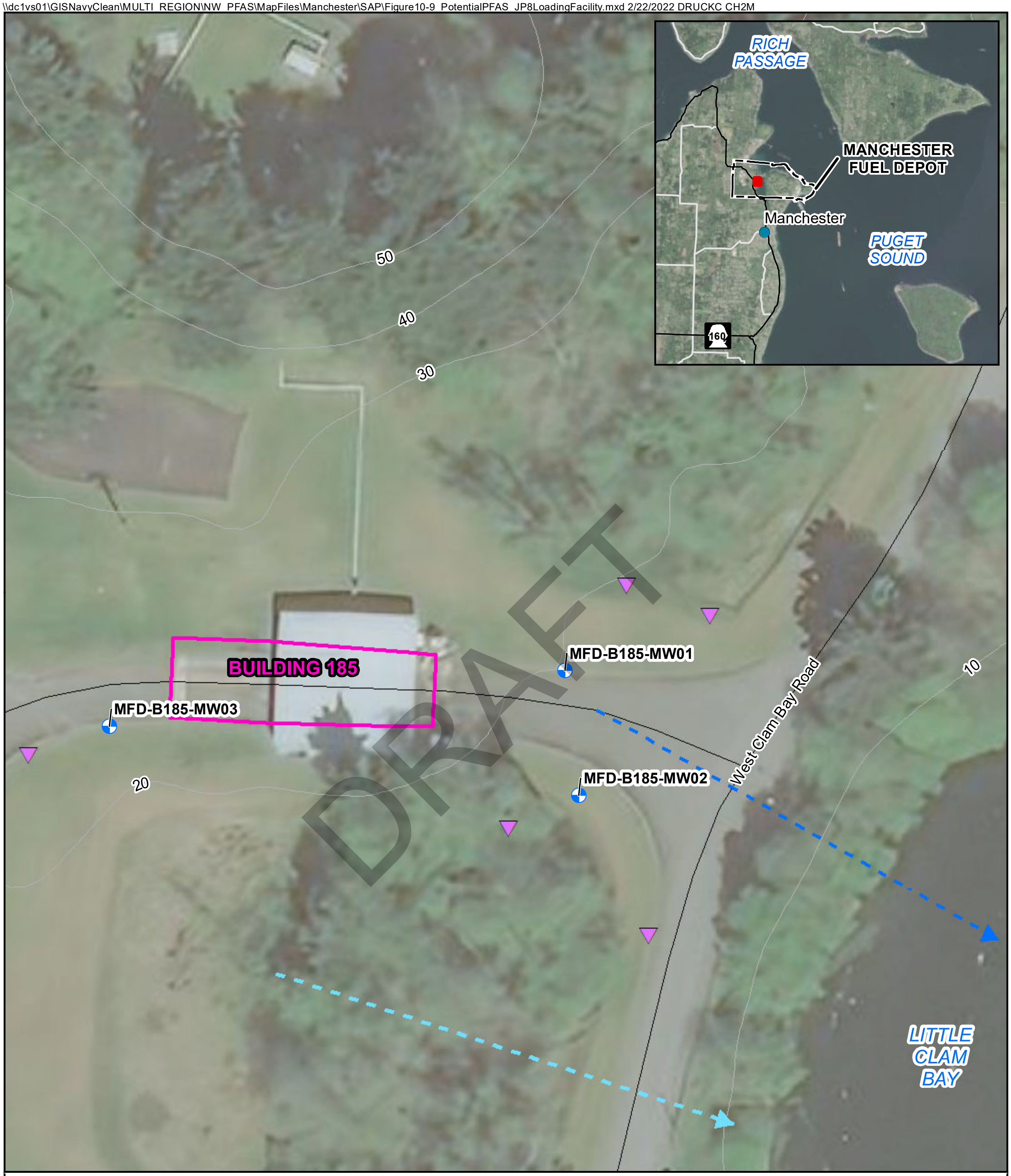
- ◐ Proposed Monitoring Well/Soil Boring Location
- ◉ Proposed Surface Soil Location
- ▽ Inlet
- ■ Oily Water Separator
- Unpaved Ditch
- Culvert Pipe
- Road
- Hydrology
- 10' Topographic Contour
- ➤ Anticipated Overland Drainage Direction
- ➤ Anticipated Groundwater Flow Direction
- 🟥 Aboveground Storage Tank
- ▭ Confirmed PFAS Release Area
- Installation Boundary

Figure 10-8
Test Spray Area
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

0 87.5 175
Feet
1 inch = 175 feet
N



LEGEND

- ⊕ Proposed Monitoring Well/Soil Boring Location
- ▽ Inlet
- — Road
- — 10' Topographic Contour
- ➔ Anticipated Surface Water Drainage Direction
- ➔ Anticipated Groundwater Flow Direction
- ▭ Confirmed PFAS Release Area
- ⬚ Installation Boundary

Figure 10-9
JP-8 Truck Loading Facility (Building 185)
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

NOTE:
MFD = Manchester Fuel Depot

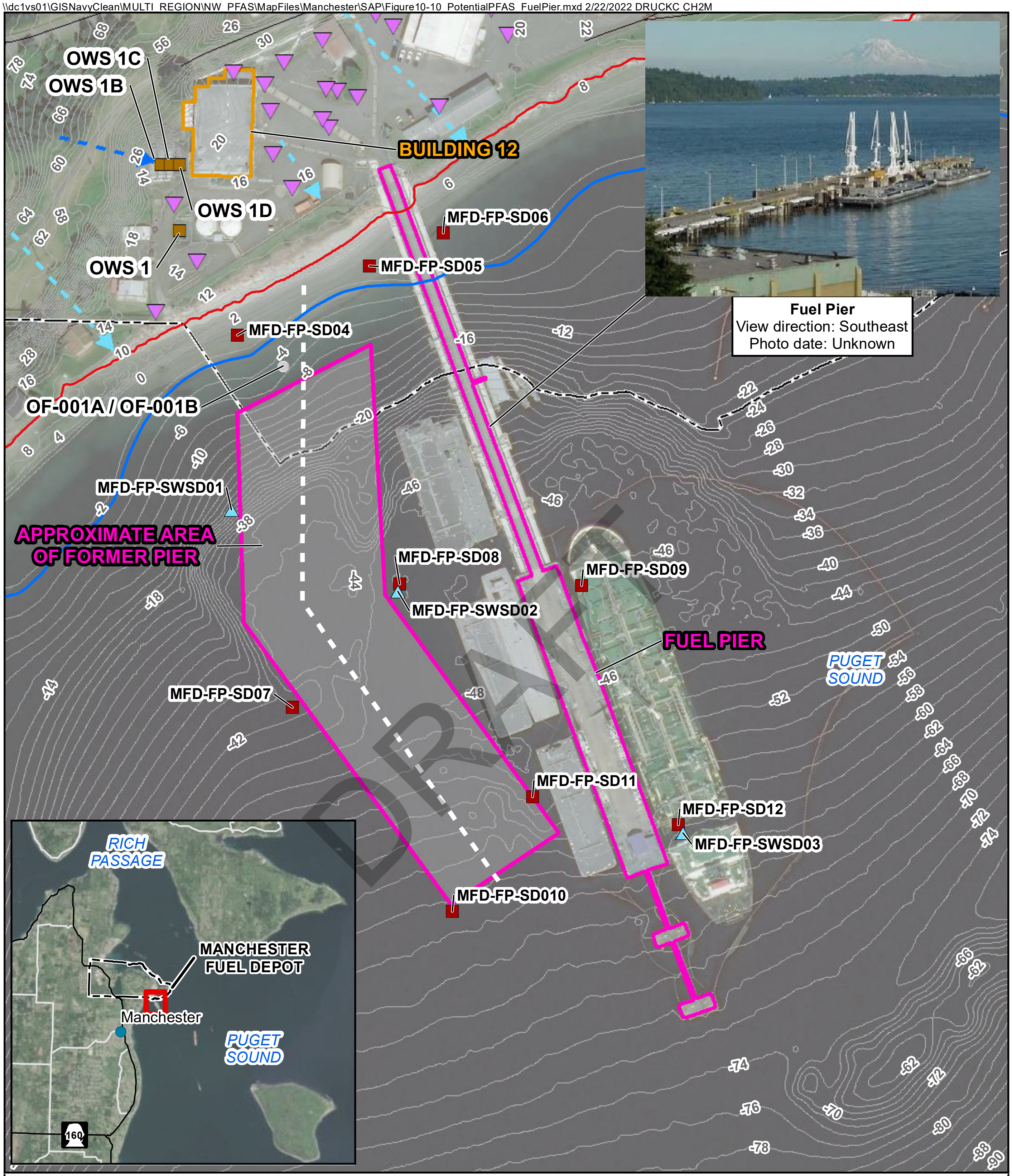
IMAGERY SOURCE:
ESRI ArcGIS Online Web
Service, World Imagery, 2021

0 25 50 Feet

1 inch = 50 feet

N

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-10_PotentialPFAS_FuelPier.mxd 2/22/2022 DRUCKC CH2M



LEGEND

- ■ Proposed Sediment Sample
- ▲ Proposed Surface Water Sample
- ▼ Inlet
- ● Discharge
- ■ Oily Water Separator
- — Road
- — 2' Topographic Contour
- — MLLW (-2.52 ft)
- — MHHW (9.22 ft)
- ➤ Anticipated Overland Drainage Direction
- ➤ Anticipated Groundwater Flow Direction
- ▭ Potential PFAS Release Area
- ▭ Confirmed PFAS Release Area
- ▭ Installation Boundary

Figure 10-10
Fuel Pier
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web
Service, World Imagery, 2021

0 100 200 Feet
1 inch = 200 feet

N

\\dc1vs01\GISNavyClean\MULTI_REGION\NW_PFAS\MapFiles\Manchester\SAP\Figure10-11_PotentialPFAS_PCB_Disposal.mxd 3/15/2022 DRUCKC CH2M

LEGEND

- ◐ Proposed Monitoring Well/Soil Boring Location
- ◉ Proposed Surface Soil Location
- ● Discharge
- Unpaved Ditch
- Culvert Pipe
- Road
- Hydrology
- 10' Topographic Contour
- ▭ Potential PFAS Release Area
- Installation Boundary
- ➤ Anticipated Overland Drainage Direction
- ➤ Anticipated Groundwater Flow Direction

Figure 10-11

PCB Disposal Area (Site 302)

PFAS SI Sampling and Analysis Plan

Manchester Fuel Depot, Kitsap County, Washington

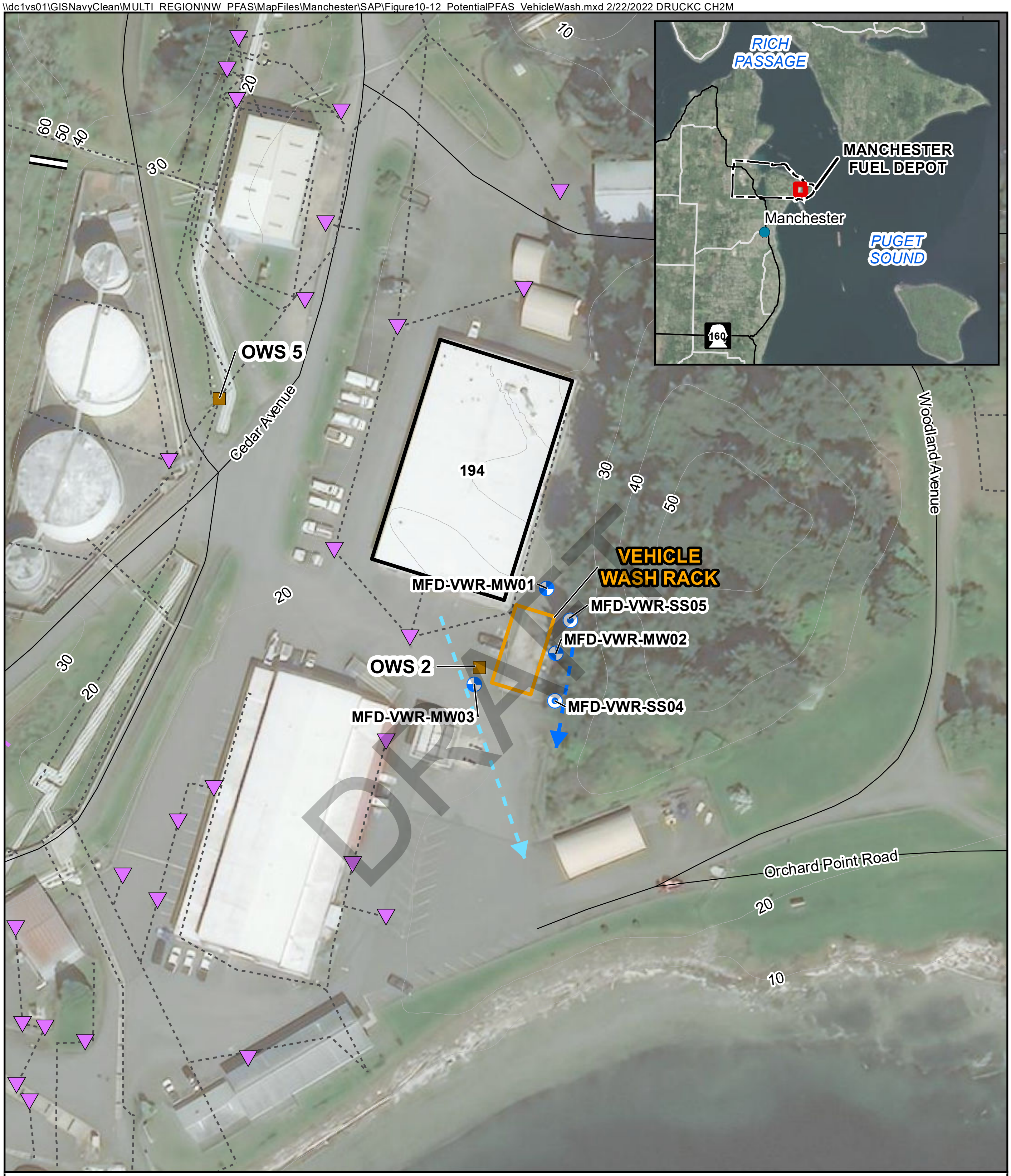
NOTE:
MFD = Manchester Fuel Depot

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

0 75 150 Feet

1 inch = 150 feet

N



LEGEND

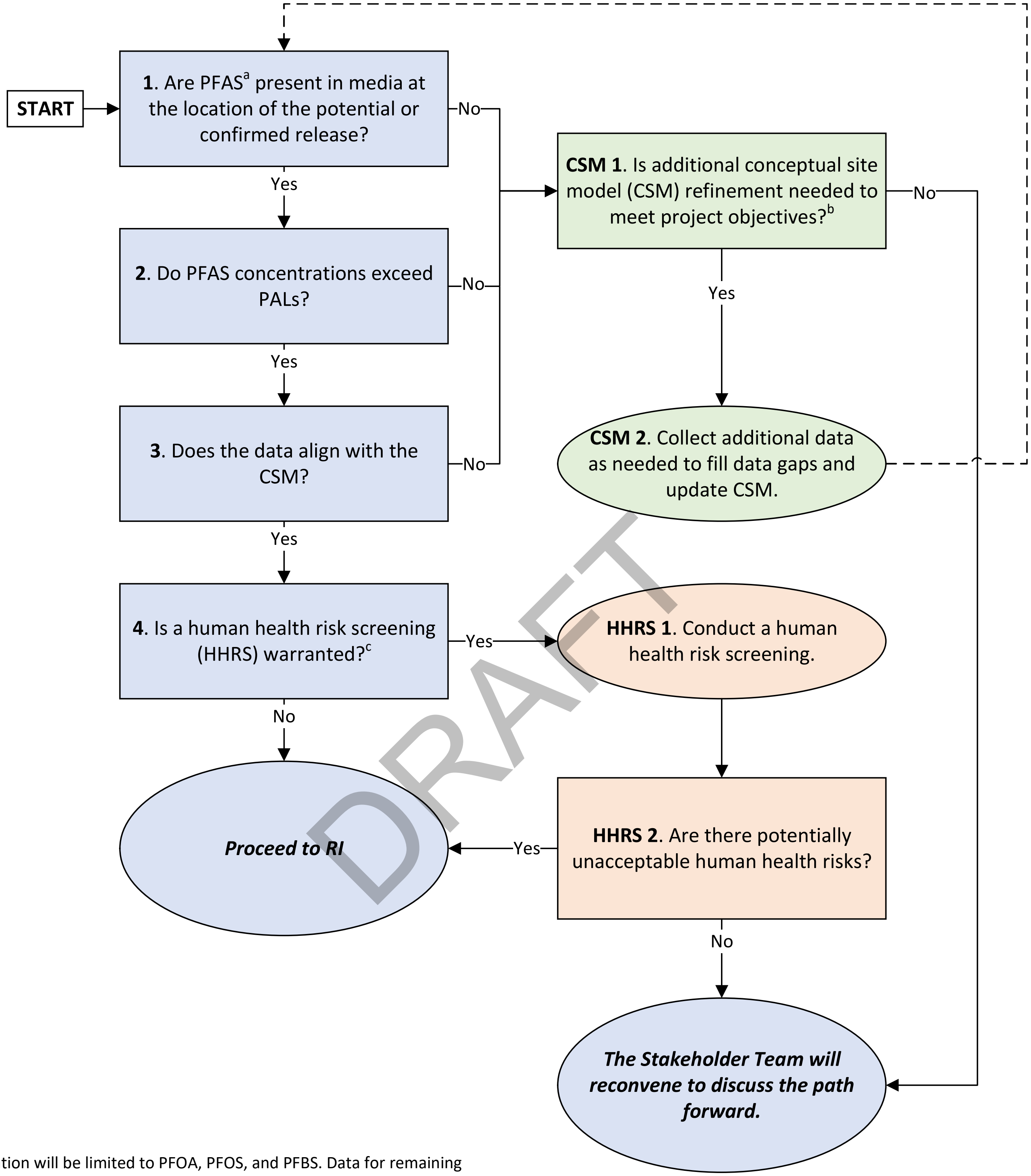
- ◐ Proposed Monitoring Well/Soil Boring Location
- ◉ Proposed Surface Soil Location
- ▽ Inlet
- ■ Oily Water Separator
- - - Unpaved Ditch
- ═ Culvert Pipe
- ----- Main
- —— Road
- —— 10' Topographic Contour
- ▭ Potential PFAS Release Area
- ▭ Building
- ▶ Anticipated Overland Drainage Direction
- ▶ Anticipated Groundwater Flow Direction

NOTE:
MFD = Manchester Fuel Depot

Figure 10-12
Vehicle Wash Rack
PFAS SI Sampling and Analysis Plan
Manchester Fuel Depot, Kitsap County, Washington

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery, 2021

0 50 100 Feet
1 inch = 100 feet
N



Notes

[a] Evaluation will be limited to PFOA, PFOS, and PFBS. Data for remaining constituents will be archived for future use if appropriate PALs become available.

[b] Additional CSM refinement may be warranted if, for example, the groundwater flow direction is significantly different than the inferred direction assumed during SI planning or the measured concentration gradient suggests a potential upgradient source that is not otherwise accounted for.

[c] An HHRS is not required and is only performed if useful for site management decisions. The decision to use the HHRS as a site management tool should be made using the most current conceptual site model. The HHRS is most often used as a site management tool when initial results do not point to a straightforward path forward for a site.

Figure 11-1

Site Inspection Decision Logic

PFAS SI Sampling and Analysis Plan

Manchester Fuel Depot, Kitsap County, Washington

Appendix A
Field Standard Operating Procedures – CH2M and NAVFAC

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV. Procedures

The term “chain-of-custody” refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see **Attachment A**). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project – Name of project site.

- Sample Identification - The unique sample number identifying this sample.

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 05/21/17).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name or initials of the sampler.
- Remarks - Any pertinent additional information.

The field team should always follow the sample ID system prepared by the Project Chemist and reviewed by the Project Manager.

Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include ***only*** the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample

locations in photographs, an easily read sign with the appropriate sample location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler**. A Chain-of-Custody Record Form example is shown in **Attachment B**. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used and enter the airbill number under "Remarks," in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. **Attachment C** is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

V Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VI Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Attachment A

Example Sample Label

QAL

Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client ____________________
Sample No. ____________________
Location ____________________
Analysis ____________________
Preservative HCL
Date __________ By __________

CEIMIC
CORPORATION
10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME	**DATE**
ANALYSIS	**TIME**
	PRESERVATIVE

SAMPLE TYPE

☐ Grab ☐ Composite ☐ Other ________

COLLECTED BY:

Attachment B

Example Chain-of-Custody Record

COC.doc

CH2M HI
APPLIED S ENCES LABORATORY

CHAIN OF CUSTODY ORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project # ☐☐☐☐☐☐☐☐.☐☐.☐☐

Purchase Order #

Project Name

Company Name CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

SHADED AREA– FOR LAB USE ONLY

Lab 1 #
Lab 2 #
Quote #
Kit Request #
Project #
No. of Samples
Page of
Login
LIMS Ver

Sampling		Type		Matrix			CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	LAB TEST CODES ANALYSES REQUESTED									REMARKS	LAB 1 ID	LAB 2 ID
Date	Time	COMP	GRAB	WATER	SOIL	AIR														

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	QC Level: 1 2 3 Other: ____
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	COC Rec / ICE
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time	Ana Req / TEMP Cust Seal / Ph
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other ____	Shipping #	
Work Authorized By (Please sign and print name)	Remarks			

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client
REV 3/94 FORM 340

Attachment C
Example Custody Seal

CH2M HILL

CUSTODY SEAL

Date ______________________

Signature ______________________

STANDARD OPERATING PROCEDURE
NAVY CLEAN PROGRAM

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Meter with Flow-Through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality meter for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Monitoring System with flow-though cell (Horiba, YSI, In-Situ, Ion Science, etc.)
- Calibration Standard Solution(s) (provided by rental company)
- Deionized water in spray bottle

III. Procedures and Guidelines

A. General Parameters and Specifications:

Note: the general parameters listed below may not be available for every type of meter used. Please refer to the specific meter's manual to determine meter's range of measurement and accuracy.

