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NAS OCEANA, VA
SSIC 5000-33a

FINAL BASEWIDE PER AND POLYFLUOROALKYL SUBSTANCES SITE INSPECTION ADDENDUM SAMPLING AND ANALYSIS PLAN NAS OCEANA VA

05/01/2019
CH2M HILL

Approved for public release: distribution unlimited.

Rev. 4, 27 July 2019

Mid-Atlantic
Norfolk, Virginia

Final

Basewide Per- and Polyfluoroalkyl Substances Site Inspection Addendum Sampling and Analysis Plan

Naval Air Station Oceana
Virginia Beach, Virginia

May 2019

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SAP Worksheet #1—Title and Approval Page

Mid-Atlantic
Norfolk, Virginia

Final

Basewide Per- and Polyfluoroalkyl Substances Site Inspection Addendum Sampling and Analysis Plan

Naval Air Station Oceana
Virginia Beach, Virginia

May 2019

Prepared for NAVFAC Mid-Atlantic
by CH2M HILL, Inc.
Virginia Beach, Virginia
Contract N62470-16-D-9000
CTO WE14

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Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

Approval Signatures:

AP Jones

Angela Jones
Naval Facilities Engineering Command Atlantic
Remedial Project Manger

Connor O'Loughl.

Connor O'Loughlin
United States Environmental Protection Agency Region 3
Remedial Project Manger

Steph Mihalko

Steve Mihalko
Virginia Department of Environmental Quality
Remedial Project Manger

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Executive Summary

This Sampling and Analysis Plan (SAP) presents the technical approach for the Basewide Site Inspection (SI) Addendum for per- and polyfluoroalkyl substances (PFAS) to be conducted at Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. This SI Addendum is being conducted for Department of the Navy (Navy), Naval Facilities Engineering Command Mid-Atlantic, under the Navy Comprehensive Long-term Environmental Action – Navy (CLEAN) 9000 Program.

This SI Addendum SAP is being completed under Contract N62470-16-D-9000, Contract Task Order WE14, in accordance with the Navy's SAP policy guidance to help ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended purposes. The objectives and technical approach included in this SAP were jointly scoped by the NAS Oceana Tier I Partnering Team, which includes representatives from the Navy, U.S. Environmental Protection Agency (USEPA) Region 3, and Virginia Department of Environmental Quality.

The laboratory information cited in this SAP is specific to Gulf Coast Analytical Laboratories and Battelle Memorial Institute. If additional laboratory services are requested requiring modification to the existing SAP, revised SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

NAS Oceana, located in Virginia Beach, Virginia, is a 6,000-acre master jet base supporting a community of more than 9,100 Navy personnel and 11,000 dependents. The mission of NAS Oceana is to provide the personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment.

The Basewide PFAS SI at NAS Oceana was initiated in 2016 as part of the Navy-wide initiative to assess PFAS releases at facilities with historical use of aqueous film-forming foam (AFFF) and the potential for exposure to these chemicals through groundwater used as drinking water. The SI included collecting groundwater samples from on