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 ºC	+/- 1.0 ºC
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution. Refer to the specific instrumentation manual for the proper calibration methods.

C. Sample Measurement:

The water quality probes are inserted into a flow-through cell, and the purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere. The flow-through cell should be positioned out of direct sunlight to reduce solar heating, and wrapped in aluminum foil to minimize heat loss or gain.

As water passes through the flow-through the flow cell, press MEAS to obtain readings or the readings are displayed on the meter for each parameter (dependent on the type of meter used). Record the water quality parameter data in a field notebook.

Once the parameters have stabilized (see *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III* or *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV* depending on project site location), remove the tubing from the bottom port of the flow-through cell.

Never collect a groundwater sample for laboratory analysis from the flow-through cell. Rinse the flow-through cell between wells to remove any sediment buildup within the cell.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction

WATER LEVEL MEASUREMENTS

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard protocols for all U.S. Naval Facilities Engineering Command Northwest (NAVFAC NW) field personnel for use in making water level measurements.

2.0 PROCEDURE

2.1 EQUIPMENT

Equipment and materials used during liquid level and well-depth measurements:

- Electronic water level indicator with cable marked with 0.01-foot increments
- Electronic oil-water interface probe
- Engineers measuring tape with 0.01-foot increments may be used for water and petroleum reactive pastes as an alternative to an oil-water interface probe
- Weighted steel tape with 0.01-foot increments and chalk may be used as an alternative to a water level indicator
- Decontamination equipment
- Weatherproof, bound field logbook with numbered pages (see SOP III-D, *Logbooks*)
- Health and safety equipment appropriate for site conditions
- Keys for locked well covers
- Wire cutters if well has a security tag
- Turkey baster or hand pump in case flush-mount manhole is filled with water
- Bolt cutters for cutting "frozen" or rusted locks. HWD-40 is used to lubricate a rusted lock, but extreme care should be taken to avoid possible contamination to the well and equipment.
- Extra locks to replace cut locks

2.2 PRELIMINARY STEPS

Follow these steps prior to disturbing the liquid level in the well:

1. Locate the well and, confirm its label (if marked), and verify its position relative to other site features on the site map. Gain access to the top of the well casing.

2. Locate the permanent reference mark at the top of the well casing. This reference point shall be scribed, notched, or otherwise noted on the top of the casing. If no such marks are present, measure depth relative to the top of the highest point of the well casing and note this fact in the field logbook. Determine from the records and record the elevation of the permanent reference point and record it in the logbook.
3. Record any observations and remarks regarding the characteristics and condition of the well, such as evidence of cracked casing or surface seals, security of the well (locked cap), evidence of tampering, missing well cap, surface water entering the well casing, etc.

2.3 OPERATION

Follow these steps when taking depth to liquid level measurements in well suspected to have NAPL present.

1. Sample the air in the wellhead for gross organic vapors if required.
2. If non-aqueous phase liquid (NAPL) contamination is suspected, use an oil-water interface probe to determine the existence and thickness of the NAPL.
3. Open interface probe housing, turn probe on, and test the alarm. Ground the probe, because the slight electric charge from the probe could set off an explosion of highly flammable vapors. Slowly lower the probe into the well until the alarm sounds. A continuous alarm indicates light non-aqueous phase liquid (LNAPL), while an intermittent alarm indicates water. If LNAPL is detected, record depth of the initial (first) alarm. Mark the spot by grasping the cable with the thumb and forefingers at the top of the casing. Determine the depth to liquid relative to the permanent reference point on the well casing. Withdraw cable sufficiently to record the depth from the scale on the interface probe cable.
4. Continue to slowly lower the probe until it passes into the water phase (intermittent alarm). Slowly retract the probe until the NAPL continuous alarm sounds and record that level in the same manner as described above.
5. Record the depth to NAPL and the depth to water readings independently in the logbook. The thickness of the LNAPL can be calculated by subtracting depth to LNAPL reading from depth to water measurement.
6. Continue to slowly lower the interface probe through the water column to check for the presence of dense non-aqueous phase liquid (DNAPL) if suspected.
7. Measure and record the depths of the DNAPL layer (if any) as described above.
8. Slowly raise the interface probe, recording the depth to each interface as the probe is withdrawn. If there is a discrepancy in depths, clean the probe sensor and recheck the depth measurements.
9. Always lower and raise the interface probe slowly to minimize mixing of media.
10. Always perform a NAPL check in wells installed in areas with suspected NAPL contamination. Always perform a NAPL check if headspace test reveals presence of volatiles. Always perform a NAPL check the first time depth to liquid is measured in a well. If a well has been measured previously, with no NAPLs present, and none of the preceding conditions are met, the NAPL check may be omitted.

11. Decontaminate interface probe as appropriate.

For wells where NAPL is not suspected to be present, an electronic water level indicator or steel tape can be used as described below:

1. Remove the water level indicator probe from the case, turn on the sounder, and test the battery and sensitivity scale by pushing the test button. Adjust the sensitivity scale until you can hear the alarm.
2. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering the probe until the alarm sounds. Very slowly raise and lower the probe until the point is reached where the meter just beeps. Mark the spot by grasping the cable with thumb and forefingers at the top of the casing. Record the depth to water relative to the permanent reference point. If no mark is present, use the highest point on the casing as a reference point. Withdraw the cable and record the depth.
3. Alternately, use a steel tape with an attached weight if the aquifer gradients are lower than 0.05 ft./ft. Due to the possibility of adding unknown contaminants from chalk colorants, only white chalk is permitted as a level indicator.
4. Rub chalk onto the end (first 1 foot) of the steel tape and slowly lower the chalked end into the well until the weighted end is below the water surface. (A small splash can be heard when the weighted end hits the water surface.)
5. Mark the spot on the tape by grasping the tape with the thumb and forefingers at the top of the casing as described in the subsection (2) above. Record this spot on the tape in the logbook as the "HOLD". Ensure not to retract the tape from the well until after the depth measurement (HOLD) is recorded.
6. Remove the steel tape from the well. The chalk will be wet or absent where the tape was below the water surface. Locate, read, and record this length in the logbook as the "CUT". Subtract the "CUT" length from the "HOLD" length and record the difference in the logbook. This is the depth to water table.
7. Decontaminate water level indicator or steel tape as appropriate

2.4 PRECAUTIONS

- Depending on the device used, correction factors may be required for some measurements. For example, if the water level indicator has been shortened during its repair.
- Check instrument batteries prior to each use.
- Exercise care not to break the seals at the top of the electric water level indicator probe.
- It is important to note that when measuring total well depth (bottom of casing), using an interface probe or water level indicator, the increments of measure are ticked off from the alarm sensor on the probe. On some meters there is a portion of the probe that sticks out beyond the alarm sensor. This needs to be accounted for when reading the bottom of casing measurement (i.e., added onto the reading). A potential problem arises if it is unknown whether this has been done on previous readings or not.

3.0 DOCUMENTATION

This section describes the documentation necessary for depth to liquid and well-depth measurements. All information shall be recorded in the field logbook using indelible ink in accordance with SOP III-D, *Logbooks*. At a minimum, the following information must be recorded:

- Date
- Time
- Weather
- Field personnel
- Well location and label
- Well condition
- Monitoring equipment type and readings
- Depth to Liquid measurements obtained
- Any other observations

All entries in the field logbook must be printed in black ink and legible. The actual readings measured should be recorded directly in the logbook. If calculations are necessary to determine the depth to liquid or liquid elevation, they should be performed using direct readings documented in the logbook.

Water level measurements must also be submitted electronically using the appropriate Naval Electronic Data Deliverable (NEDD) format for loading into NIRIS as defined in the NAVFAC NW SOPs (V5.0 or more current).

4.0 REFERENCES

SOP III-D, *Logbooks*

Thornhill, Jerry T. 1989. “Accuracy of Depth to Groundwater Measurements.” In *EPA Superfund Groundwater Issue.* EPA/504/4-89/002.

5.0 ATTACHMENTS

None.

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gauges in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers)*.

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a solid tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically, this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also, when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gauges may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gauge is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment*.

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two or three (lab dependent) 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notes as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a submersible pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

Groundwater Sampling for Per- and Polyfluoroalkyl Substances (PFAS)

I. Purpose and Scope

This SOP provides guidelines for groundwater sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified. This SOP should be used in conjunction with approved region-specific groundwater sampling SOPs which provide methods for general and low-flow groundwater sampling. In cases in which information in this SOP conflicts with region-specific groundwater sampling SOPs, this SOP will supersede the information in the general SOPs.

Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

A. Equipment and Materials Required

- If installing wells, ensure driller does not use polytetrafluoroethylene (PFTE)-containing drill lube or other drilling lubes containing PFAS. Biolube has been determined to be an acceptable drilling lube for installing wells where PFAS may be of concern. Additionally, Waterra surge blocks have been confirmed to not contain PFAS and may be used for development.
- Groundwater sampling equipment
    - PFAS-free tubing (avoid Teflon, Viton, PTFE and other fluorinated compounds)
        - High density polyethylene tubing (unlined)
        - If Masterflex tubing is needed for peristaltic pumps, Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
    - PFAS-free Bailer (if using a bailer[1])

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[1] Geotech and Waterra offer PFAS free bailer options

  - PFAS-free Pump such as:
    - Geotech PFAS-free Portable Bladder Pump (note, most bladder pumps include a Teflon-lined bladder, but Geotech currently has one model which is Teflon-free).
    - Panacea P120 or P125. The P200 Stainless Steel Pump may also be used, but the standard model contains Teflon at the tube connection. If you are using this Panacea model, you must request one with the "PTFE-free thread sealant option."
    - Waterra stainless foot-valve
    - QED Sample Pro
    - Monsoon or Mega Monsoon submersible pump
    - Grundfos Rediflo2 (this pump contains small Teflon components, but has not been shown to leach, it is less preferable than the other options)
    - Peristaltic pump (may be suitable for shallow locations)
- Groundwater sample containers (high density polyethylene [HDPE] bottle with HDPE screwcap), sample bottles should not be glass as glass may sorb PFAS. Sample bottle caps should not contain Teflon. Notify your project manager (PM) if bottles provided by the lab are glass or contain Teflon parts.
- Laboratory prepared deionized, certified PFAS-free water for field blank collection
- PFAS-free shipping supplies (labels [if available][2], coolers, and ice)
- Loose leaf paper without waterproof coating or a spiralbound notebook (not waterproof)
- Metal clip board (if using loose-leaf paper)
- Pen (not Sharpie)
- Nitrile or latex gloves

B. Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect groundwater samples should not contain any fluorinated compounds, Teflon, or synthetic rubber with fluoropolymer elastomers (e.g., Viton).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings.
- New clothing that has been washed fewer than six times.

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[2] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Wash hands with dish detergent before sampling and don nitrile gloves. Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine

Follow Navy CLEAN SOPs for low-flow or conventional groundwater sample collection, depending on site requirements.

A. Sample Collection

Once water quality parameters have stabilized for low-flow purging, samples can be collected. For conventional purging, if water quality parameters do not stabilize, a minimum of 3 well volumes must be purged prior to sample collection.

The steps to be followed for sample collection are as follows:

1. Ensure that the end of the tubing does not touch the ground or equipment. Remove the cap from the sample bottle. Position the sample bottle under the end of the tubing.
2. Fill the bottle. Do not fill the bottle past the middle of the bottle shoulder. Samples do not need to be collected headspace free.
3. Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling. Pack the sample on ice immediately for shipment to the offsite laboratory. Avoid packing materials that may contain fluorine. Unpublished research has allowed us to generate a list of packing materials which do not contain fluorine. Please contact Bill Diguiseppi or Laura Cook for recommendations (because the research is not ours, it cannot be released externally at this time).

B. Equipment Decontamination

Whenever possible, use disposable equipment when collecting groundwater samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

Use of Water Quality Equipment and Water Level Indicators

Water quality meters typically do not contain PFAS. However, consistent with general sampling SOPs, disconnect the water quality meter prior to sampling. Some water level indicators do contain small polyvinylidene fluoride (a PFAS constituent for which we do not currently monitor) or less frequently, Teflon, components, but we have not noted cross contamination from water level indicators at any sites. The Durham Geoslope Water Level Indicators and the Solinst Model 101 with the P2 meter have been shown to be fluorine free.

IV. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/ Tandem Mass Spectrometry (LC/MS/MS).* September.

United States Navy, 2020. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/November 2020 Update*. November.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic Acid.* September.

Soil Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose

This SOP provides guidelines for soil sample collection and handling for samples that will be analyzed for per- and polyfluoroalkyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified at the time of analysis. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

A. Equipment and Materials Required

A hand auger or other device that can be used to remove the soil from the ground. Stainless steel tools, carbon steel tools, or steel DPT tooling with acetate sleeves are preferred for PFAS sampling. Avoid any sampling materials containing PFAS (such as Teflon, Viton, PTFE, or other fluorinated compounds). Any plastic sampling materials should be evaluated thoroughly before selection to ensure they are fluorine-free.

A stainless steel spatula or fluorine-free disposable plastic scoop should be used to remove material from the sampling device.

Unpainted wooden stakes or pin flags

Fiberglass measuring tape (at least 200 feet in length)

GPS Unit

- PFAS-free labels (if available[1]) shipping materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard (if using loose-leaf paper)
- Pen (not Sharpie)

Personal protection equipment (rubber or latex gloves, boots, etc.). Check with your SME prior to selecting PPE to ensure there are no fluorine-containing components.

Sample jars (sample jars should be made of high density polyethylene (HDPE) as glass jars may sorb PFAS, please notify the project manager [PM] if glass jars are provided by the lab). Sample containers should not contain Teflon lids.

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[1] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

Laboratory-prepared deionized, certified PFAS-free water for field blank collection

B. Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect soil samples should not contain any fluorinated compounds including Teflon or synthetic rubber with fluoropolymer elastomers (e.g. Viton).

If a driller is supporting collection of soil samples in split spoons or acetate DPT sleeves, ensure the driller has not used and will not use drilling lube containing polytetrafluoroethylene (PTFE) or any other fluorine-containing substance. Biolube has been determined to be an acceptable substitute.

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings.
- New clothing that has been washed fewer than six times.

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Once the area has been determined to be free of materials potentially containing PFAS, these steps can be followed to collect the soil samples:

Wear protective gear, as specified in the Health and Safety Plan.

To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

A. Samples On A Grid

1. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the field notebook/clipboard.
2. Proceed to sample the points on the grid line.

3. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.
4. Proceed to sample the points on the grid line as described in Section C below.
5. Make sure to stake location after sample collection in case professional surveying is to be completed.
6. Repeat 1c and 1e above until all samples are collected from the area.
7. Or, a GPS unit can be used to identify each location based on map coordinates, if available.

B. Non-Grid Samples

1. Use measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).
2. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.
3. Proceed to sample as described in Section C below.
4. Make sure to stake location after sample collection in case professional surveying is to be completed.
5. Repeat 2a through 2d above until all samples are collected from the area.
6. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point may be deleted from the program. The FTL will contact the CH2M HILL PM immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

C. Collecting Samples Using Hand Tools

1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoop to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks if the disposable scoops have been confirmed by your project PFAS subject matter expert (SME) to be PFAS free.
2. If sampling:
    - Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.
    - Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Record lithologic description and any pertinent observations (such as discoloration) in the field notebook/clipboard.
4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.
5. Repeat this procedure until sufficient soil is collected to meet volume requirements.
6. Homogenize cuttings in the pan using a decontaminated stainless steel utensil.
7. Transfer sample for analysis into appropriate containers with a decontaminated utensil. Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling.
8. Immediately upon collection, all samples for chemical analysis are to be placed in a closed container on ice unless it is not possible to do so. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible.
9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

To Collect Samples Using DPT Methods

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*. Ensure that decontamination water used is PFAS free (do not use water from fire hydrants on-base for steam cleaning unless the water has been demonstrated to be free of PFAS).
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.
4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).

5. Fill all sample containers, using a decontaminated or dedicated sampling implement. Label the containers and immediately place samples on ice for shipment to the laboratory.

6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP Decontamination of Personnel and Equipment and ensure decontamination water is from a PFAS-free water source.
7. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

D. Equipment Decontamination

Whenever possible, use disposable equipment when collecting soil samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

IV. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).* September.

United States Navy, 2020. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/November 2020 Update.* November.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic Acid.* September

STANDARD OPERATING PROCEDURE

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, stainless steel pans, disposable scoop/trowel, and dedicated sealable bag.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for semivolatiles, pesticides, PCBs, metals, cyanide, or field XRF screening should be homogenized in the field. After a sample is taken, a stainless-steel spatula or disposable plastic scoop should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

Samples for VOCs should be taken immediately upon collection and should not be homogenized.

Prior to homogenizing the soil or sediment sample, any rocks, twigs, leaves, or other debris should be removed from the sample. The sample should be placed in a decontaminated stainless-steel pan and thoroughly mixed using a stainless-steel spoon or disposable plastic scoop. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

Alternatively, the contents of the scoop/trowel can be placed into dedicated sealable bag. The contents should then be thoroughly mixed by kneading the bag, breaking up any clods.

All stainless-steel spoons, spatulas, and pans must be decontaminated following procedures specified in SOP *Decontamination of Personnel and Equipment* prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

V. Attachments

None.

VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless-steel bowl or dedicated sealable bag.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under Jacobs Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should contact a designated Jacobs HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- Strapping tape
- Contractor bags
- Absorbent pads or equivalent
- Resealable bags
- Bubble bags (for glass bottle ware)
- Bubble wrap (if needed)
- Ice

- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

  - Tape drains shut.
  - Place mailing label with laboratory address on top of coolers.
  - Fill bottom of coolers with absorbent pads or similar material.
  - Place a contractor bag inside the cooler.

B. Affix appropriate adhesive sample labels to each container. Protect with clear packing tape.

C. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks. Cross check CoC to ensure all samples are present.

D. Seal each glass sample bottle within a separate bubble bag (VOCs grouped per sample location). Sample labels should be visible through the bag. Whenever possible, group samples per location for all analytes and place in resealable bags. Make sure to release as much air as practicable from the bag before sealing.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in resealable bags and placed on and around the containers.

G. Fill remaining spaces with bubble wrap if needed.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear packing tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with clear packing tape to avoid seals being able to be peeled from the cooler.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Scan airbill receipt and CoC and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result, only employees who are trained under Jacobs Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should contact a designated Jacobs HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® and water solution
- Pesticide-grade (90%) isopropanol in squeeze bottle
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.
2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.

3. Remove disposable coveralls ("Tyvek") and discard into DOT-approved 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the work day, shower entire body, including hair, either at the work site or at home.
7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Spread plastic on the ground to keep equipment from touching the ground
3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.
4. Turn pump back on and recirculate 1 gallon of Liquinox® solution through the sampling pump for a minute. Turn off the pump and containerize the used solution.
5. Turn pump back on and recirculate 1 gallon of tap water for a minute. (deionized water may be substituted for tap water) Turn off the pump and containerize the used solution.
6. If pump was exposed to non-aqueous phase liquids remove pump from the tube and rinse lightly (a few cc's of solvent is sufficient) with isopropanol, over and through the pump, and allow to air dry. Note that isopropanol is highly flammable and should be used very sparingly and away from potential sources of ignition.
7. Turn pump back on and recirculate 1 gallon of tap water for a minute. (deionized water may be substituted for tap water) Turn off the pump and containerize the used solution.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.

4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. If equipment was exposed to non-aqueous phase liquids rinse lightly with isopropanol and allow to air dry.
7. Rinse with deionized water.
8. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, and finally three times with a towel wet with distilled water. Solvents should not be used to clean plastic instruments as they could cause damage. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, Liquinox® solution (optional), and distilled water.
- Use isopropanol only if heavy organic contamination is present, and then sparingly. Isopropanol should be allowed to evaporate rather than contained as it may render liquid investigation derived waste ignitable.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or frac tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or roll-offs or frac tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes (fill drum ¾, not to top), capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. Check with the Environmental Manager (EM) assigned to the project prior to sample collection for frequency and analysis. Unless otherwise specified by the EM, the drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. Additional analysis may be required by your EM.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Analysis pending labels should be used initially. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to frac tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents as per instruction from the project EM. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills. The drums should be staged such that the labels are all visible and there should be enough room to walk between rows of drums if applicable.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Contact the project Environmental Manager prior to containerizing waste to determine containerization method and sampling frequency and analysis.
- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

STANDARD OPERATING PROCEDURE
NAVY CLEAN PROGRAM

Management of Liquid Waste Containing Per- and Polyfluoroalkyl Substances (PFAS)

I. Purpose and Scope

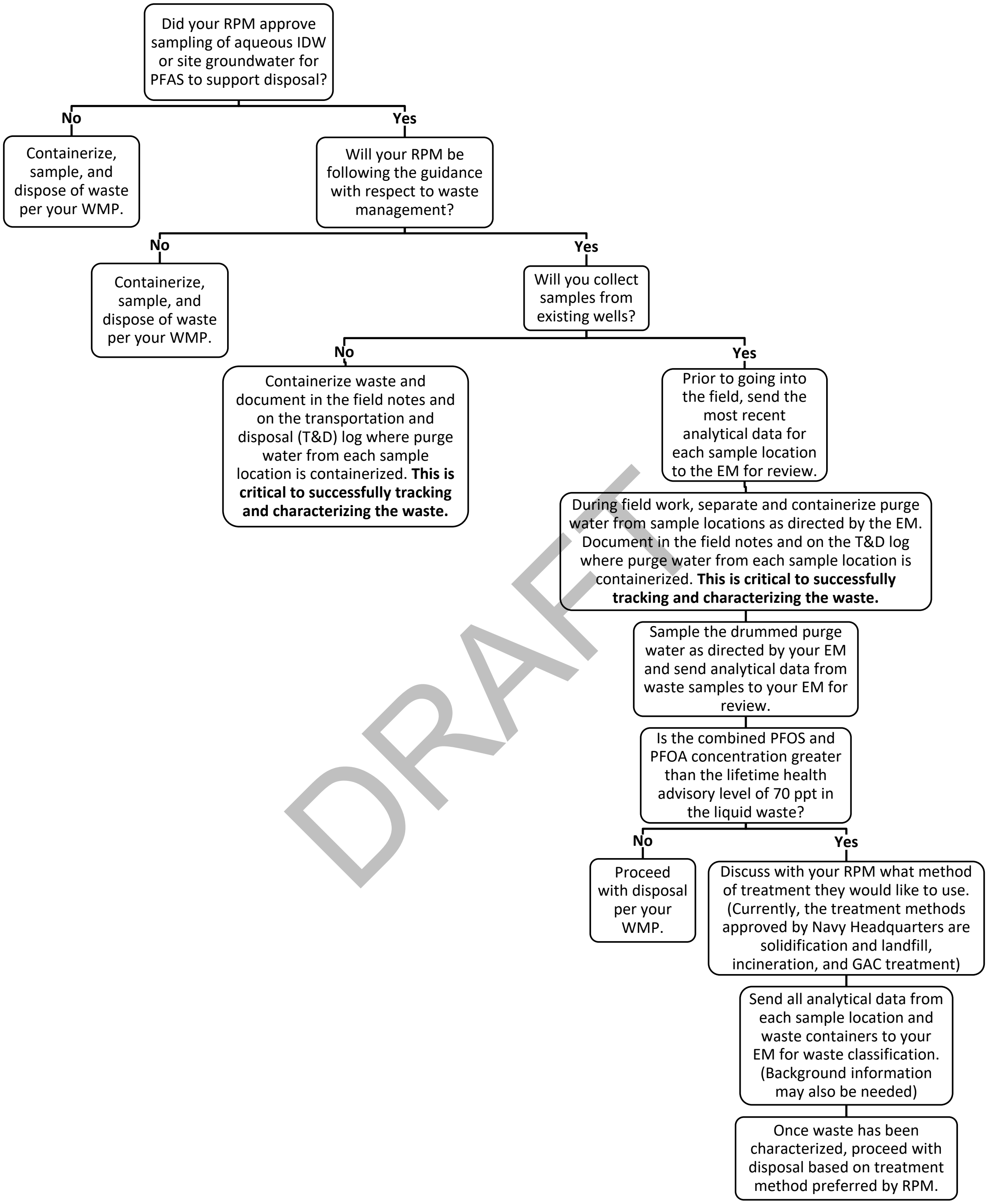
This SOP provides guidelines for managing waste containing per- and polyfluoroalkyl substances (PFAS) in accordance with the Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/November 2020 Update (guidance). This SOP should be used in conjunction with an Environmental and/or Waste Management Plan (EMP and/or WMP) approved by your Environmental Manager (EM). If you do not have a site-specific EMP, please contact your EM.

Standard procedures for managing liquid waste during PFAS investigation are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program.

Currently, PFAS are not regulated as a hazardous waste in US EPA regulations (state and territory rules may vary). Treatment of liquid waste containing PFAS, as recommended by the guidance, is a client directed action. When and how it is implemented will be left to the discretion of the individual RPMs. These project specific actions will be communicated with the Project Manager (PM) and/or Activity Manager (AM).

II. Procedures and Guidelines

The following flowchart outlines the procedures required to manage liquid waste during PFAS investigations. Any deviations from this procedure must be approved by the EM.


Did your RPM approve sampling of aqueous IDW or site groundwater for PFAS to support disposal?
No
Containerize, sample, and dispose of waste per your WMP.
Yes
Will your RPM be following the guidance with respect to waste management?
No
Containerize, sample, and dispose of waste per your WMP.
Yes
Will you collect samples from existing wells?
No
Containerize waste and document in the field notes and on the transportation and disposal (T&D) log where purge water from each sample location is containerized. **This is critical to successfully tracking and characterizing the waste.**
Yes
Prior to going into the field, send the most recent analytical data for each sample location to the EM for review.
During field work, separate and containerize purge water from sample locations as directed by the EM. Document in the field notes and on the T&D log where purge water from each sample location is containerized. **This is critical to successfully tracking and characterizing the waste.**
Sample the drummed purge water as directed by your EM and send analytical data from waste samples to your EM for review.
Is the combined PFOS and PFOA concentration greater than the lifetime health advisory level of 70 ppt in the liquid waste?
No
Proceed with disposal per your WMP.
Yes
Discuss with your RPM what method of treatment they would like to use. (Currently, the treatment methods approved by Navy Headquarters are solidification and landfill, incineration, and GAC treatment)
Send all analytical data from each sample location and waste containers to your EM for waste classification. (Background information may also be needed)
Once waste has been characterized, proceed with disposal based on treatment method preferred by RPM.

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in **Attachment D**.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, and then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

III. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with a MultiRAE or equivalent may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

IV. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safety plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

V. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can

also be used to puncture the drum for sampling. See **Attachment D** for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.

8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.

9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See **Attachments**). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).

11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.
2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.
3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.
4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.
5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.
2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.
3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.
4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)
5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.
6. Sample each trailer compartment.
7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.
8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging,

labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

Drum

Glass tube	—	Procedure 1
COLIWASA	—	Procedure 2

Storage Tank and Tank Trailer

COLIWASA	—	Procedure 2
Bacon Bomb	—	Procedure 3
Gravity Corer (for bottom sludge)	—	Procedure 4

VI. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

IX. References

A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C., 1987.

Data Quality Objectives for Remedial Activities - Development Process, EPA/540/G-87/003, U.S. Environmental Protection Agency, Washington, D.C., 1987.

Annual Book of ASTM Standards, *Standard Recommended Practices for Sampling Industrial Chemicals*, ASTM-E-300, 1986.

Test Method for Evaluating Solid Waste, SW-846, Volume II, Field Methods, Second Edition, U.S. Environmental Protection Agency, Washington, D.C., 1982.

U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites — A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

Environmental Surveillance Procedures, Quality Control Program, Martin Marietta Energy Systems, ESH/Sub/87-21706/1, Oak Ridge, TN, September 1988.

X. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for “waste,” so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.

9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless-steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.
2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler’s locking block.
3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.
5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.
6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.
7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

<u>Uses</u>

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

<u>Procedures for Use</u>

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked “NON SPARKING” is encouraged. However, the use of a “NON SPARKING” wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

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[1] Taken from EPA Training Course: “Sampling for Hazardous Materials,” U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4- foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, “sprayers” may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be "staged," or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time-consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to Jacobs and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on Jacobs to clear the dig locations.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So,while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20-foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility or 811
- Utility location subcontractors (hired by us)

Jacobs internal Subsurface Utility Investigation team

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C.**

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by Jacobs and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These “dig permit” requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

Jacobs Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by Jacobs as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company research will be compiled and must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to Jacobs) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.

- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.
- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the Jacobs-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The Jacobs

subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E defined by the American Public Works Association (APWA) . The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by Jacobs when the dig location (e.g. mechanical drilling, excavating) is expected to be within 3 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.

Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by Jacobs upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A Jacobs representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1) *a 20-ft radius of the XX proposed soil boring locations* (OR) *within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint *(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to Jacobs (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) *The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.*

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of Jacobs.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. Jacobs will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to Jacobs, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the Jacobs Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the Jacobs representative to resume operations. Subcontractor standby time also will include potential delays caused by the Jacobs representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and Jacobs representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on Jacobs's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and Jacobs representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility or 811
- Utility location subcontractors (hired by Jacobs)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "811 One Call" Services for Public Utility Mark-outs

Miss Utility or "811 One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "811 One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Miss (?) Utilities and is part of the response process for Miss Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "811 One Call" services are free to the public. Note that the "811 One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "811 One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all Jacobs field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort,

including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, Jacobs may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, Jacobs will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			☐					
Utilities Search, Inc.*	Jim Davis 703-369-5758	☐				☐	☐	☐	☐
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	☐					☐	☐	☐
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	☐	☐						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	☐	☐	☐	☐	☐	☐	☐	☐
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	☐	☐	☐	☐	☐	☐	☐	

Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	☐	☐	☐	☐	☐	☐	☐	☐

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that Jacobs requests for this type of work at many Navy sites.

[1] Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2] Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

Jacobs In-house Utility Location Experts

Steve Saville/KNV

Home Office Phone – 720-261-5367

Nick Jones/DEN

Home Office Phone- 303-478-0655

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

PMS 219

PMS 1795*

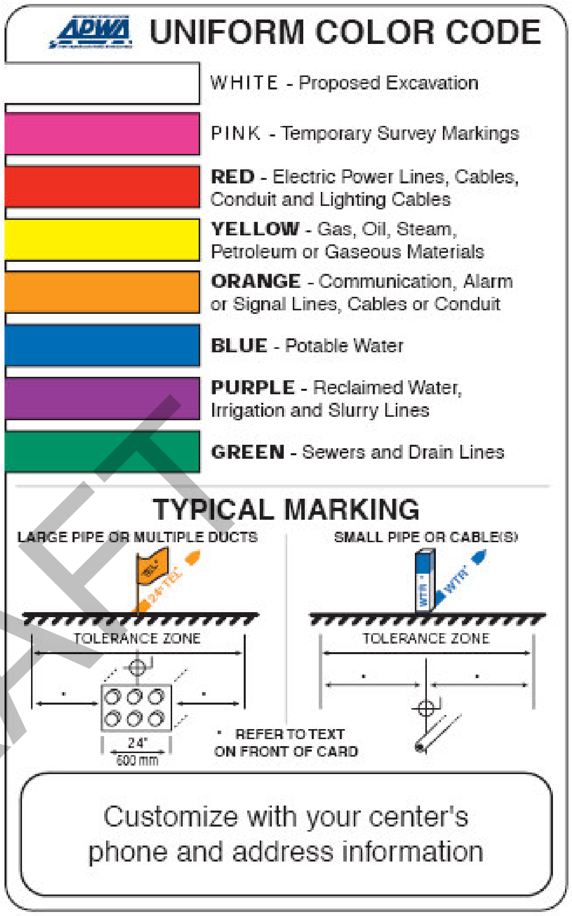
PMS 108

PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

PMS 3415



UNIFORM COLOR CODE

WHITE - Proposed Excavation

PINK - Temporary Survey Markings

RED - Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials

ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit

BLUE - Potable Water

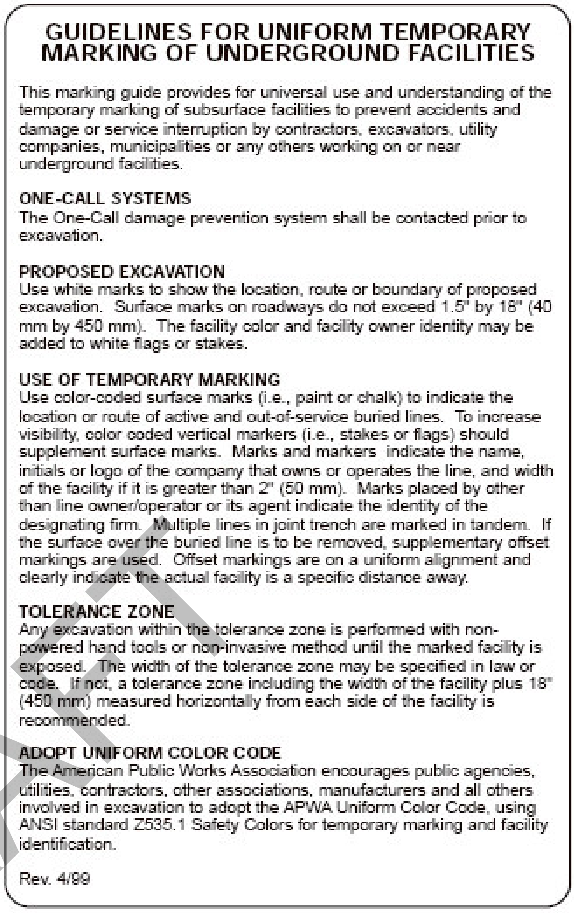
PURPLE - Reclaimed Water, Irrigation and Slurry Lines

GREEN - Sewers and Drain Lines

TYPICAL MARKING

* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information



GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

Buried Utility Location Tracking Form

(Submit to Jacobs PM within 24 hrs of location activities)

Project Location:
Jacobs Project No.:
Jacobs Project Manager: Name/Phone:
Fax:
Email:
Jacobs Field Team Leader: Name/Phone:

Jacobs Purchase Order:

Utility Location Subcontractor:
Subcontractor POC:

Dates of location activities:

	Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.																	
Station ID	**Gas (Yellow)**	**Electric (Red)**	**Fiber optic (Orange)**	**Cable (Orange)**	**Water (Blue)**	**San. Sewer (Green)**	**Storm Sewer (Green)**	**Steam (Yellow)**	**Petroleum (Yellow)**	**Compressed air (Yellow)**	**Other ___**	**Other ___**	**Other ___**	**Other ___**	**Date completed**	**Technician initials**	Notes (methods/tools used

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the Jacobs scope of work.

Subcontractor's Signature

Date

STANDARD OPERATING PROCEDURE

General Guidance for Monitoring Well Installation

I. Purpose

To provide site personnel with a review of the well installation procedures that will be performed. These procedures are to be considered general guidelines only and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

II. Scope

Monitoring well installations are planned for shallow and/or deep unconsolidated aquifers and/or for bedrock aquifers. The SOPs *Installation of Shallow Monitoring Wells, Installation of Surface-Cased Monitoring Wells, Installation of Bedrock Monitoring Wells,* and *Installation of Monitoring Wells Using Sonic Drilling* provide more specifics.

III. Equipment and Materials

1. Drilling rig (hollow stem auger, sonic, air hammer, air rotary, or mud rotary) without per- and polyfluoroalklyl substances (PFAS)-containing components (Avoid Teflon, Viton, PTFE and all other fluorinated compounds). This includes drilling and well development equipment.
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite[1], grout, and surface-finish materials). Ensure all materials are PFAS-free.
3. Development equipment
4. Ensure the driller has not used and will not use drilling lube containing polytetrafluoroethylene (PFTE) or any other fluorine-containing substance. Biolube has been determined to be an acceptable substitute.

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[1] Do not use coated bentonite pellets. Polymer coated bentonite formulations have been shown to contain PFAS.

5. Do not use water from the facility (e.g. fire hydrants) for decontamination of equipment or preparation of grout mix if there is a possibility that the water available is contaminated with PFAS.

IV. Procedures and Guidelines

1. Wells will be installed in accordance with standard EPA procedures. Note that USEPA Region III requires any well penetrating a confining layer to be double-cased.
2. The threaded connections will be water-tight.
3. Well screens generally will be constructed of 10-slot or 20-slot Schedule 40 PVC and will be 5 to 10 feet in length depending on saturated thickness of unconsolidated sediments. The exact slot size and length will be determined by the field team supervisor. Stainless-steel may be required under certain contaminant conditions.
4. Stick-up wells will be surrounded by four concrete-filled guard posts at least 2 inches in diameter.
5. A record of the finished well construction will be compiled.
6. All soils and liquids generated during well installations will be drummed for proper disposal.

Monitoring Well Installation

- 2" monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless-steel) screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base of the well to 2 feet above

the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.

Screen Size Opening (Inches)	Screen Size Slot Number	Typical Sand Pack Mesh Size (U.S. Standard Sieve Number)
0.005	5	100
0.010	10	20 to 40
0.020	20	10 to 20
0.030	30	10 to 20

- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary, the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.
- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage. A grout density scale is recommended for determining the correct density. See attached grout volume and weights chart for calculation of grout volume.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.

- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.
- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis and transport the drums to a designated site for storage.

V. Attachments

Grout Volume and Weights Chart

VI. Key Check and Items

- Ensure that all equipment is properly decontaminated as needed.
- Only new, sealed materials (e.g., screens, risers, and sand) will be used in constructing the well.

- Care shall be taken when making downhole measurements to ensure that proper heights of sand, seal, and grout are achieved.

Bentonite as % of cement weight	Density	Mixing water		Volume of Slurry
		gal/94 lb sack	ft^3/94 lb sack	ft^3/94 lb sack
2%	1.73	6.98	0.94	1.43
	1.77	6.53	0.88	1.37
	1.80	6.08	0.82	1.31
	1.84	5.63	0.76	1.25
	1.88	5.18	0.69	1.19
4%	1.63	8.79	1.18	1.68
	1.66	8.34	1.12	1.62
	1.68	7.89	1.06	1.56
	1.71	7.44	1.00	1.50
	1.74	6.98	0.94	1.44
7%	1.59	9.91	1.33	1.84
	1.61	9.46	1.27	1.78
	1.63	9.01	1.21	1.72
	1.65	8.56	1.15	1.66
	1.68	8.11	1.09	1.60
8%	1.53	11.72	1.57	2.10
	1.54	11.27	1.51	2.04
	1.56	10.81	1.45	1.98
	1.57	10.36	1.39	1.92
	1.59	9.91	1.33	1.86

No. of bags	Volume of cement		Weight of cement	Volume of water		Weight of water	Volume of Bentonite	Weight of Bentonite	Volume of Slurry		Slurry density
	gallons	ft3	lbs	gallons	ft3	lbs	ft3	lbs	gallons	ft3	lbs/gall.
1	3.59	0.48	94.00	6.53	0.87	54.39	0.01	1.88	10.70	1.43	14.69
1	3.59	0.48	94.00	6.53	0.87	54.39	0.01	1.88	10.25	1.37	14.69
1	3.59	0.48	94.00	6.08	0.81	50.65	0.01	1.88	9.80	1.31	14.99
1	3.59	0.48	94.00	5.63	0.75	46.90	0.01	1.88	9.35	1.25	15.31
1	3.59	0.48	94.00	5.63	0.75	46.90	0.01	1.88	8.90	1.19	15.31
1	3.59	0.48	94.00	8.79	1.17	73.22	0.02	3.76	12.57	1.68	13.59
1	3.59	0.48	94.00	8.34	1.11	69.47	0.02	3.76	12.12	1.62	13.78
1	3.59	0.48	94.00	7.80	1.04	64.97	0.02	3.76	11.67	1.56	14.04
1	3.59	0.48	94.00	7.44	0.99	61.98	0.02	3.76	11.22	1.50	14.22
1	3.59	0.48	94.00	6.98	0.93	58.14	0.02	3.76	10.77	1.44	14.48
1	3.59	0.48	94.00	9.80	1.31	81.63	0.04	6.58	13.77	1.84	13.27
1	3.59	0.48	94.00	9.46	1.26	78.80	0.04	6.58	13.32	1.78	13.40
1	3.59	0.48	94.00	9.10	1.21	75.80	0.04	6.58	12.87	1.72	13.54
1	3.59	0.48	94.00	8.56	1.14	71.30	0.04	6.58	12.42	1.66	13.76
1	3.59	0.48	94.00	8.11	1.08	67.56	0.04	6.58	11.97	1.60	13.97
1	3.59	0.48	94.00	11.72	1.56	97.63	0.05	7.52	15.71	2.10	12.69
1	3.59	0.48	94.00	11.27	1.50	93.88	0.05	7.52	15.26	2.04	12.82
1	3.59	0.48	94.00	10.81	1.44	90.05	0.05	7.52	14.81	1.98	12.96
1	3.59	0.48	94.00	10.36	1.38	86.30	0.05	7.52	14.36	1.92	13.10
1	3.59	0.48	94.00	9.91	1.32	82.55	0.05	7.52	13.91	1.86	13.26

Bags of cement	1		Weight of cement =	94.00	lbs
Volume of cemer	0.48	ft3	Weight of water =	64.97	lbs
Volume of watei	7.8	gallons	Total weight =	158.97	lbs
Volume of watei	1.04	ft3			
Total volume of slu	1.52	ft3	Slurry density	13.93	lbs/gall.

Bentonite as percent of cement	**Sacks of Cement**	**Volume of cement**		**Weight of cement**	**Volume of water**		**Weight of water**	**Weight of Bentonite**	**Volume of Bentonite**	**Volume of Slurry**		**Slurry density**	
		gallons	**ft3**	**lbs**	**gallons**	**ft3**	**lbs**	**lbs**	**ft3**	**gallons**	**ft3**	**lbs/gal.**	**SG**
4%	1	3.59	0.48	94	7.80	1.04	64.97	3.76	0.02	11.56	1.55	14.04	1.68
	2	7.18	0.96	188	15.60	2.08	129.95	7.52	0.05	23.12	3.09	14.04	1.68
	3	10.77	1.44	282	23.40	3.12	194.92	11.28	0.07	34.68	4.64	14.04	1.68
	4	14.36	1.92	376	31.20	4.17	259.90	15.04	0.10	46.25	6.18	14.04	1.68
	5	17.95	2.40	470	39.00	5.21	324.87	18.80	0.12	57.81	7.73	14.04	1.68
	6	21.55	2.88	564	46.80	6.25	389.84	22.56	0.15	69.37	9.27	14.04	1.68
	7	25.14	3.36	658	54.60	7.29	454.82	26.32	0.17	80.93	10.82	14.04	1.68
	8	28.73	3.84	752	62.40	8.33	519.79	30.08	0.19	92.49	12.36	14.04	1.68
	9	32.32	4.32	846	70.20	9.37	584.77	33.84	0.22	104.05	13.91	14.04	1.68
	10	35.91	4.80	940	78.00	10.41	649.74	37.60	0.24	115.61	15.45	14.04	1.68

STANDARD OPERATING PROCEDURE

Installation of Monitoring Wells by Sonic Drilling

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of groundwater monitoring wells and piezometers in unconsolidated or poorly consolidated materials using sonic drilling techniques. Sonic drilling technology potentially eliminates telescoping monitoring wells, allowing the installation of aquifer penetrating, single-cased wells.

II. Equipment and Materials

Drilling

- Sonic drilling rig without per- and polyfluoroalklyl substances (PFAS)-containing components (Avoid Teflon, Viton, PTFE and all other fluorinated compounds). This includes drilling and well development equipment.
- Override casings and core barrel
- Ensure the driller has not used and will not use drilling lube containing polytetrafluoroethylene (PFTE) or any other fluorine-containing substance. Biolube has been determined to be an acceptable substitute.
- Do not use water from the facility (e.g. fire hydrants) for decontamination of equipment or preparation of grout mix if there is a possibility that the water available is contaminated with PFAS.

Well Riser/Screen

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainless steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless-steel screen.

Bottom Cap

- PVC, threaded to match the well screen; alternatively, stainless-steel
- Centering guides (if used)

Well Cap

- Above-grade well completion: PVC, threaded or push-on type, vented
- Flush-mount well completion: PVC, locking, leak-proof seal
- Stainless-steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- PFAS-free Pure, additive-free bentonite pellets
- PFAS-free Pure, additive-free powdered bentonite
- PFAS-free Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 pounds of bentonite added per bag of cement to reduce shrinkage

Protective Casing

- Above-grade well completion: 6-inch minimum ID black iron steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: 8-inch or 12-inch dia. manhole cover, or equivalent; rubber seal to prevent leakage

Well Development

- Surge block
- Well-development pump and associated equipment
- Calibrated meters to measure pH, temperature, specific conductance, and turbidity of development water
- Containers (e.g., 55-gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Drill rods and core barrel with a minimum 6-inch inside diameter (ID) will be used to drill monitoring well boreholes. Continuous core soil samples (4-inches outside diameter) will be collected for lithologic classification and intervals may be selected for chemical analysis. Soil sampling procedures are detailed in SOP *Shallow Soil Sampling*.

The use of water and additives to assist in sonic drilling for monitoring well installation will be minimized, unless required for such conditions as running sands or drilling bedrock formations.

Override casings, core barrels, and other downhole drilling tools will be decontaminated prior to the initiation of drilling activities and between each borehole location. Core barrels and other downhole soil sampling equipment will also be decontaminated before and after each use. SOP *Decontamination of Drilling Rigs and Equipment* details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the Sampling and Analysis Plan.

B. Monitoring Well Installation

Sonic drilling technology eliminates the necessity to install double or triple cased wells since the borehole will be fully cased during drilling activities. Monitoring wells will be constructed inside the override casing(s), once the borehole has been advanced to the desired depth. Following setting the well screen, riser, filter pack, and bentonite seal, the well will be grouted as the temporary casing is withdrawn, preventing cross contamination. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or a bentonite-cement slurry to a depth approximately 2 feet below the intended well depth. Approximately 2 feet of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the temporary casing to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 0.010-inch slotted screen and Morie No. 01 (or DSI No.2) silica sand for 0.020-inch slotted screen will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The inner-most override casing will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the innermost override casing be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will extend from the bottom of the borehole to a minimum of 2 feet above the top of the well screen. A secondary, finer-grained sand pack may be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for a shallow water table and small saturated thickness of the surficial aquifer.

A bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to discharge laterally into the borehole and not disturb the bentonite pellet seal.

C. Well Completion

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 2 feet into the ground and 3 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans) and poured into wooden forms. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing, within the edges of the concrete pad. Guard posts will be concrete-filled, at least 2 inches in diameter, and will extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber gasket and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12-inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

C. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a tight-fitting surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, turbidity and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of one hour until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring well construction (MWSingleDiag.xls)

PROJECT NUMBER	WELL NUMBER SHEET 1 OF 1

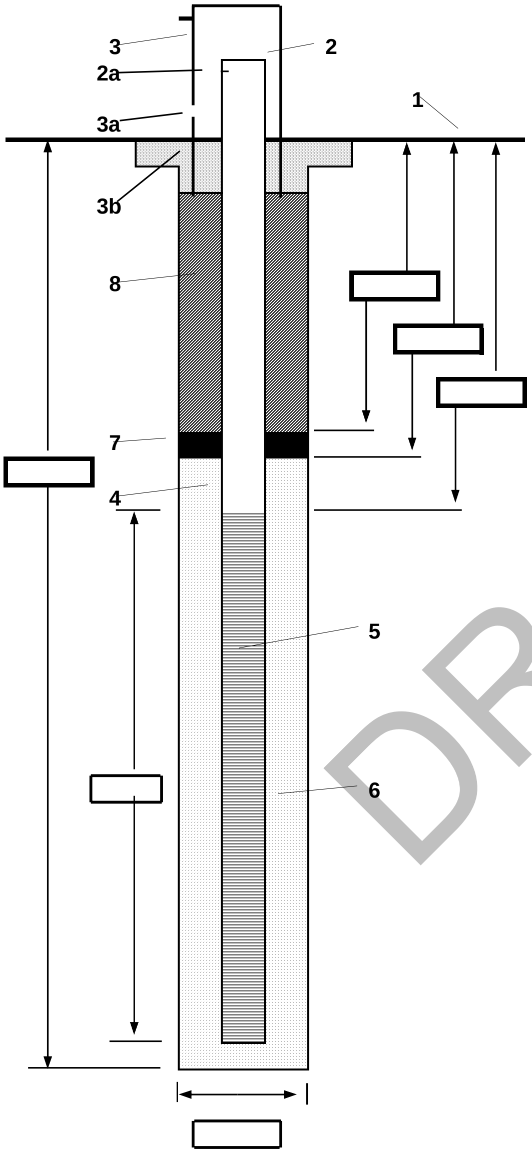
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well ____________

2- Top of casing elevation ____________

a) vent hole? ____________

3- Wellhead protection cover type ____________

a) weep hole? ____________

b) concrete pad dimensions ____________

4- Dia./type of well casing ____________

5- Type/slot size of screen ____________

6- Type screen filter ____________

a) Quantity used ____________

7- Type of seal ____________

a) Quantity used ____________

8- Grout

a) Grout mix used ____________

b) Method of placement ____________

c) Vol. of well casing grout ____________

Development method ____________

Development time ____________

Estimated purge volume ____________

Comments ____________

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- 2.5% (W/W) Liquinox® and water solution
- Buckets
- Brushes
- Isopropanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM–Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

   Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

   - Rinse with Liquinox® and water solution
   - Rinse with de-ionized water
   - Solvent rinse with isopropanol (Optional)
   - Rinse with de-ionized water

2. Probes

   Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, PID equipment, the probe will be wiped with clean paper-towels or cloth wetted with isopropanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

STANDARD OPERATING PROCEDURE

Civil Surveying

I. Purpose and Scope

The SOP describes survey procedures to be used on CLEAN projects. Modified third-order survey procedures will be used for most surveying. Geographic Positioning System techniques will be used for measurement of some horizontal coordinates. These procedures are general guidelines only and are in no way intended to replace the specifications in the surveyor's subcontract.

II. Records and Definitions

All field notes should be kept in bound books. Each book should have an index. Each page of field notes should be numbered and dated and should show the initials of all crew members. The person taking field notes will be identified in the log. Information on weather (wind speed/wind direction, cloud cover, etc.) and on other site conditions should also be entered in the notes. Notes should also include instrument field identification number and environmental settings. Graphite pencils or waterproof ballpoint pens should be used. Erasing is not acceptable; use a single-strike-through and initial it. The notekeeping format should conform to the *Handbook of Survey Notekeeping* by William Pafford. A survey work drawing with grid lines and at the scale of the topographic map should be prepared for all survey field work. Field notebooks will be available on site.

The following terms are defined to clarify discussion in this SOP:

- North American Datum (NAD) -The standard geodetic datum on the North American continent.
- National Geodetic Vertical Datum (NGVD) - The vertical-control datum used (1929 or later) by the National Geodetic Survey for vertical control.
- Horizontal Control - Horizontal location of an object from surveyed corners or other features on permanent land monuments in the immediate site area. Will be based on North American Datum (NAD) 1983 and state plane grid systems.
- Vertical Control - Vertical location of an object compared to the adjacent ground surface.
- Bench Mark - Precisely determined elevation above or below sea level. May also have horizontal control (northing, easting) determined for location.

III. Surveying

Horizontal Survey

Horizontal angular measurements shall be made with a 20-second or better theodolite or transit. When using a 20-second instrument the horizontal angles shall be turned four times (two each direct and inverted) with the mean of the fourth angle being within 5 seconds of the mean of the second angle. When using a 10-second or better instrument the angles shall be doubled (once each direct and inverted), with the mean of the second angle within 5 seconds of the first angle. The minimum length of any traverse courses shall be 300 feet.

Distance measurements shall be made with a calibrated steel tape corrected for temperature and tension or a calibrated electronic distance meter (EDM). When using an EDM the parts per million (PPM), curvature and refraction corrections shall be made. Vertical angle measurements used for distance slope corrections shall be recorded to the nearest 20 seconds of arc deviation from the horizontal plane. Horizontal locations will be surveyed to within 0.05-foot of the true location.

Horizontal traverse stations shall be established and referenced for future use. All stations shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The station shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, or iron rod and cap.

The horizontal location will be referenced to NAD83 and the appropriate state plane grid system.

Some horizontal coordinates will be measured using Geographic Positioning System (GPS) equipment. This approach will be used in particular for determining the coordinates of surface-water and sediment sampling locations, and may be used also for determining the locations of piezometers and monitoring wells. The GPS survey will be performed by staff trained in the use of the equipment and will conform to guidance provided by the manufacturer.

Vertical Survey

When practical, vertical control will be referenced to the National Geodetic Vertical Datum (NGVD) of 1929, obtained from a permanent benchmark. If practical, level circuits should close on a known benchmark other than the starting benchmark. The following criteria shall be met in conducting the survey:

- Instruments shall be pegged weekly or after any time it is dropped or severely jolted.
- Foresight and backsight distances shall be reasonably balanced and shall not be greater than 250 feet in length.
- No side shot shall be used as a beginning or ending point in another level loop.
- Rod readings shall be made to 0.01-foot and estimated to 0.005-foot.

- Elevations shall be adjusted and recorded to 0.01-foot.

Temporary benchmarks (TBMs) shall be established and referenced for future use. All TBMs shall be described in the field notes with sufficient detail to facilitate their recovery at a later date. The TBMs shall consist of a permanent mark scribed on facilities such as sidewalks, curbs, concrete slabs, etc. or spikes set in the base of trees (not power poles), or tops of anchor bolts for transmission line towers, etc. (Horizontal traverse stations will not be considered as a TBM but may be used as a permanent turning point.)

Traverse Computations and Adjustments

Traverses will be closed and adjusted in the following manner:

- Step One—Coordinate closures will be computed using unadjusted bearings and unadjusted field distances.
- Step Two—Coordinate positions will be adjusted (if the traverse closes within the specified limits) using the compass rule.
- Step Three—Final adjusted coordinates will be labeled as "adjusted coordinates." Field coordinates should be specifically identified as such.
- Step Four—The direction and length of the unadjusted error of closure, the ratio of error, and the method of adjustment shall be printed with the final adjusted coordinates.

Level Circuit Computations and Adjustments

Level circuits will be closed and adjusted in the following manner:

- For a single circuit, elevations will be adjusted proportionally, provided the raw closure is within the prescribed limits for the circuit.
- In a level net where the elevation of a point is established by more than one circuit, the method of adjustment should consider the length of each circuit, the closure of each circuit, and the combined effect of all the separate circuit closures on the total net adjustments.

Piezometer and Monitoring-Well Surveys

Piezometer and monitoring-well locations will be surveyed only after the installation of the protective casing, which is set in concrete. The horizontal plane survey accuracy is ±0.05-foot and is measured to any point on the protective-casing cover. The vertical plane survey must be accurate to ±0.01-foot. The following two elevations will be measured at piezometers and monitoring wells:

- Top of the piezometer or well riser (not on the protective casing), preferably on the north side
- Ground surface, preferably on the north side of the well

If no notch or mark exists, the point at which the elevation was measured on the inner casing shall be described so that water-level measurements may be taken from the same location.

Grid Surveys

Selected soil boring locations may be located by the survey crew after the soil borings are complete. The selected borings will be staked in the field by the field team leader. The stake will be marked with the boring number for reference. The horizontal plane survey accuracy is ± 1 foot and is measured to any point on the ground surface immediately adjacent to the stake.

Exhibit A

STANDARDS FOR MODIFIED THIRD-ORDER PLANE SURVEYS

Traverse

Max Number of bearing courses between azimuth checks	30
Astronomical bearings: standard error of results	6"
Azimuth closure at azimuth checkpoint not to exceed	20" $\sqrt{N}$
Standard error of the mean for length measurements	1 in 50,000
Position closure per loop in feet before azimuth adjustment	1:10,000

Leveling

Levels error of closure per loop in feet	0.05 $\sqrt{M}$

N = the number of stations for carrying bearing
M = the distance in miles

STANDARD OPERATING PROCEDURE

Global Positioning System

I. Purpose

The procedure describes the calibration, operation, and functions associated with a Trimble® GeoExplorer® 6000 series. The GeoExplorer 6000 series includes the GeoXH™ and GeoXT™ handhelds. These handhelds combine a Trimble GNSS receiver with a field computer powered by Microsoft Windows Mobile version 6.5 operating system. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

II. Scope

This procedure provides information regarding the field operation and general maintenance of a Trimble® GeoExplorer® 6000 series. The information contained herein presents the operation procedures for this equipment. Review of the equipment's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the equipment.

III. Definitions

GPS: Global Positioning System - A system of satellites developed and operated by the US DOD. Continuous 3D coordinate information is broadcast free of charge on a worldwide basis enabling precise positional location. The GeoExplorer 6000 series handheld includes an integrated GNSS receiver that enables the collection of GPS and GLONASS data for incorporating into a GIS or for managing assets.

GPS (Global Positioning System) and GLONASS (GLObal NAvigation Satellite System) are Global Navigation Satellite Systems (GNSS). Each system consists of a constellation of satellites that orbit the earth. GNSS provides worldwide, all-weather, 24-hour time and position information.

IV. Procedures and Guidelines

The procedure for calibration, operation, and maintenance of the GPS unit is outlined below. Daily calibration and battery recharging is typical operating procedure; frequencies other than daily shall be noted in the logbook and reason for increased frequency recorded. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

The procedures described below include additional features pre-programmed into the GPS datalogger to aid the data collection process.

A. GeoExplorer 6000 Unit

Parts of the GeoExplorer 6000 series handheld

The following diagrams show the main parts of the handheld.

Keypad buttons

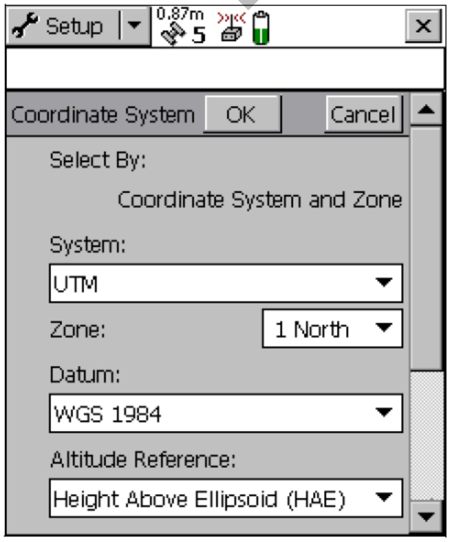
The GeoExplorer 6000 series handheld has a keypad for fast, easy access to common actions. LEDs provide visual notifications of system events.

B. Operations for surveying coordinates of a location

The TerraSync software consists of five sections as described below:

Use this section …	to …
Map	view features, background files, and the GPS trail graphically
Data	work with data files: • create a new data file or open an existing data file • log base station data to file or broadcast real-time corrections • collect new features or maintain existing features • move, copy, delete, or rename data and background files
Navigation	navigate to features using the *Direction Dial* and *Close-up* screens, or the graphical lightbar
Status	view information about: • the satellites the TerraSync software is tracking, their relative positions in the sky, and your current position • the predicted satellite constellation and position quality over the next 12 hours • communication ports that the TerraSync software is using • your GPS receiver and real-time correction source • the current UTC time • the TerraSync software version and trademark information
Setup	configure the TerraSync software

1. Configure coordinate settings: To open the **Coordinate System** form, tap Coordinate System in the Setup screen. Use this form to specify the coordinate system you want the TerraSync software to display foreground and background files.



Coordinate System

Select By: Coordinate System and Zone

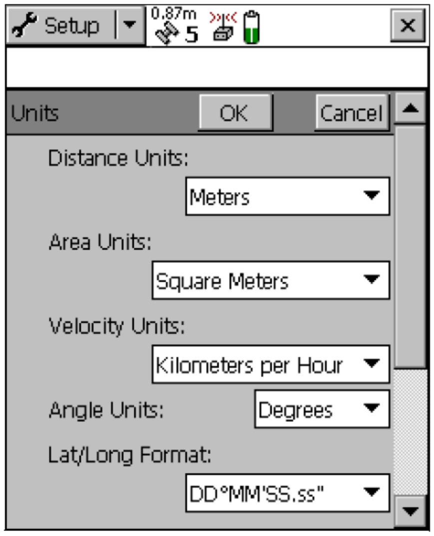
System: UTM

Zone: 1 North

Datum: WGS 1984

Altitude Reference: Height Above Ellipsoid (HAE)

2. Configure unit settings: To open Units form, tap **Units** in the Setup screen. Use this form to specify the units used for measurements and display.



Distance Units: Meters

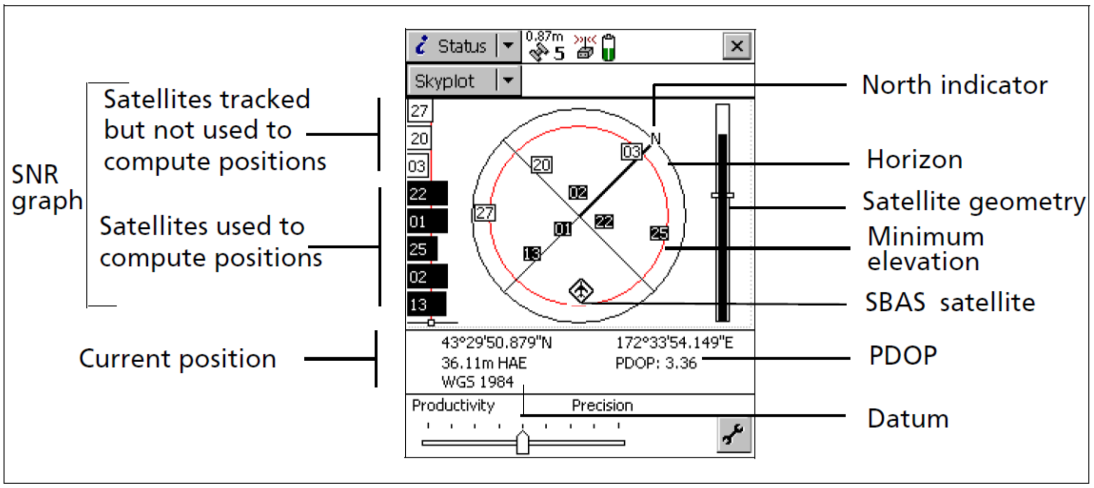
Area Units: Square Meters

Velocity Units: Kilometers per Hour

Angle Units: Degrees

Lat/Long Format: DD°MM'SS.ss"

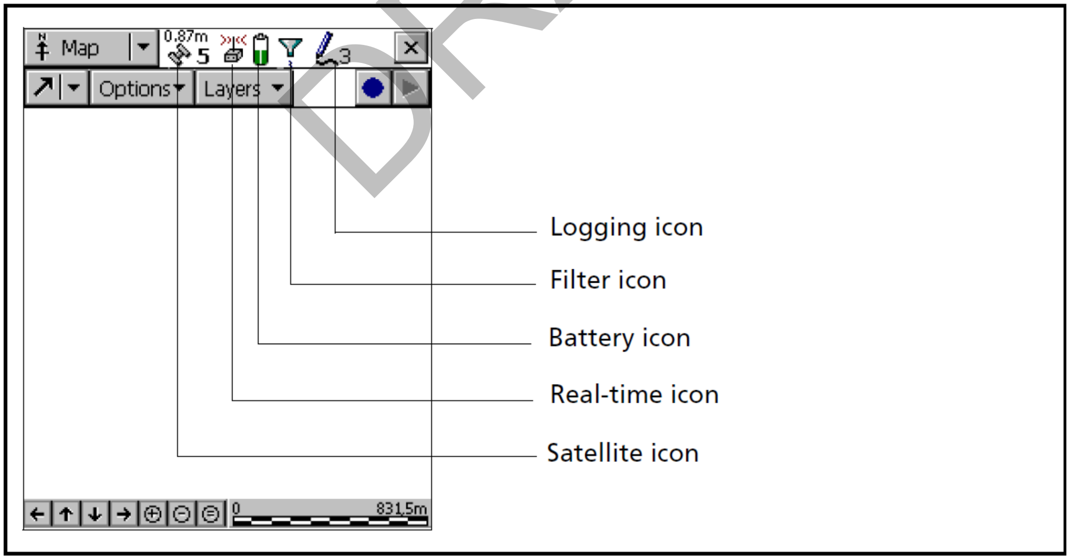
3. Starting the TerraSync Software:
   - When you are outside and ready to begin, switch on your data collector and start the TerraSync software. The GPS receiver should activate automatically.
   - On the Microsoft Windows® or Windows Mobile® taskbar, tap the windows icon and the select Programs/TerraSync. While the software is loading, a Trimble identification screen appears.
4. Getting a clear view of the sky. Move to a location where the receiver has a clear view of the sky. Signals can be received from any direction. Satellite signals can be blocked by people, buildings, heavy tree cover, large vehicles, or powerful transmitters. GPS signals can go through leaves, plastic, and glass, but they will weaken the signal.
5. Checking the GPS status. When you start the TerraSync software, it automatically connects to the GPS receiver and begins to track visible satellites to calculate its current position. Use the satellite icon on the status bar to check whether the receiver is computing GPS positions.
6. To view the GPS status: The Skyplot screen appears when you first run the TerraSync software. If this screen is not visible, tap the Section button, select Status, tap the Subsection list button and then select Skyplot.



43°29'50.879"N
36.11m HAE
WGS 1984
172°33'54.149"E
PDOP: 3.36

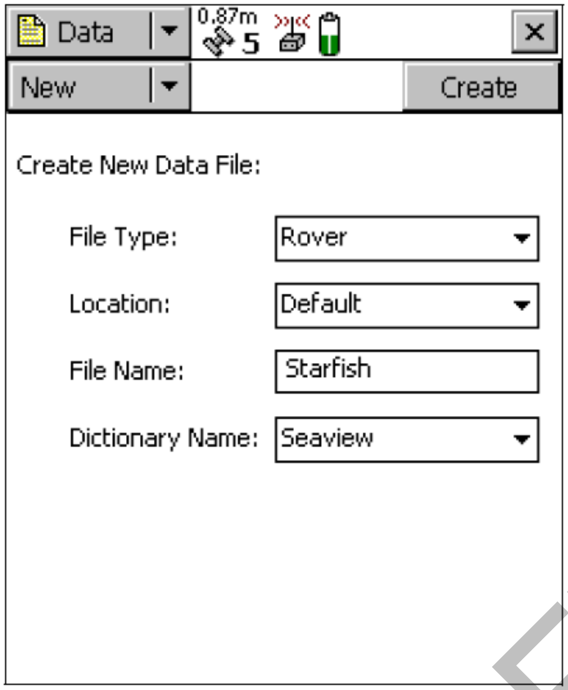
- Filled black boxes represent satellites that the receiver is using to compute its current GPS position.
- White boxes represent satellites that the receiver is getting signals from but is not using because the signals are too weak.

7. You need a minimum of four satellites with good geometry to computer a 3D GPS position.
8. Status Bar: The status bar appears in the top row of the TerraSync screen. It is always visible, but the icons displayed depend on the current status of the TerraSync software.



9. Creating a New Data File: Before starting the data collection session, you need t create a new data file to store the new features and attributes you collect. Use the Data section to do this.
    - Tap the Section list button and then select Data

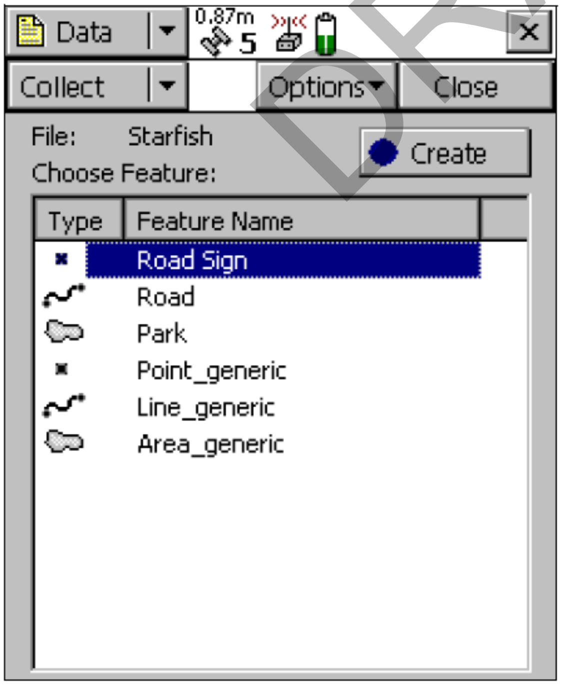
- Tap the Subsection list button and then select New.



Create New Data File:

File Type: Rover
Location: Default
File Name: Starfish
Dictionary Name: Seaview

- In the Dictionary Name field, select a data dictionary.
- Tap **Create**. The Collect Features screen appears:



File: Starfish
Choose Feature:

Type	Feature Name
	Road Sign
	Road
	Park
	Point_generic
	Line_generic
	Area_generic

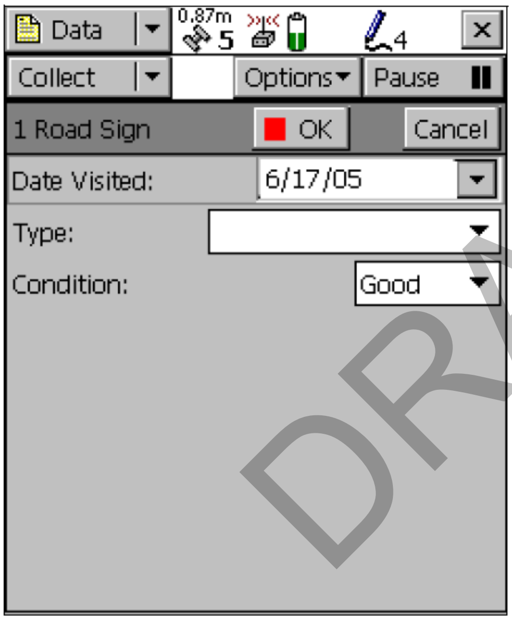
10. Collecting a Point Feature: When you record a point feature, you remain stationary for some time. The TerraSync software logs a number of GPS positions during this time.

These positions are averaged together to compute the final GPS position of the point feature.

When the TerraSync software is logging GPS positions, the logging icon appears in the status bar. The number beside the icon indicates how many positions have been logged for the selected feature. It is recommended that a minimum of 20 positions are logged prior to recording the feature.

To record a Point Feature:

- Ake sure the Collect Features screen is open.
- In the Choose Feature list, highlight an appropriate point feature and then tap **Create**. The attribute entry form for the feature type appears:
- Fill in the attribute field with appropriate values



Date Visited: 6/17/05

Type:

Condition: Good

- Once you have reached the desired amount of positions, tap OK to close the road sign feature. The attribute entry form closes and you are returned to the Collect Features screen.
- Refer to the TerraSync Orientation Guide for steps on how to collect other features.

11. Ending the data collection session: When the data collection session is complete, close the data file and then exit the Terra Sync software.

    - In the Collect Features screen, tap **Close**.
    - A message appears asking you to confirm that you want to close the open file. Tap **Yes** to close.

- Tap the X button in the top right corner of the screen.
- A message appears asking you to confirm that you want to close the TerraSync software. Tap **Yes** to close.

C. Preventive Maintenance

Data should be downloaded from the datalogger a minimum of once daily, twice daily is preferred. At the end of each day the receiver batteries should be recharged. For technical assistance call the rental company through which you acquired the Trimble® unit. Guidance is also provided in the manual and at http://www.trimble.com.

V. References

GeoExplorer® 6000 series, Trimble, February 2011.

TerraSync and GPS Pathfinder Office Software Guide, December 2006

Sediment Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose and Scope

This SOP provides guidelines for sediment sample collection and handling for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified at the time of analysis. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

A. Equipment and Materials Required

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device). Check with your PFAS subject matter expert (SME) during field preparation to ensure all equipment is free of fluorine-containing components.
- Stainless steel spoon or spatula or fluorine-free plastic disposable scoop for media transfer
- Measuring tape
- GPS Unit
- PFAS-free labels (if available[1]) shipping materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard (if using loose-leaf paper)
- Pen (not Sharpie)
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.). Check with your SME prior to selecting PPE to ensure there are no fluorine-containing components.
- Materials for classifying soils, particularly the percentage of fines
- Sample jars (high density polyethylene [HDPE] with HDPE screw cap [no Teflon caps])
- Laboratory prepared deionized, certified PFAS-free water for field blank collection

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[1] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

B. Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect soil samples should not contain any fluorinated compounds including Teflon or synthetic rubber with fluoropolymer elastomers (e.g. Viton).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings.
- New clothing that has been washed fewer than six times.

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Wash hands with dish detergent before sampling and don nitrile gloves. Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine.

Once the area has been determined to be free of materials potentially containing PFAS, these steps can be followed to collect the sediment samples:

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc.).
3. Note in the field book any possible outside sources of contamination; for example, the outlet to a drainage culvert in the water body near your sampling location.
4. Transfer sample into appropriate sample jars with a stainless steel utensil or plastic disposable scoop confirmed to be fluorine-free. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the

water off the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay. Affix the sample label to the container after the container has been closed; collect only one sample at a time to avoid mislabeling.

5. Rocks and other debris should be removed before placement in jars.
6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loess silt and muck) which can make wading difficult.
7. Immediately upon collection, all samples are to be placed in a closed container on ice. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible.
8. Equipment Decontamination
    - Whenever possible, use disposable equipment when collecting sediment samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

IV. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).* September.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic Acid.* September.

STANDARD OPERATING PROCEDURE
NAVY CLEAN PROGRAM

Surface Water Sampling for Per- and Polyfluoroalkyl Substances

I. Purpose and Scope

This SOP provides guidelines for surface water sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with the most recent version of the Quality Systems Manual (QSM) for which the lab is certified at the time of analysis. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Materials and Equipment

A. Equipment and Materials Required

- Open tube sampler
- Dip sampler
- Weighted bottle sampler (no glass)
- Hand pump without Teflon components
- Van Dorn sampler (Kemmerer cannot be used as it has Teflon caps)
- Depth-integrating sampler
- Peristaltic pump and PFAS-free tubing
- High density polyethylene tubing (unlined)
- Masterflex tubing such as Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
- Sample containers (high density polyethylene [HDPE] with HDPE screw cap [no Teflon caps])
- PFAS-free labels (if available[1]) and shipping materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard

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[1] Efforts will be made to obtain PFAS-free labels; however, information on labels is scarce and labels are frequently mounted on PFAS-coated paper to allow for easy removal.

- Pen (not Sharpie)
- Nitrile or Latex gloves (Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine)
- Meters for specific conductance, temperature, pH, and dissolved oxygen

Equipment and materials used to collect surface water samples should not contain any fluorinated compounds including Teflon or synthetic rubber with fluoropolymer elastomers (e.g. Viton). Neoprene and rubber waders should not be an issue, however, check with your PFAS subject matter expert (SME) during field preparation to ensure all equipment is free of fluorine-containing components.

B. Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect groundwater samples should not contain any fluorinated compounds, Teflon, or synthetic rubber with fluoropolymer elastomers (e.g., Viton).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard brand or similar water repellent, fluoropolymer-coated Tyvek, wrinkle-resistant fabrics, and fire-resistant clothing with fluorochemical treatment or anything advertised as water repellant.
- Weather-proof log books with fluorochemical coatings.
- New clothing that has been washed fewer than six times.

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellant and other personal hygiene products that may contain PFAS

Research which has not yet been published has allowed us to generate a list of sunscreens and insect repellents which do not contain fluorine. Check with Bill Diguiseppi or Laura Cook on recommendations (because the research is not ours, it cannot be released externally at this time).

III. Procedures and Guidelines

Wash hands with dish detergent before sampling and don nitrile gloves. Do not use Kleen Guard powder free nitrile gloves which were shown in research to contain fluorine.

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment* as well as this SOP (see below). Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Once the area has been determined to be free of materials potentially containing PFAS, follow the methods for surface water sample collection described below.

Surface water samples are collected manually by submerging a clean stainless steel or polypropylene container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline provided the bottle or bottle cap does not contain Teflon. The most common sampler types are sealable bottles, pond samplers, peristaltic pumps, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. A specific type of weighted bottle sampler is the Van Dorn and is acceptable in most instances. The Kemmerer weighted bottle sampler cannot be used for PFAS sampling due to the Teflon caps.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time. Fill all sample containers to the middle of the bottle shoulder. Do not fill bottles completely. Affix labels after sample containers are closed; collect only one sample at a time to avoid mislabeling.
5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

A. Equipment Decontamination

Whenever possible, use disposable equipment when collecting surface water samples. If reusable equipment must be used, the equipment must be cleaned/decontaminated between uses. Alconox and Liquinox soap are acceptable for cleaning/decontaminating reusable equipment at PFAS sites. Any water used for cleaning/decontamination must be certified PFAS-free by a laboratory. Consider triple-rinsing. Once decontaminated, wrap equipment in plastic bags (such as Ziploc), and store away from potential PFAS sources.

Use of Water Quality Equipment

Water quality meters typically do not contain PFAS. However, consistent with general sampling SOPs, disconnect the water quality meter prior to sampling.

IV. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS).* September.

United States Navy, 2015. *Navy Drinking Water Sampling Policy for Perfluorochemicals: Perfluorooctane Sulfonate and Perfluorooctanoic Acid.* September.

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books (hard copy and electronic) during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities. Field notes may be recorded in field log books or electronically on computer tablets.

III. Equipment and Materials

- Log book
- Indelible pen
- Jacobs supplied electronic tablet or laptop with notebook software

IV. Procedures and Guidelines

Properly completed field log books are a requirement for all of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Rite in the Rain® or Sanford Sharpie® permanent markers. **Note:** for sites where PFC is being analyzed for, Rite-in-the-Rain®, Sanford Sharpie®, or anything water-resistant or with Teflon® cannot be used in the field. All field book materials must be “fluorine free”. Acceptable substitutes would be a sewn notebook

without a plastic cover, or loose-leaf notebook paper.

2. Alternatively, field notes may be recorded electronically in Jacobs provided field tablets or laptop computers. Notes are recorded in appropriate note collection software; e.g., Microsoft One Note. At the end of each day, the electronic notes must be digitally signed by the author and downloaded for electronic file storage. The notes may be converted to an Adobe pdf file prior to storage. It is important that the field notes be downloaded daily to ensure the electronic time stamp of the notes is the same as the day the notes were recorded.

3. On the inside cover of the log book the following information should be included:

    - Company name and address
    - Log-holders name if log book was assigned specifically to that person
    - Activity or location
    - Project name
    - Project manager's name
    - Phone numbers of the company, supervisors, emergency response, etc.

4. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

5. If field notes are recorded electronically, the author will not have any spaces between entries.

6. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

7. Daily entries will be made chronologically.

8. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

9. Each page of the log book will have the date of the work and the note takers initials.

10. The final page of each day's notes will include the note-takers

signature as well as the date.

11. Only information relevant to the subject project will be added to the log book.

12. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector’s memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work

plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Draw a box around the sample ID so that it stands out in the field notes
    - Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)

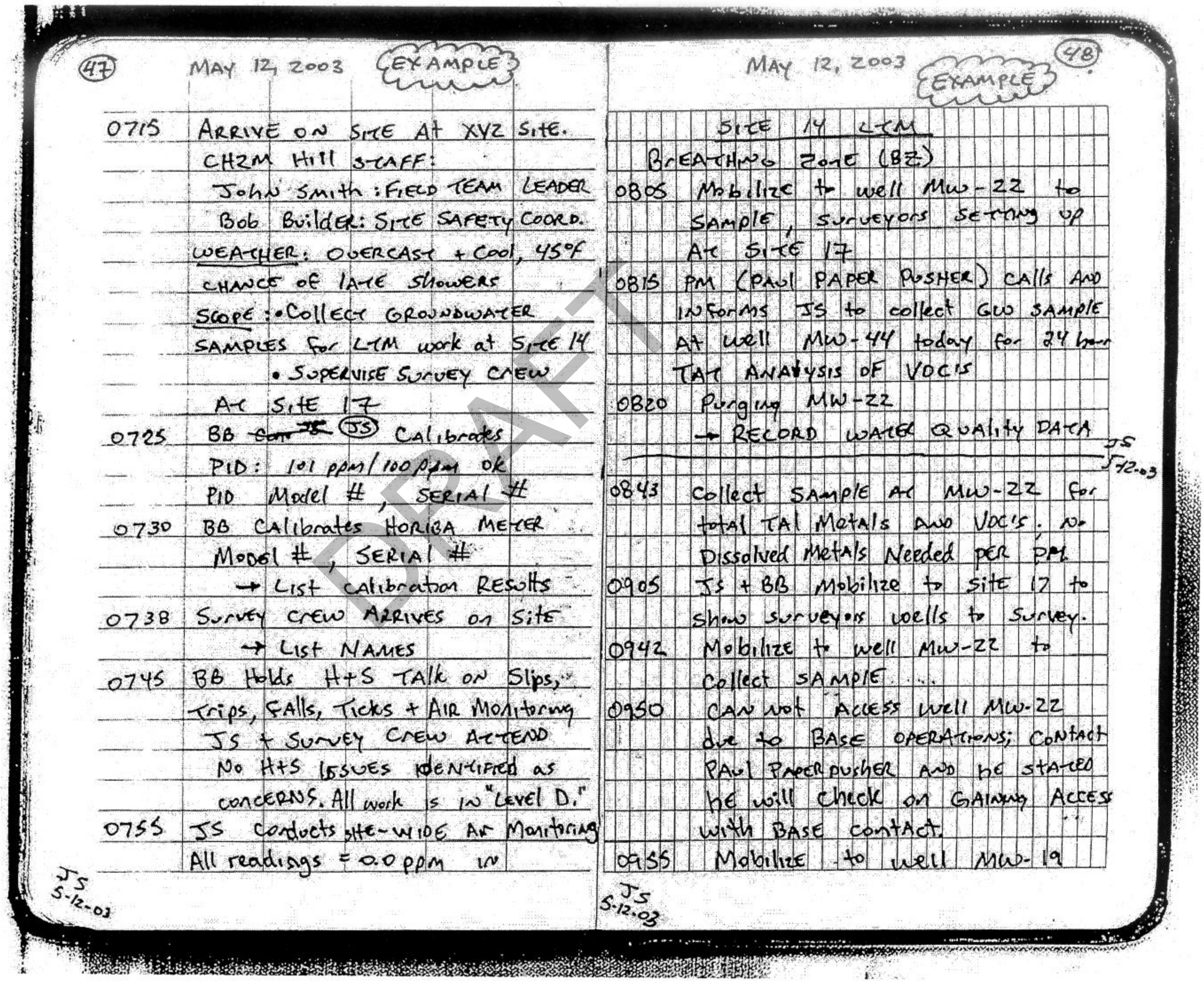
- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.



(47) MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M Hill STAFF:
John Smith : FIELD TEAM LEADER
Bob Builder: SITE SAFETY COORD.
WEATHER: OVERCAST + Cool, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • Collect GROUNDWATER
SAMPLES for LTM work at Site 14
• SUPERVISE SURVEY CREW
AT SITE 17
0725 BB ~~Con JS~~ JS Calibrates
PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #
0730 BB Calibrates HORIBA METER
Model #, SERIAL #
→ List calibration Results
0738 Survey crew ARRIVES on Site
→ List NAMES
0745 BB Holds H+S TALK ON Slips,
Trips, Falls, Ticks + AIR Monitoring
JS + SURVEY CREW ATTEND
No H+S ISSUES IDENTIFIED as
concerns. All work is in "Level D."
0755 JS conducts site-wide Air Monitoring
All readings = 0.0 ppm in

JS
5-12-03

MAY 12, 2003 EXAMPLE (48)

SITE 14 LTM
BREATHING ZONE (BZ)
0805 Mobilize to well MW-22 to
SAMPLE, surveyors setting up
AT SITE 17
0815 PM (PAUL PAPER PUSHER) CAlls AND
INFORMS JS to collect GW SAMPLE
AT well MW-44 today for 24 hour
TAT ANALYSIS OF VOC'S
0820 Purging MW-22
→ RECORD WATER QUALITY DATA

JS
5-12-03

0843 Collect SAMPLE AT MW-22 for
total TAL Metals AND VOC'S. No
Dissolved Metals Needed per PM.
0905 JS + BB Mobilize to site 17 to
show surveyors wells to survey.
0942 Mobilize to well MW-22 to
collect SAMPLE...
0950 CAN not ACCESS well MW-22
due to BASE OPERATIONS; Contact
PAUL PAPERPUSHER AND he stated
he will check on GAINING ACCESS
with BASE contact.
0955 Mobilize to well MW-19

JS
5-12-03

STANDARD OPERATING PROCEDURE

Soil Boring Drilling and Abandonment

I. Purpose and Scope

The purpose of this guideline is to describe methods to obtain samples of subsurface soil using either hollow-stem auger, rotary, or sonic drilling methods, or tripod-mounted rig and then backfill boreholes to the surface. The guideline covers both split-spoon sampling and thin-walled tube sampling and includes soil borings through surface casings installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units.

II. Equipment and Materials

- Truck-mounted drilling rig, skid rig, or tripod rig
- Hollow-stem augers and associated equipment or either rotary-drilling or sonic-drilling equipment
- Black iron steel or Schedule 80 PVC casing, at least 6-inch inside diameter (if surface casing is required), or sonic rig with telescoping casing
- Split-spoon or thin-walled tube samplers
- Downhole compacting tool (e.g., a pipe with a flat plate attached to the bottom)
- Cement
- Bentonite

III. Procedures and Guidelines

A. Drilling

Continuous-fight hollow-stem augers (HSA) with an inside diameter of at least 3.25 inches typically are used. The use of water or other fluid to assist in hollow-stem drilling will be avoided. Rotary drilling will be with a similar minimum diameter.

The bit of the auger or drill is placed on the ground at the location to be drilled and then turned with the drilling or soil-coring rig. The drilling is advanced to a depth just above the top of the interval to be sampled. For sonic drilling, a continuous core is collected and the sample interval is selected from the length of core run.

While advancing the auger or drill to the full borehole depth, the soils removed from the boring will be screened using a portable volatile organics detector.

A tripod drilling rig is generally a tripod equipped to collect soil samples using a hammer-driven sampler. The soil sample collection will be the same as that outlined for hollow-stem and rotary drilling. Borehole collapse due to soft sediments may occur when collecting samples using a tripod drilling rig.

Temporary surface casing may be installed where soil borings will penetrate a confining layer. The surface casing will be installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units. Typically, surface casing has a 6-inch inside diameter (ID).

If the split-spoon sampling is to be advanced with a 3.25-inch ID and 7.25-inch outside diameter (OD) HSA, it will be necessary to pull the 3.25-inch augers and ream the hole with a minimum 10.25-inch ID HSA for the installation of the temporary surface casing. Alternatively, if the split-spoon sampling is advanced with mud-rotary drilling, it would require a 10.25-inch rotary bit to make room for the 6-inch ID surface casing.

The surface casing will be seated at least 5 feet into an underlying clay or silt layer and will be sealed in place using a bentonite slurry or bentonite pellets. This seal will prevent movement of groundwater downward from the shallow water-bearing unit but will allow the casing to be removed easily when the split-spoon sampling is completed. The split-spoon sampling will then be advanced with a 6-inch mud-rotary bit.

B. Sampling

Using the drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically, this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight "hammer" dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded on the boring log and/or field notebook. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations. Samples will be collected from the soil borings at 2-foot to 5-foot intervals. For sonic drilling, a continuous core is collected, and the sample interval is selected from the length of core run.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. Samples may be collected for chemical analysis. These samples are collected in either decontaminated steel split-spoon samplers or new plastic sleeves for sonic drilling. Sampling the soil for chemical analysis is described in SOP *Soil Boring Sampling – Split Spoon.*

Undisturbed fine-grained samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for geochemical analysis normally are not collected from thin-walled tube samples. More details are provided in the ASTM D 1587 standard (attached).

C. Abandonment

The borehole will be grouted from total depth to the surface with bentonite-cement grout. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface. When installing grout in soil borings, the grout will be installed through a tremie pipe that is placed inside the augers or to the bottom of the borehole. The grouting will be completed before the augers or any temporary casing or drilling mud is removed.

D. Decontamination and Waste Disposal

Before sampling begins, equipment will be decontaminated according to the procedures identified in SOPs *Decontamination of Personnel and Equipment* and *Decontamination of Drilling Rig and Equipment*. The location to be sampled is cleared of debris and trash, and the location is noted in the logbook.

The soil cuttings are to be drummed and managed as described in SOP *Disposal of Waste Fluids and Soils* and the investigation-derived waste management plan.

IV. Attachments

ASTM D 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils*

V. Key Checks and Preventative Maintenance

- Check that the drilling rig or soil-coring rig is in working order.
- Check that the borehole is grouted to the ground surface at the completion of drilling and sampling.

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCL, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the soil boring log form (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for ASTM D1586, a standard soil boring log form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both sample jar labels and on the log sheets.

B. Heading Information

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as “approximate” or “estimated” as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger, sonic). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. Technical Data

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as “WOH.”

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil consistency of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An “N” value need not be calculated.

Soil Description. The soil classification should follow the format described in the “Field Classification of Soil” subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils.

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density (coarse grained) or consistency (fine grained)
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as “Interlayered Sand and Silt,” should be used. In addition, the relative proportion of each soil type should be indicated (see **Table 1** for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on **Table 2**.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in **Tables 3 and 4**.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch OD, and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch OD). A stiffer rod, such as an "N" rod (2-5/8-inch OD), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

Soil Boring Log Form with a completed example (Soil_Log_Examp.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

VI. References

ASTM D2488-17e1, Standard Practice for Description and Identification of Soils (Visual-Manual Procedures), ASTM International, West Conshohocken, PA, 2017, www.astm.org

ASTM D1586 / D1586M-18, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, ASTM International, West Conshohocken, PA, 2018, www.astm.org

JACOBS

PROJECT NUMBER

BORING NUMBER

SOIL BORING LOG

PROJECT :
LOCATION :
ELEVATION :
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED :
ATD WATER LEVEL :
START :
END :
LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	SAMPLE #/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N')	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	USCS	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. DRILLING ACTIONS/DRILLER COMMENTS PID Readings: Breathing Zone: Above Hole:

CH2M HILL

PROJECT NUMBER	BORING NUMBER SHEET OF

SOIL BORING LOG

PROJECT ______ LOCATION ______

ELEVATION ______ DRILLING CONTRACTOR ______

DRILLING METHOD AND EQUIPMENT ______

WATER LEVELS ______ START ______ FINISH ______ LOGGER ______

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION

Figure 1
SOIL BORING LOG, FORM D1586

(B-30)

REV 11/89 FORM D1586

CH2M HILL

PROJECT NUMBER DEN 22371.G5	BORING NUMBER BL-3 SHEET 1 OF 3

SOIL BORING LOG

PROJECT Howard Ave Landslide LOCATION Howard & 24th Ave, Centennial, CO
ELEVATION 5136 Feet DRILLING CONTRACTOR Kendall Explorations, Ashcan, Colorado
DRILLING METHOD AND EQUIPMENT 4"-inch H.S. Augers, Mobil B-61 rotary drill rig
WATER LEVELS 3.2 Feet, 8/5/89 START August 4, 1989 FINISH August 8, 1989 LOGGER J.A. Michner

DEPTH BELOW SURFACE (FT)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	COMMENTS
	INTERVAL	NUMBER AND TYPE	RECOVERY (FT)	6"-6"-6" (N)	SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					Surface material consist of 4 inches AC underlain by 6 inches of 3/4 inch minus base rock	Start Drilling @ 3:00
	2.5					
	4.0	1-S	1.5	2-3-4 (7)	POORLY-GRADED SAND WITH SILT, (SP-SM), fine, light brown, wet, loose	Driller notes water at 4 feet
	5.0					Driller notes very soft drilling 4ft. dark grey, wet silty cuttings.
5	6.5	2-S	0.9	WOH/12"-1	ORGANIC SILT, (OL), very dark, gray to black, wet, very soft, strong H_2S odor, many fine roots up to about 1/4 inch	
	8.0					
	10.0	3-ST	1.3	—	ORGANIC SILT, similar to 2-S, except includes fewer roots (by volume)	
10	11.5	4-S	1.3	2-2-2 (4)	SILT, (ML), very dark gray to black, wet, soft	water level @ 3.2 feet on 8/5/89 @ 0730 Driller notes rough drilling action and chatter @ 13ft
15	15.0 15.5	5-S	0.5	60/6"	SILTY GRAVEL, (GM), rounded gravel up to about 1 inch maximum observed size, wet, very dense	
						Driller notes smoother, firm drilling @ 19 ft
20	20.0 21.0	6-S	1.0	12-50/6"	LEAN CLAY WITH SAND, (CL), medium to light green, moist, very stiff	some angular rock chips @ bot tip of 6-S, poss boulders or rock Driller notes very hard, slow grinding, smooth drilling action from 21 to 23 ft, possibly bedrock
	23.0 23.1	7-S	-0-	50/1"	NO RECOVERY	
					END SOIL BORING @ 23.1 FEET SEE ROCK CORE LOG FOR CONTINUATION OF BL-3	

Figure 2
EXAMPLE OF COMPLETED LOG FORM

Table 1
EXAMPLE SOIL DESCRIPTIONS

POORLY GRADED SAND (SP), light brown, moist, loose, fine sand size

FAT CLAY (CH), dark gray, moist, stiff

SILT (ML), light greenish gray, wet, very loose, some mica, lacustrine

WELL-GRADED SAND WITH GRAVEL (SM), reddish brown, moist, dense, subangular gravel to 0.6 inches max

POORLY GRADED SAND WITH SILT (SP-SM), white, wet, medium dense

ORGANIC SOIL WITH SAND (OH), dark brown to black, wet, firm to stiff but spongy undisturbed, becomes soft and sticky when remolded, many fine roots, trace of mica

SILTY GRAVEL WITH SAND (GM), brownish red, moist, very dense, subrounded gravel to 1.2 inches max

INTERLAYERED SILT (60 percent) AND CLAY (40 percent): SILT WITH SAND (ML), medium greenish gray, nonplastic, sudden reaction to shaking, layers mostly 1.5 to 8.3 inches thick; LEAN CLAY (CL), dark gray, firm and brittle undisturbed, becomes very soft and sticky when remolded, layers 0.2 to 1.2 inches thick

SILTY SAND WITH GRAVEL (SM), light yellowish brown, moist, medium dense, weak gravel to 1.0 inches max, very few small particles of coal, fill

SANDY ELASTIC SILT (MH), very light gray to white, wet, stiff, weak calcareous cementation

LEAN CLAY WITH SAND (CL/MH), dark brownish gray, moist, stiff

WELL-GRADED GRAVEL WITH SILT (GW-GM), brown, moist, very dense, rounded gravel to 1.0 inches max

Table 2
CRITERIA FOR DESCRIBING MOISTURE CONDITION

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

Table 3
RELATIVE DENSITY OF COARSE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Relative Density	Field Test
0-4	Very loose	Easily penetrated with ½-in. steel rod pushed by hand
5-10	Loose	Easily penetrated with ½-in. steel rod pushed by hand
11-30	Medium	Easily penetrated with ½-in. steel rod driven with 5-lb hammer
31-50	Dense	Penetrated a foot with ½-in. steel rod driven with 5-lb hammer
>50	Very dense	Penetrated only a few inches with ½-in. steel rod driven with 5-lb hammer

Table 4
CONSISTENCY OF FINE-GRAINED SOIL
(Developed from Sowers, 1979)

Blows/Ft	Consistency	Pocket Penetrometer (TSF)	Torvane (TSF)	Field Test
<2	Very soft	<0.25	<0.12	Easily penetrated several inches by fist
2-4	Soft	0.25-0.50	0.12-0.25	Easily penetrated several inches by thumb
5-8	Firm	0.50-1.0	0.25-0.5	Can be penetrated several inches by thumb with moderate effort
9-15	Stiff	1.0-2.0	0.5-1.0	Readily indented by thumb, but penetrated only with great effort
16-30	Very stiff	2.0-4.0	1.0-2.0	Readily indented by thumbnail
>30	Hard	>4.0	>2.0	Indented with difficulty by thumbnail

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Stainless-steel is preferred. However, split spoons, which are most commonly available in carbon steel are acceptable for use only if they are not rusty.
- A stainless-steel spatula or disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit (if available)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

   1. For samples on a grid:

      a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

   b. Proceed to sample the points on the grid line.

   c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

   d. Proceed to sample the points on the grid line as described in Section C below.

   e. Repeat 1c and 1d above until all samples are collected from the area.

   f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

2. For non-grid samples:

   a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

   b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

   c. Proceed to sample as described in Section C below.

   d. Repeat 2a through 2c above until all samples are collected from the area.

   e. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents' activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point will be deleted from the program. The FTL will contact the project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless-steel scoop/trowel or disposable plastic scoop to scrape away surficial organic material (grass, leaves, etc.) adjacent to the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

   a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

   b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take a photo ionization detector (PID) reading of the sampled soil if organics are anticipated to be present and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless-steel pan or dedicated sealable bag.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel or scoop or specialized sampling equipment (i.e. Encore® or Terra Core® sampler) and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless-steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.

8. For TCL PCBs, soil samples should include rocks and hard chunks encountered. The extraction procedure may require that the lab screen the soil to eliminate rocks larger than 3/8 inch in diameter, but the criteria are too complicated to allow a decision to be made in the field.

9. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

10. Immediately upon collection, all samples for chemical analysis are to be placed in a closed container on ice unless it is not possible to do so. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible

11. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

STANDARD OPERATING PROCEDURE

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, scoop, coring device, hand auger, or other appropriate hand tool
- Split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan/bowl or disposable sealable bags
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel trowel or disposable plastic scoop is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling.*

B. Split-Spoon Sampling

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically, this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless-steel tray or disposable sealable bag. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

C. Thin-Walled Tube Sampling

Undisturbed fine grained samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for geochemical analysis normally are not collected from thin-walled tube samples.

IV. Attachments

ASTM D 1586 *Standard Penetration Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils* (ASTM D1587.pdf)

V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough.
- Check that sample collection is swift to avoid loss of volatile organics during sampling.

STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual, if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula or plastic disposable scoop for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and

consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).

3. Note in the field book any possible outside sources of contamination; for example, the outlet to a drainage culvert in the water body near your sampling location.
4. Transfer sample into appropriate sample jars with a stainless-steel utensil or plastic disposable scoop. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.
6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.
7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.
8. Immediately upon collection, all samples for chemical analysis are to be placed in a closed container on ice unless it is not possible to do so. Although unusual and uncommon, there may be instances where it is not possible to have containers with ice at the sample location. In these instances, the samples should be placed on ice as soon as practical and during the time between collection and placing the samples on ice, the samples should be kept as cool as possible.
9. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
10. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.

- Log exact locations using permanent features.
- Beware of hidden hazards.

STANDARD OPERATING PROCEDURE

Vibracore Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples using a vibracore over water during field operations.

II. Scope

The procedures herein describe necessary equipment procedures, and documentation for the collection of representative sediment from a vibracore sample.

III. Equipment and Materials

- Ensure that the sampling vessel is appropriate for anticipated sampling conditions (mooring, core deployment and recovery system, vessel draft).
- Nautical charts and tide tables
- Marine VHF radio and cellular telephone
- US Coast Guard (USCG) required vessel safety device, including personal flotation device (PFD)
- Appropriate vessel navigation and position recording equipment, including shore side reference station beacon and tide staff gage installed onsite
- Fathometer and bar gauge or equivalents for recording depth to sediment
- Vibratory core barrel of appropriate sampling length, and polycarbonate core liner material, if required
- Decontaminated core cutter (nose cone) and sample retainer (catcher) assemblies
- Decontaminated core cutting and sample processing equipment
- Decontamination supplies, including wash down pump and hoses
- Steel tape measure
- Sample coolers and ice
- Log book

- Personal protective equipment (nitrile gloves, rubber boots, rain gear, etc.)

IV. Procedures and Guidelines

1. Inspect decontaminated core cutter and core retainer assemblies prior to vessel departure.
2. Conduct tailgate health and safety meeting at the launch site, prior to vessel departure. Review day's planned sampling activities to ensure that all required equipment is onboard the vessel, and that the planned sampling order is appropriate. Program sample location coordinates into onboard navigation system and confirm that they were determined in the proper coordinate system and datum for the site.
3. Sampling will begin downstream and work upstream to prevent contamination of unsampled areas. For tidally influenced sites, sampling will be scheduled to coincide with low tide and under low flow conditions when possible to minimize the dilution of possible contaminants.
4. Confirm that land-based reference beacon (if used) and differential GPS (DGPS) links have been established, and GPS antenna is over sample location, and antenna offsets have been measured to correct for the actual sampling location.
5. Inspect tide staff gage and record water surface level to the nearest 0.1'.
6. Navigate to sampling location and anchor in position, securing the mooring to minimize the effects of current and wind. Follow all vessel crew instructions, remaining clear of equipment and moorage rigging.
7. Once vessel is in position; at the direction of the vessel crew, record sampling station ID, depth to sediment from the vessel decking using a bar gauge and fathometer, depth to water from vessel deck, position coordinates, position relative to fixed reference points, weather, and water surface conditions.
8. Prior to the advancement of the core, ensure that winch cable, push rod, or vibracore barrel have been measured and clearly marked in order to record penetration depth and note changes in drilling advancement or effort.
9. Core assembly is lowered or pushed until penetrative depth or refusal has been encountered. Record depth of penetration, vessel position, time, and apparent sampling conditions. As soon as is practicable following sampling, record water surface level reading from the staff gage. In the event of sample refusal relocate within 5' and repeat procedure from Step 6.
10. Observe vessel crew instructions and clear the sampling portal or boom area as core is retrieved, monitor worker breathing space air quality.

11. Once vessel crew has secured the core barrel inspect the barrel cutter head. Provide qualitative description of cutter head catch condition, or soil if retained.

12. Ensure that external sampling equipment is decontaminated using site water and a decontaminated brush, while not disturbing the open end of the core barrel.

13. Label sample end cap for base of sample, remove cutter head assembly, affix end cap, and decontaminate cutter head assembly.

14. Once suspended sediment has had adequate time to settle following sample staging (15-30 minutes), measure total recovery, using a decontaminated tape, calculate and record recovered percentage.

15. Cut or drill a small drain slit above the water-sediment interface, above the depth of recovered sediment and decant supernatant water. Once water has been decanted cut excess sample barrel or liner approximately 1" above the water-sediment interface, label end cap and affix to barrel. Dry barrel and label with an indelible marker. Sample labeling should include up and down designations with the sample number on the end caps, and directional arrows on the barrel or liner body. Cut barrel sections to fit staging coolers, transfer labeled samples to coolers immediately post-processing.

V. Attachments

None

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

STANDARD OPERATING PROCEDURE

Surface Water Grab Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Sampling and Analysis Plan should be consulted for project-specific details. Equipment used to collect surface water grab samples includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Peristaltic pump
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. Surface water samples collected from tidally influenced water bodies should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants.

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, peristaltic pumps, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly.

Specific types of weighted bottle samplers include Kemmerer or Van Dorn and are acceptable in most instances.

A sample is collected with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.
5. Collect water quality parameters (pH, specific conductance, temperature, oxidation-reduction potential [ORP], turbidity, total dissolved solids [TDS], and dissolved oxygen [DO]) using a handheld water quality meter and record in the logbook.

IV. Attachments

None.

V. Key Checks and Items

- Start downstream, work upstream
- Log exact locations using permanent features
- Beware of hidden hazards

Appendix B

Laboratory Department of Defense Environmental Laboratory Accreditation Program Letters

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2017) General Requirements for the competence of Testing and Calibration Laboratories and the United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP) requirements identified within the DoD/DOE Quality Systems Manual (DoD/DOE QSM) Version 5.3 May 2019 and is accredited is accordance with the:

United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)

This accreditation demonstrates technical competence for a defined scope and the
operation of a laboratory quality management system
(as outlined by the joint ISO-ILAC-IAF Communiqué dated April 2017):

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen

Tracy Szerszen
President

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
November 17, 2016	February 22, 2021	March 31, 2023

Accreditation No:	*Certificate No.:*
91667	L21-123

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 533	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
Drinking Water	EPA 533	LC/MS/MS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
Drinking Water	EPA 533	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (Adona)
Drinking Water	EPA 533	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Drinking Water	EPA 533	LC/MS/MS	Nonafluoro-3,6-Dioxaheptanoic Acid (NFDHA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-butanoic Acid (PFBA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Drinking Water	EPA 533	LC/MS/MS	1H,1H,2H,2H-Perfluorodecane sulfonate (8:2FTS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro(2-ethoxyethane)sulfonic Acid (PFEESA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-1-heptanesulfonate (PFHpS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Drinking Water	EPA 533	LC/MS/MS	1H,1H,2H,2H-Perfluorohexane sulfonate (4:2FTS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-3-Methoxypropanoic Acid (PFMPA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-4-Methoxybutanoic Acid (PFMBA)
Drinking Water	EPA 533	LC/MS/MS	Perfluorononanoic acid (PFNA)
Drinking Water	EPA 533	LC/MS/MS	1H,1H,2H,2H-Perfluorooctane sulfonate (6:2FTS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-pentanoic acid (PFPeA)
Drinking Water	EPA 533	LC/MS/MS	Sodium perfluoro-1-pentanesulfonate (PFPeS)
Drinking Water	EPA 533	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Drinking Water	EPA 537.1.1	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (ADONA)
Drinking Water	EPA 537.1.1	LC/MS/MS	9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)
Drinking Water	EPA 537.1.1	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
Drinking Water	EPA 537.1.1	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluorononanoic acid (PFNA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Drinking Water	EPA 537.1.1	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Drinking Water	EPA 537.1.1	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Drinking Water	EPA 537.1.1	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic Acid (3:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (5:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	3-Perfluoropropyl propanoic acid (7:3 FTCA)
Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-octanesulfonamide (PFOSA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	4,8-dioxa-3H-perfluorononanoic acid (Adona)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11CI-PF3OUdS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Hexafluoropropylene oxide dimer acid (HFPO-DA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Sodium perfluoro-1-pentanesulfonate (PFPeS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-nonanesulfonate (PFNS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-heptanesulfonate (PFHpS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorohexane sulfonate (4:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorooctane sulfonate (6:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorodecane sulfonate (8:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-butanoic Acid (PFBA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-pentanoic acid (PFPeA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluorononanoic acid (PFNA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluoro-1-decanesulfonate (PFDS)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,3',4,5-Hexachlorobiphenyl (BZ 129)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ 180)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ 183)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ 138)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,4',6,6'-Heptachlorobiphen yl (BZ 184)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ 187)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,4,5'-Pentachlorobiphenyl (BZ 87)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',3,5'-Tetrachlorobiphenyl (BZ 44)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ 153)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,5,5'-Pentachlorobiphenyl (BZ 101)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',4,5'-Tetrachlorobiphenyl (BZ 49)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',5,5'-Tetrachlorobiphenyl (BZ 52)

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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,2',5-Trichlorobiphenyl (BZ 18)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3,3',4',6-Pentachlorobiphenyl (BZ 110)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3',4,4',5-Pentachlorobiphenyl (BZ 118)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,3',4,4'-Tetrachlorobiphenyl (BZ 66)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4,4'-Trichlorobiphenyl (BZ 28)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDD
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDE
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-DDT
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	2,4'-Dichlorobiphenyl (BZ 8)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4',5-Pentachlorobiphenyl (BZ 126)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	3,3',4,4'-Tetrachlorobiphenyl (BZ 77)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDD
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDE
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	4,4'-DDT
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Aldrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	alpha-BHC (alpha-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	alpha-Chlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	beta-BHC (beta-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Chlorpyrifos
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	cis-Nonachlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Decachlorobiphenyl (BZ 209)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	delta-BHC
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Dieldrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan II
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan I
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endosulfan sulfate
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin aldehyde
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Endrin ketone
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	gamma-Chlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Heptachlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Heptachlor epoxide
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Hexachlorobenzene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Methoxychlor
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Mirex
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	Oxychlordane
Aqueous/Solid/Tissue	EPA 8081 MOD	GC-ECD	trans-Nonachlor
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	1-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	1-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ 194)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (BZ 207)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',6,6'-Octachlorobiphenyl (BZ 197)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4',6-Heptachlorobiphenyl (BZ 171)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (BZ 208)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,5',6-Octachlorobiphenyl (BZ 198)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,5',6'-Octachlorobiphenyl (BZ 199)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,5'-Heptachlorobiphenyl (BZ 172)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,6,6'-Octachlorobiphenyl (BZ 200)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ 201)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,6-Heptachlorobiphenyl (BZ 173)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ 174)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5',6-Heptachlorobiphenyl (BZ 175)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5',6'-Heptachlorobiphenyl (BZ 177)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,5'-Hexachlorobiphenyl (BZ 130)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,6,6'-Heptachlorobiphenyl (BZ 176)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4,6-Hexachlorobiphenyl (BZ 131)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',4-Pentachlorobiphenyl (BZ 82)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5,5',6,6'-Octachlorobiphenyl (BZ 202)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5,5',6-Heptachlorobiphenyl (BZ 178)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5,6,6'-Heptachlorobiphenyl (BZ 179)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5,6-Hexachlorobiphenyl (BZ 134)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5,6'-Hexachlorobiphenyl (BZ 135)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',5-Pentachlorobiphenyl (BZ 83)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',6,6'-Hexachlorobiphenyl (BZ 136)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3',6-Pentachlorobiphenyl (BZ 84)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,3'-Tetrachlorobiphenyl (BZ 40)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ 203)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ 180)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ 183)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',5-Hexachlorobiphenyl (BZ 137)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ 138)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ 184)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',6-Hexachlorobiphenyl (BZ 139)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4',6'-Hexachlorobiphenyl (BZ 140)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,4'-Pentachlorobiphenyl (BZ 85)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,5,5',6-Heptachlorobiphenyl (BZ 185)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ 187)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ 141)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',5,5'-Hexachlorobiphenyl (BZ 146)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',5,6,6'-Heptachlorobiphenyl (BZ 188)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',5',6-Hexachlorobiphenyl (BZ 149)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,5',6-Hexachlorobiphenyl (BZ 144)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4,5'-Pentachlorobiphenyl (BZ 87)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',5'-Pentachlorobiphenyl (BZ 97)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4',6-Pentachlorobiphenyl (BZ 91)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4-Tetrachlorobiphenyl (BZ 41)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,4'-Tetrachlorobiphenyl (BZ 42)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,5,5',6-Hexachlorobiphenyl (BZ 151)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,5,5'-Pentachlorobiphenyl (BZ 92)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,5',6-Pentachlorobiphenyl (BZ 95)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,5-Tetrachlorobiphenyl (BZ 43)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,5'-Tetrachlorobiphenyl (BZ 44)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,6'-Tetrachlorobiphenyl (BZ 46)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3,6-Tetrachlorobiphenyl (BZ 45)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',3-Trichlorobiphenyl (BZ 16)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ 153)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ 154)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4',5-Pentachlorobiphenyl (BZ 99)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4',6,6'-Hexachlorobiphenyl (BZ 155)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4',6-Pentachlorobiphenyl (BZ 100)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,4'-Tetrachlorobiphenyl (BZ 47)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,5,5'-Pentachlorobiphenyl (BZ 101)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,5-Tetrachlorobiphenyl (BZ 48)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,5'-Tetrachlorobiphenyl (BZ 49)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,6,6'-Pentachlorobiphenyl (BZ 104)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,6'-Tetrachlorobiphenyl (BZ 51)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4,6-Tetrachlorobiphenyl (BZ 50)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',4-Trichlorobiphenyl (BZ 17)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',5,5'-Tetrachlorobiphenyl (BZ 52)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',5,6'-Tetrachlorobiphenyl (BZ 53)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',5-Trichlorobiphenyl (BZ 18)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',6,6'-Tetrachlorobiphenyl (BZ 54)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2',6-Trichlorobiphenyl (BZ 19)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,2'-Dichlorobiphenyl (BZ 4)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5,5',6-Octachlorobiphenyl (BZ 205)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5,6-Heptachlorobiphenyl (BZ 190)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5',6-Heptachlorobiphenyl (BZ 191)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5-Hexachlorobiphenyl (BZ 156)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 157)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4',6-Hexachlorobiphenyl (BZ 158)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4',5,5',6-Heptachlorobiphenyl (BZ 193)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4',5,6-Hexachlorobiphenyl (BZ 163)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4',5',6-Hexachlorobiphenyl (BZ 164)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4',6-Pentachlorobiphenyl (BZ 110)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,3',4'-Tetrachlorobiphenyl (BZ 56)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4,4',5,6-Hexachlorobiphenyl (BZ 166)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4,4',5-Pentachlorobiphenyl (BZ 114)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4,4',5-Pentachlorobiphenyl (BZ 118)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4,4',5'-Pentachlorobiphenyl (BZ 123)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4,4',6-Pentachlorobiphenyl (BZ 115)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4,4'-Tetrachlorobiphenyl (BZ 60)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4,4'-Tetrachlorobiphenyl (BZ 66)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4',5,5'-Pentachlorobiphenyl (BZ 124)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4',5',6-Pentachlorobiphenyl (BZ 125)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4',5-Tetrachlorobiphenyl (BZ 63)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4,5-Tetrachlorobiphenyl (BZ 67)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4',5-Tetrachlorobiphenyl (BZ 70)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4',6-Tetrachlorobiphenyl (BZ 64)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4',6-Tetrachlorobiphenyl (BZ 71)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,4'-Trichlorobiphenyl (BZ 22)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4-Trichlorobiphenyl (BZ 25)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',4'-Trichlorobiphenyl (BZ 33)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',5-Trichlorobiphenyl (BZ 26)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,5-Trimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3,6-Trichlorobiphenyl (BZ 24)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3',6-Trichlorobiphenyl (BZ 27)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3-Dichlorobiphenyl (BZ 5)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,3'-Dichlorobiphenyl (BZ 6)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4,4',5-Tetrachlorobiphenyl (BZ 74)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4,4',6-Tetrachlorobiphenyl (BZ 75)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4,4'-Trichlorobiphenyl (BZ 28)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4,5-Trichlorobiphenyl (BZ 29)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4',5-Trichlorobiphenyl (BZ 31)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4,6-Trichlorobiphenyl (BZ 30)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4',6-Trichlorobiphenyl (BZ 32)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4'-DDD
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4'-DDE
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4'-DDT
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4-Dichlorobiphenyl (BZ 7)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,4'-Dichlorobiphenyl (BZ 8)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,5-Dichlorobiphenyl (BZ 9)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2,6-Dimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2-Chlorobiphenyl (BZ 1)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2-Chloronaphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	2-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3',4,4',5-Pentachlorobiphenyl (BZ 126)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3',4,4'-Tetrachlorobiphenyl (BZ 77)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3',4,5,5'-Pentachlorobiphenyl (BZ 127)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3',5,5'-Tetrachlorobiphenyl (BZ 80)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,3'-Dichlorobiphenyl (BZ 11)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,4,4',5-Tetrachlorobiphenyl (BZ 81)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,4,4'-Trichlorobiphenyl (BZ 37)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,4-Dichlorobiphenyl (BZ 12)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,4'-Dichlorobiphenyl (BZ 13)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	3,6-Dimethylphenanthrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	4,4'-Dichlorobiphenyl (BZ 15)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	4-Chlorobiphenyl (BZ 3)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Acenaphthene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Acenaphthylene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Anthracene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(a)anthracene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(a)pyrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(b)thiophene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(e)pyrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Biphenyl
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Chrysene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	cis-Decalin
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Decachlorobiphenyl (BZ 209)
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Dibenz(a,h)anthracene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Dibenzofuran
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Dibenzothiophene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Fluoranthene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Fluorene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Indeno(1,2,3-cd)pyrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Naphthalene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Perylene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Phenanthrene
Aqueous/Solid/Tissue	EPA 8270E MOD	GC-MS	Pyrene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Battelle

141 Longwater Drive, Suite 202, Norwell, MA 02061
Contact Name: Jonathan Thorn Phone: 781-681-5565

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270DE MOD	GC-MS	trans-Decalin
Aqueous	EPA 3510 C	Separatory Funnel	Prep
Aqueous/Solid/Tissue	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Aqueous/Solid/Tissue	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solids/Tissues	NOAA NOS ORCA 71	Orbital Shaker	Prep
Tissue	NOAA NOS ORCA 71	Tissuemizer	Prep

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Gulf Coast Analytical Laboratories, LLC dba Pace Analytical Gulf Coast

7979 Innovation Park Drive, Baton Rouge, LA 70820

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2017 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.3 May 2019 and is accredited is accordance with the:

United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
October 2, 2013	December 23, 2020	January 31, 2023

Accreditation No.	*Certificate No.:*
74960	L20-773

Tracy Szerszen
President

Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 1664A	Gravimetric	Oil & Grease
Aqueous	EPA 200.8	ICP-MS	Aluminum
Aqueous	EPA 200.8	ICP-MS	Antimony
Aqueous	EPA 200.8	ICP-MS	Arsenic
Aqueous	EPA 200.8	ICP-MS	Barium
Aqueous	EPA 200.8	ICP-MS	Beryllium
Aqueous	EPA 200.8	ICP-MS	Boron
Aqueous	EPA 200.8	ICP-MS	Cadmium
Aqueous	EPA 200.8	ICP-MS	Calcium
Aqueous	EPA 200.8	ICP-MS	Chromium
Aqueous	EPA 200.8	ICP-MS	Cobalt
Aqueous	EPA 200.8	ICP-MS	Copper
Aqueous	EPA 200.8	ICP-MS	Iron
Aqueous	EPA 200.8	ICP-MS	Lead
Aqueous	EPA 200.8	ICP-MS	Magnesium
Aqueous	EPA 200.8	ICP-MS	Manganese
Aqueous	EPA 200.8	ICP-MS	Molybdenum
Aqueous	EPA 200.8	ICP-MS	Nickel
Aqueous	EPA 200.8	ICP-MS	Potassium
Aqueous	EPA 200.8	ICP-MS	Selenium
Aqueous	EPA 200.8	ICP-MS	Silver
Aqueous	EPA 200.8	ICP-MS	Sodium
Aqueous	EPA 200.8	ICP-MS	Strontium
Aqueous	EPA 200.8	ICP-MS	Thallium
Aqueous	EPA 200.8	ICP-MS	Tin
Aqueous	EPA 200.8	ICP-MS	Titanium
Aqueous	EPA 200.8	ICP-MS	Total Hardness (as CaCO3)
Aqueous	EPA 200.8	ICP-MS	Vanadium
Aqueous	EPA 200.8	ICP-MS	Zinc
Aqueous	EPA 200.8	ICP-MS	Zirconium
Aqueous	EPA 245.2	CVAA	Mercury
Aqueous	EPA 300.0	IC	Bromide
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate and Nitrite as N
Aqueous	EPA 300.0	IC	Nitrate as N

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 300.0	IC	Nitrite as N
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 420.4	FIA	Total Phenolics (4AAP)
Aqueous	EPA 624.1	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous	EPA 624.1	GC-MS	1,1,1-Trichloroethane
Aqueous	EPA 624.1	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous	EPA 624.1	GC-MS	1,1,2-Trichloroethane
Aqueous	EPA 624.1	GC-MS	1,1-Dichloroethane
Aqueous	EPA 624.1	GC-MS	1,1-Dichloroethene
Aqueous	EPA 624.1	GC-MS	1,1-Dichloropropene
Aqueous	EPA 624.1	GC-MS	1,2 Dichlorobenzene
Aqueous	EPA 624.1	GC-MS	1,2 Dichloroethane
Aqueous	EPA 624.1	GC-MS	1,2,3-Trichlorobenzene
Aqueous	EPA 624.1	GC-MS	1,2,3-Trichloropropane
Aqueous	EPA 624.1	GC-MS	1,2,4-Trichlorobenzene
Aqueous	EPA 624.1	GC-MS	1,2,4-Trimethylbenzene
Aqueous	EPA 624.1	GC-MS	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous	EPA 624.1	GC-MS	1,2-Dibromoethane (EDB)
Aqueous	EPA 624.1	GC-MS	1,2-Dichloropropane
Aqueous	EPA 624.1	GC-MS	1,3 Dichlorobenzene
Aqueous	EPA 624.1	GC-MS	1,3,5-Trimethylbenzene
Aqueous	EPA 624.1	GC-MS	1,3-Dichloropropane
Aqueous	EPA 624.1	GC-MS	1,4 Dichlorobenzene
Aqueous	EPA 624.1	GC-MS	2,2-Dichloropropane
Aqueous	EPA 624.1	GC-MS	2-Butanone (MEK)
Aqueous	EPA 624.1	GC-MS	2-Chloroethylvinylether
Aqueous	EPA 624.1	GC-MS	2-Chlorotoluene
Aqueous	EPA 624.1	GC-MS	2-Hexanone
Aqueous	EPA 624.1	GC-MS	4-Chlorotoluene
Aqueous	EPA 624.1	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous	EPA 624.1	GC-MS	Acetone
Aqueous	EPA 624.1	GC-MS	Acetonitrile
Aqueous	EPA 624.1	GC-MS	Acrolein
Aqueous	EPA 624.1	GC-MS	Acrylonitrile
Aqueous	EPA 624.1	GC-MS	Benzene
Aqueous	EPA 624.1	GC-MS	Bromochloromethane
Aqueous	EPA 624.1	GC-MS	Bromodichloromethane

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 624.1	GC-MS	Bromoform
Aqueous	EPA 624.1	GC-MS	Bromomethane
Aqueous	EPA 624.1	GC-MS	Carbon disulfide
Aqueous	EPA 624.1	GC-MS	Carbon tetrachloride
Aqueous	EPA 624.1	GC-MS	Chlorobenzene
Aqueous	EPA 624.1	GC-MS	Chloroethane
Aqueous	EPA 624.1	GC-MS	Chloroform
Aqueous	EPA 624.1	GC-MS	Chloromethane
Aqueous	EPA 624.1	GC-MS	cis-1,2-Dichloroethene
Aqueous	EPA 624.1	GC-MS	cis-1,3-Dichloropropylene
Aqueous	EPA 624.1	GC-MS	Dibromochloromethane
Aqueous	EPA 624.1	GC-MS	Dibromomethane
Aqueous	EPA 624.1	GC-MS	Dichlorodifluoromethane
Aqueous	EPA 624.1	GC-MS	Ethylbenzene
Aqueous	EPA 624.1	GC-MS	Hexachlorobutadiene
Aqueous	EPA 624.1	GC-MS	Isopropylbenzene
Aqueous	EPA 624.1	GC-MS	m+p-Xylene
Aqueous	EPA 624.1	GC-MS	Methyl tert-butyl ether (MTBE)
Aqueous	EPA 624.1	GC-MS	Methylene Chloride
Aqueous	EPA 624.1	GC-MS	Naphthalene
Aqueous	EPA 624.1	GC-MS	n-Butylbenzene
Aqueous	EPA 624.1	GC-MS	n-Propylbenzene
Aqueous	EPA 624.1	GC-MS	o-Xylene
Aqueous	EPA 624.1	GC-MS	p-Isopropyltoluene
Aqueous	EPA 624.1	GC-MS	sec-Butylbenzene
Aqueous	EPA 624.1	GC-MS	Styrene
Aqueous	EPA 624.1	GC-MS	tert-Butylbenzene
Aqueous	EPA 624.1	GC-MS	Tetrachloroethene
Aqueous	EPA 624.1	GC-MS	Toluene
Aqueous	EPA 624.1	GC-MS	trans-1,2-Dichloroethene
Aqueous	EPA 624.1	GC-MS	trans-1,3-Dichloropropene
Aqueous	EPA 624.1	GC-MS	Trichloroethene
Aqueous	EPA 624.1	GC-MS	Trichlorofluoromethane
Aqueous	EPA 624.1	GC-MS	Vinyl acetate
Aqueous	EPA 624.1	GC-MS	Vinyl chloride
Aqueous	EPA 624.1	GC-MS	Xylenes, total
Aqueous	EPA 625.1	GC-MS	1,2,4,5-Tetrachlorobenzene

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 625.1	GC-MS	1,2,4-Trichlorobenzene
Aqueous	EPA 625.1	GC-MS	1-Methylnaphthalene
Aqueous	EPA 625.1	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous	EPA 625.1	GC-MS	2,4,5-Trichlorophenol
Aqueous	EPA 625.1	GC-MS	2,4,6-Trichlorophenol
Aqueous	EPA 625.1	GC-MS	2,4-Dichlorophenol
Aqueous	EPA 625.1	GC-MS	2,4-Dimethylphenol
Aqueous	EPA 625.1	GC-MS	2,4-Dinitrophenol
Aqueous	EPA 625.1	GC-MS	2,4-Dinitrotoluene
Aqueous	EPA 625.1	GC-MS	2,6-Dichlorophenol
Aqueous	EPA 625.1	GC-MS	2,6-Dinitrotoluene
Aqueous	EPA 625.1	GC-MS	2-Chloronaphthalene
Aqueous	EPA 625.1	GC-MS	2-Chlorophenol
Aqueous	EPA 625.1	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous	EPA 625.1	GC-MS	2-Methylnaphthalene
Aqueous	EPA 625.1	GC-MS	2-Methylphenol
Aqueous	EPA 625.1	GC-MS	2-Nitroaniline
Aqueous	EPA 625.1	GC-MS	2-Nitrophenol
Aqueous	EPA 625.1	GC-MS	3,3'-Dichlorobenzidine
Aqueous	EPA 625.1	GC-MS	3-Nitroaniline
Aqueous	EPA 625.1	GC-MS	4-Bromophenyl-phenylether
Aqueous	EPA 625.1	GC-MS	4-Chloro-3-methylphenol
Aqueous	EPA 625.1	GC-MS	4-Chloroaniline
Aqueous	EPA 625.1	GC-MS	4-Chlorophenyl-phenylether
Aqueous	EPA 625.1	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous	EPA 625.1	GC-MS	4-Nitroaniline
Aqueous	EPA 625.1	GC-MS	4-Nitrophenol
Aqueous	EPA 625.1	GC-MS	Acenaphthene
Aqueous	EPA 625.1	GC-MS	Acenaphthylene
Aqueous	EPA 625.1	GC-MS	Aniline
Aqueous	EPA 625.1	GC-MS	Anthracene
Aqueous	EPA 625.1	GC-MS	Benzidine
Aqueous	EPA 625.1	GC-MS	Benzo(a)anthracene
Aqueous	EPA 625.1	GC-MS	Benzo(a)pyrene
Aqueous	EPA 625.1	GC-MS	Benzo(b)fluoranthene
Aqueous	EPA 625.1	GC-MS	Benzo(g,h,i)perylene
Aqueous	EPA 625.1	GC-MS	Benzo(k)fluoranthene

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 625.1	GC-MS	Benzoic acid
Aqueous	EPA 625.1	GC-MS	Benzyl alcohol
Aqueous	EPA 625.1	GC-MS	bis(2-Chloroethoxy)methane
Aqueous	EPA 625.1	GC-MS	bis(2-Chloroethyl)ether
Aqueous	EPA 625.1	GC-MS	bis(2-Chloroiospropyl) ether
Aqueous	EPA 625.1	GC-MS	bis(2-ethylhexyl) phthalate
Aqueous	EPA 625.1	GC-MS	Butyl benzyl phthalate
Aqueous	EPA 625.1	GC-MS	Carbazole
Aqueous	EPA 625.1	GC-MS	Chrysene
Aqueous	EPA 625.1	GC-MS	Dibenzo(a,h)anthracene
Aqueous	EPA 625.1	GC-MS	Dibenzofuran
Aqueous	EPA 625.1	GC-MS	Diethyl phthalate
Aqueous	EPA 625.1	GC-MS	Dimethyl phthalate
Aqueous	EPA 625.1	GC-MS	Di-n-butylphthalate
Aqueous	EPA 625.1	GC-MS	Di-n-octylphthalate
Aqueous	EPA 625.1	GC-MS	Fluoranthene
Aqueous	EPA 625.1	GC-MS	Fluorene
Aqueous	EPA 625.1	GC-MS	Hexachlorobenzene
Aqueous	EPA 625.1	GC-MS	Hexachlorocyclopentadiene
Aqueous	EPA 625.1	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous	EPA 625.1	GC-MS	Isophorone
Aqueous	EPA 625.1	GC-MS	Naphthalene
Aqueous	EPA 625.1	GC-MS	Nitrobenzene
Aqueous	EPA 625.1	GC-MS	N-Nitrosodiethylamine
Aqueous	EPA 625.1	GC-MS	N-Nitrosodimethylamine
Aqueous	EPA 625.1	GC-MS	N-Nitroso-di-n-propylamine
Aqueous	EPA 625.1	GC-MS	N-Nitrosodiphenylamine
Aqueous	EPA 625.1	GC-MS	o-Toluidine
Aqueous	EPA 625.1	GC-MS	Pentachlorobenzene
Aqueous	EPA 625.1	GC-MS	Pentachlorophenol
Aqueous	EPA 625.1	GC-MS	Phenanthrene
Aqueous	EPA 625.1	GC-MS	Phenol
Aqueous	EPA 625.1	GC-MS	Pyrene
Aqueous	EPA 625.1	GC-MS	Pyridine
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8011	GC-ECD	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous	EPA 8011	GC-ECD	1,2-Dibromoethane (EDB)

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 8081B	GC-ECD	Diallate
Aqueous	EPA 9040C	pH Meter	Corrosivity (pH)
Aqueous	HACH 8000	Spectrophotometer	COD
Aqueous	RSK175	GC-TCD	Carbon Dioxide
Aqueous	RSK175	GC-TCD	Carbon Monoxide
Aqueous	RSK175	GC-RGD	Hydrogen
Aqueous	RSK175	GC-TCD	Methane
Aqueous	RSK175	GC-TCD	Nitrogen
Aqueous	RSK175	GC-TCD	Oxygen
Aqueous	RSK175/ASTM D8028	GC-FID	Acetylene
Aqueous	RSK175/ASTM D8028	GC-FID	n-Butane
Aqueous	RSK175/ASTM D8028	GC-FID	iso-Butane
Aqueous	RSK175/ASTM D8028	GC-FID	Ethane
Aqueous	RSK175/ASTM D8028	GC-FID	Ethene
Aqueous	RSK175/ASTM D8028	GC-FID	Methane
Aqueous	RSK175/ASTM D8028	GC-FID	Propane
Aqueous	RSK175/ASTM D8028	GC-FID	Propene
Aqueous	SM 2130B	Turbidimetric	Turbidity
Aqueous	HACH 10242	Spectrophotometer	Total Kjeldahl Nitrogen
Aqueous	SM 2310B	Titration	Acidity(as CaCO3)
Aqueous	SM 2320B	Titration	Total Alkalinity(as CaCO3)
Aqueous	SM 2340B	ICP-MS	Total Hardness (as CaCO3)
Aqueous	SM 2540B	Gravimetric	Total Solid
Aqueous	SM 2540C	Gravimetric	Total Dissolved Solid (TDS)
Aqueous	SM 2540D	Gravimetric	Non-Filterable Residue (TSS)
Aqueous	SM 3500-Fe B	Spectrophotometer	Ferrous Iron
Aqueous	SM 4500-H+ B	pH Meter	Corrosivity (pH)
Aqueous	SM 4500-H+ B	pH Meter	pH
Aqueous	SM 4500-PE	Spectrophotometer	Orthophosphate as P
Aqueous	SM 4500-S2 D	Spectrophotometer	Sulfide
Aqueous	SM 4500-S2 F	Titration	Sulfide
Aqueous	SM 4500-SiO2 C	Spectrophotometer	Silica
Aqueous	SM 4500-SO4 E	IC	Sulfate
Aqueous	SM 5310B	TOC Analyzer	TOC
Aqueous	EPA 8270C/D/E	GC-MS	p-Dioxane
Aqueous	EPA 9066	FIA	Total Phenolics (4AAP)
Aqueous	SM4500-NH3 B & D	ISE	Ammonia as N

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 533	LC/MS/MS	NFDHA (Nonafluoro-3,6-dioxaheptanoic acid)
Drinking Water	EPA 533	LC/MS/MS	PFEESA (Perfluoro(2-ethoxyethane)sulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	PFMPA (Perfluoro-3-methoxypropanoic acid)
Drinking Water	EPA 533	LC/MS/MS	PFMBA (Perfluoro-4-methoxybutanoic acid)
Drinking Water	EPA 533	LC/MS/MS	4:2 FTS (1H, 1H, 2H, 2H-Perfluorohexane sulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	6:2 FTS (1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	8:2 FTS (1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	PFBA (Perfluorobutanoic acid)
Drinking Water	EPA 533	LC/MS/MS	PFHpS (Perfluorohexanesulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	PFPeS (Perfluoropentanesulfonic acid)
Drinking Water	EPA 533	LC/MS/MS	PFPeA (Perfluoropentanoic acid)
Drinking Water	EPA 537.1	LC/MS/MS	NMeFOSAA(N-methyl perfluorooctanesulfonamidoacetic acid)
Drinking Water	EPA 537.1	LC/MS/MS	NEtFOSAA(N-ethyl perfluorooctanesulfonamidoacetic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFBS(Perfluorobutanesulfonic acid)
Drinking Water	EPA 537.1	LC/MS/MS	PFTA(Perfluorotetradecanoic acid)
Drinking Water	EPA 537.1	LC/MS/MS	PFTrDA(Perfluorotridecanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	11Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	HFPO-DA (GenX , Hexafluoropropylene oxide dimer acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	ADONA (4,8-dioxa-3H-perfluorononanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFDA(Perfluorodecanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFDoA(Perfluorododecanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFHpA(Perfluoroheptanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFHxS(Perfluorohexanesulfonic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFHxA(Perfluorohexanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFNA(Perfluorononanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFOS(Perfluorooctanesulfonic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFOA(Perfluorooctanoic acid)
Drinking Water	EPA 537.1 EPA 533	LC/MS/MS	PFUnA(Perfluoroundecanoic acid)
Solid	EPA 1030	N/A	Ignitability
Solid	EPA 3060A	N/A	Hexavalent Chromium Preparation
Solid	EPA 7471B	CVAA	Mercury

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Solid	EPA 9045D	pH Meter	Corrosivity (pH)
Solid	EPA 9095B	N/A	Paint Filter Test
Solid	SM 2540G	Gravimetric	Percent Moisture
Solid	SM 2540G	Gravimetric	Total Solid
Aqueous/Solid	EPA 1010A	Automated FP Analyzer	Ignitability
Aqueous/Solid	EPA 353.2	FIA	Nitrate and Nitrite as N
Aqueous/Solid	EPA 353.2	FIA	Nitrate as N
Aqueous/Solid	EPA 353.2	FIA	Nitrite as N
Aqueous/Solid	EPA 365.1	FIA	Total Phosphorous
Aqueous/Solid	EPA 6020B	ICP-MS	Aluminum
Aqueous/Solid	EPA 6020B	ICP-MS	Antimony
Aqueous/Solid	EPA 6020B	ICP-MS	Arsenic
Aqueous/Solid	EPA 6020B	ICP-MS	Barium
Aqueous/Solid	EPA 6020B	ICP-MS	Beryllium
Aqueous/Solid	EPA 6020B	ICP-MS	Boron
Aqueous/Solid	EPA 6020B	ICP-MS	Cadmium
Aqueous/Solid	EPA 6020B	ICP-MS	Calcium
Aqueous/Solid	EPA 6020B	ICP-MS	Chromium
Aqueous/Solid	EPA 6020B	ICP-MS	Cobalt
Aqueous/Solid	EPA 6020B	ICP-MS	Copper
Aqueous/Solid	EPA 6020B	ICP-MS	Iron
Aqueous/Solid	EPA 6020B	ICP-MS	Lead
Aqueous/Solid	EPA 6020B	ICP-MS	Magnesium
Aqueous/Solid	EPA 6020B	ICP-MS	Manganese
Aqueous/Solid	EPA 6020B	ICP-MS	Molybdenum
Aqueous/Solid	EPA 6020B	ICP-MS	Nickel
Aqueous/Solid	EPA 6020B	ICP-MS	Potassium
Aqueous/Solid	EPA 6020B	ICP-MS	Selenium
Aqueous/Solid	EPA 6020B	ICP-MS	Silver
Aqueous/Solid	EPA 6020B	ICP-MS	Sodium
Aqueous/Solid	EPA 6020B	ICP-MS	Strontium
Aqueous/Solid	EPA 6020B	ICP-MS	Thallium
Aqueous/Solid	EPA 6020B	ICP-MS	Tin
Aqueous/Solid	EPA 6020B	ICP-MS	Titanium
Aqueous/Solid	EPA 6020B	ICP-MS	Vanadium
Aqueous/Solid	EPA 6020B	ICP-MS	Zinc

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 6020B	ICP-MS	Zirconium
Aqueous/Solid	EPA 7196A	Spectrophotometer	Chromium VI
Aqueous/Solid	EPA 8015C	GC-FID	Diesel range organics (DRO)
Aqueous/Solid	EPA 8015C	GC-FID	Gasoline range organics (GRO)
Aqueous/Solid	EPA 8015C	GC-FID	Oil Range Organics (ORO)
Aqueous/Solid	EPA 8081B	GC-ECD	Aldrin
Aqueous/Solid	EPA 8081B	GC-ECD	alpha-BHC
Aqueous/Solid	EPA 8081B	GC-ECD	alpha-Chlordane
Aqueous/Solid	EPA 8081B	GC-ECD	beta-BHC
Aqueous/Solid	EPA 8081B	GC-ECD	Chlordane
Aqueous/Solid	EPA 8081B	GC-ECD	Chlordane (total)
Aqueous/Solid	EPA 8081B	GC-ECD	DDD (4,4’)
Aqueous/Solid	EPA 8081B	GC-ECD	DDE (4,4’)
Aqueous/Solid	EPA 8081B	GC-ECD	DDT (4,4’)
Aqueous/Solid	EPA 8081B	GC-ECD	delta-BHC
Aqueous/Solid	EPA 8081B	GC-ECD	Dieldrin
Aqueous/Solid	EPA 8081B	GC-ECD	Endosulfan I
Aqueous/Solid	EPA 8081B	GC-ECD	Endosulfan II
Aqueous/Solid	EPA 8081B	GC-ECD	Endosulfan sulfate
Aqueous/Solid	EPA 8081B	GC-ECD	Endrin
Aqueous/Solid	EPA 8081B	GC-ECD	Endrin aldehyde
Aqueous/Solid	EPA 8081B	GC-ECD	Endrin ketone
Aqueous/Solid	EPA 8081B	GC-ECD	gamma-BHC (Lindane)
Aqueous/Solid	EPA 8081B	GC-ECD	gamma-Chlordane
Aqueous/Solid	EPA 8081B	GC-ECD	Heptachlor
Aqueous/Solid	EPA 8081B	GC-ECD	Heptachlor Epoxide (beta)
Aqueous/Solid	EPA 8081B	GC-ECD	Methoxychlor
Aqueous/Solid	EPA 8081B	GC-ECD	Toxaphene
Aqueous/Solid	EPA 8081B	GC-ECD	Toxaphene (total)
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1016
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1221
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1232
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1242
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1248
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1254
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1260
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1262

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8082A	GC-ECD	Aroclor 1268
Aqueous/Solid	EPA 8141B	GC-NPD	Azinphos-methyl (Guthion)
Aqueous/Solid	EPA 8141B	GC-NPD	Diazinon
Aqueous/Solid	EPA 8141B	GC-NPD	Disulfoton
Aqueous/Solid	EPA 8141B	GC-NPD	Malathion
Aqueous/Solid	EPA 8141B	GC-NPD	Parathion, ethyl
Aqueous/Solid	EPA 8141B	GC-NPD	Parathion, methyl
Aqueous/Solid	EPA 8141B	GC-NPD	Phorate
Aqueous/Solid	EPA 8141B	GC-NPD	Ronnel
Aqueous/Solid	EPA 8141B	GC-NPD	Stirophos
Aqueous/Solid	EPA 8151A	GC-ECD	2, 4, DB
Aqueous/Solid	EPA 8151A	GC-ECD	2, 4-D
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solid	EPA 8151A	GC-ECD	2,4,5-TP (Silvex)
Aqueous/Solid	EPA 8151A	GC-ECD	2,4-DP (Dichlorprop)
Aqueous/Solid	EPA 8151A	GC-ECD	3,5-Dichlorobenzoic acid
Aqueous/Solid	EPA 8151A	GC-ECD	4-Nitrophenol
Aqueous/Solid	EPA 8151A	GC-ECD	Acifluorfen
Aqueous/Solid	EPA 8151A	GC-ECD	Bentazon
Aqueous/Solid	EPA 8151A	GC-ECD	Chloramben
Aqueous/Solid	EPA 8151A	GC-ECD	Dacthal (DCPA)
Aqueous/Solid	EPA 8151A	GC-ECD	Dalapon
Aqueous/Solid	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solid	EPA 8151A	GC-ECD	Dinoseb
Aqueous/Solid	EPA 8151A	GC-ECD	MCPA
Aqueous/Solid	EPA 8151A	GC-ECD	MCPP
Aqueous/Solid	EPA 8151A	GC-ECD	Pentachlorophenol
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1,1-Trichloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1,2-Trichloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1-Dichloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1-Dichloroethene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,1-Dichloropropene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2 Dichloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2,3-Trichlorobenzene

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2,3-Trichloropropane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2-Dibromoethane (EDB)
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,2-Dichloropropane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,3 Dichlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,3-Dichloropropane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	1-Chlorohexane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	2,2-Dichloropropane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	2-Butanone (MEK)
Aqueous/Solid	EPA 8260B/C/D	GC-MS	2-Chloroethylvinylether
Aqueous/Solid	EPA 8260B/C/D	GC-MS	2-Chlorotoluene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	2-Hexanone
Aqueous/Solid	EPA 8260B/C/D	GC-MS	4-Chlorotoluene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Acetone
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Acetonitrile
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Acrolein
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Acrylonitrile
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Benzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Bromobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Bromochloromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Bromodichloromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Bromoform
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Bromomethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Carbon disulfide
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Carbon tetrachloride
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Chlorobenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Chloroethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Chloroform
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Chloromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	cis-1,3-Dichloropropylene

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Dibromochloromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Dibromomethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Dichlorodifluoromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Ethylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Isopropylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	m+p-Xylene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Methyl tert-butyl ether (MTBE)
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Methylcyclohexane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Methylene Chloride
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Methyl Acetate
Aqueous/Solid	EPA 8260B/C/D	GC-MS	MTBE
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Naphthalene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	n-Butylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	n-Propylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	o-Xylene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	p-Isopropyltoluene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	sec-Butylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Styrene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	tert-Butylbenzene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Tetrachloroethene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Toluene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Trichloroethene
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Trichlorofluoromethane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Vinyl acetate
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Vinyl chloride
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Xylenes, total
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Cyclohexane
Aqueous/Solid	EPA 8260B/C/D	GC-MS	Ethyl Acetate
Aqueous/Solid	EPA 8260B/C/D	GC-MS	n-Butanol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,3 Dichlorobenzene

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4-Dichlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4-Dimethylphenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4-Dinitrophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,6-Dichlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Chloronaphthalene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Chlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Methylphenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Nitroaniline
Aqueous/Solid	EPA 8270C/D/E	GC-MS	2-Nitrophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	3-Nitroaniline
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Chloroaniline
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Nitroaniline
Aqueous/Solid	EPA 8270C/D/E	GC-MS	4-Nitrophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Acetophenone
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Aniline
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Atrazine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzaldehyde
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzidine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzo(a)anthracene

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzoic acid
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Benzyl alcohol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Biphenyl
Aqueous/Solid	EPA 8270C/D/E	GC-MS	bis(2-Chloroethoxy)methane
Aqueous/Solid	EPA 8270C/D/E	GC-MS	bis(2-Chloroethyl)ether
Aqueous/Solid	EPA 8270C/D/E	GC-MS	bis(2-Chloroiospropyl) ether
Aqueous/Solid	EPA 8270C/D/E	GC-MS	bis(2-ethylhexyl) phthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Caprolactom
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Carbazole
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Dimethyl phthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Di-n-butylphthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Hexachloroethane
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Isophorone
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Nitrobenzene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	N-Nitrosodiethylamine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	N-Nitrosodimethylamine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	N-Nitroso-di-n-propylamine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	N-Nitrosodiphenylamine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	o-Toluidine
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Pentachlorobenzene

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Pentachlorophenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Phenol
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Pyrene
Aqueous/Solid	EPA 8270C/D/E	GC-MS	Pyridine
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Dibenz(a,h) anthracene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Indeno(1,2,3-cd) pyrene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	Pyrene
Aqueous/Solid	EPA 8270C/D/E SIM	GC-MS	1,4-Dioxane
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	1,3,5-TNB (1,3,5-Trinitrobenzene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	1,3-DNB (1,3-Dinitrobenzene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	2,4,6-TNT (2,4,6-Trinitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	2,4-DNT (2,4-Dinitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	2,6-DNT (2,6-Dinitrotoluene)

Certificate of Accreditation: Supplement

ISO/IEC 17025:20017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	2-Am-DNT (2-Amino-4,6-dinitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	2-NT (2-Nitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	3,5-Dinitroaniline
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	3-NT (3-Nitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	4-Am-DNT (4-Amino-2,6-dinitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	4-NT (4-Nitrotoluene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	NB (Nitrobenzene)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	NG (Nitroglycerin)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	PETN (Pentaerythritol tetranitrate)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	Tetryl (Methyl-2,4,6-trinitrophenylnitramine)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	NQ (Nitroguanidine)
Aqueous/Solid	EPA 8330A/B (including QSM 5.3 Compliant 8330B with ISM prep)	HPLC	NC (Nitrocellulose)
Aqueous/Solid	EPA 9012B	FIA	Total Cyanide
Aqueous/Solid	EPA 9038	Spectrophotometer	Sulfate
Aqueous/Solid	EPA 9056A	IC	Bromide
Aqueous/Solid	EPA 9056A	IC	Chloride

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Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 9056A	IC	Fluoride
Aqueous/Solid	EPA 9056A	IC	Nitrate and Nitrite
Aqueous/Solid	EPA 9056A	IC	Nitrate
Aqueous/Solid	EPA 9056A	IC	Nitrite
Aqueous/Solid	EPA 9056A	IC	Sulfate
Aqueous/Solid	EPA 9060A	TOC Analyzer	TOC
Aqueous/Solid	FL-PRO	GC-FID	Petroleum Hydrocarbons
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Acetic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Butyric Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Formic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Lactic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Propionic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Pyruvic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Pentanoic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	i-Pentanoic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	Hexanoic Acid
Aqueous/Solid	Pace SOP-BTRO-0042	IC	i-Hexanoic Acid
Aqueous/Solid	MADEP EPH	GC-FID	C11-C22 Aromatic Hydrocarbons
Aqueous/Solid	MADEP EPH	GC-FID	C19-C36 Aliphatic Hydrocarbons
Aqueous/Solid	MADEP EPH	GC-FID	C9-C18 Aliphatic Hydrocarbons
Aqueous/Solid	MADEP VPH	GC-FID	C5-C8 Aliphatic Hydrocarbons
Aqueous/Solid	MADEP VPH	GC-FID	C9-C10 Aromatic Hydrocarbons
Aqueous/Solid	MADEP VPH	GC-FID	C9-C12 Aliphatic Hydrocarbons
Aqueous/Solid	SM5210 B	Assay	BODs
Aqueous/Solid	SW846 Sec 7.3	FIA	Reactive Cyanide
Aqueous/Solid	SW846 Sec 7.3	Titration	Reactive sulfide
Aqueous/Solid	TCEQ 1005	GC-FID	Total Petroleum Hydrocarbon
Aqueous/Solid	TNRCC 1006	GC-FID	DRO-aplhatic
Aqueous/Solid	TNRCC 1006	GC-FID	DRO-aromatic
Aqueous/Solid	TNRCC 1006	GC-FID	DRO-Total
Aqueous/Solid	TNRCC 1006	GC-FID	GRO-aliphatic
Aqueous/Solid	TNRCC 1006	GC-FID	GRO-aromatic
Aqueous/Solid	TNRCC 1006	GC-FID	GRO-Total
Aqueous/Solid	TNRCC 1006	GC-FID	ORO-aliphatic
Aqueous/Solid	TNRCC 1006	GC-FID	ORO-aromatic
Aqueous/Solid	TNRCC 1006	GC-FID	ORO-Total
Aqueous/Solid	TNRCC 1006	GC-FID	Total Petroleum Hydrocarbon

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	11Cl-PF3OUdS (11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	9Cl-PF3ONS (9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	HFPO-DA (GenX, Hexafluoropropylene oxide dimer acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	ADONA (4,8-dioxa-3H-perfluorononanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NFDHA (Nonafluoro-3,6-dioxaheptanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFEESA (Perfluoro(2-ethoxyethane)sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFMPA (Perfluoro-3-methoxypropanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFMBA (Perfluoro-4-methoxybutanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFHxDA (Perfluorohexadecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFODA (Perfluorooctadecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFDoS (Perfluorododecanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	10:2 FTS (1H, 1H, 2H, 2H-Perfluorododecane sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NMeFOSE (N-Methyl perfluorooctane sulfonamidoethanol)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NEtFOSE (N-Ethyl perfluorooctane sulfonamidoethanol)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NMeFOSA (N-Methyl perfluorooctane sulfonamide)

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Gulf Coast Analytical Laboratories, LLC

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Contact Name: Jaqueline Bendolph Phone: 504-305-3619

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NEtFOSA(N-Ethyl perfluorooctane sulfonamide)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NEtFOSAA (N-ethyl perfluorooctanesulfonamidoacetic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	8:2 FTS (1H, 1H, 2H, 2H-Perfluorodecane sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	4:2 FTS (1H, 1H, 2H, 2H-Perfluorohexane sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	6:2 FTS (1H, 1H, 2H, 2H-Perfluorooctane sulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	NMeFOSAA (N-methyl perfluorooctanesulfonamidoacetic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFBS (Perfluorobutanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFBA (Perfluorobutanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluorodecanesulfonate (PFDS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFDA (Perfluorodecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFDoA (Perfluorododecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFHpS (Perfluorohexanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFHpA (Perfluoroheptanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFHxS (Perfluorohexanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFHxA (Perfluorohexanoic acid)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluorononanesulfonate (PFNS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFNA (Perfluorononanoic acid)Perfluorononanoic acid (PFNA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	Perfluorooctane sulfonamide (FOSA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFOS (Perfluorooctanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFOA (Perfluorooctanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFPeA (Perfluoropentanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFPeS (Perfluoropentanesulfonic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFTA (PFTeDA. Perfluorotetradecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFTrDA (Perfluorotridecanoic acid)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.3 Table B-15	LC/MS/MS	PFUnA (PFUdA, Perfluoroundecanoic acid)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2017 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

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Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 3010A	Acid Digestion - Metals	Prep Method
Aqueous	EPA 3510C	Separatory Funnel	Prep Method
Aqueous	EPA 3520C	Continuous Liquid/Liquid Extraction	Prep Method
Aqueous	EPA 3535A	Solid Phase Extraction	Prep Method
Aqueous	EPA 5030B	Purge and Trap	Prep Method
Solid	EPA 1311	TCLP	Prep Method
Solid	EPA 1312	SPLP	Prep Method
Solid	EPA 3050B	Acid Digestion	Prep Method
Solid	EPA 3535A	Incremental Sampling Method	Prep Method
Solid	EPA 3550C	Extraction - Sonication	Prep Method
Solid	EPA 3540C	Extraction - Soxhlet	Prep Method
Solid	EPA 3546	Extraction - Microwave	Prep Method
Solid	EPA 5035	Purge and Trap	Prep Method
Solid	EPA 5035 (modified per ISM-1 for in-lab compositing)	Incremental Sampling Method – Volatile Compositing with Methanolic Extraction	Prep Method
AFFF/Aqueous/Solid	Pace SWI-BTRO-0001	TOP Assay Digestion	Prep Method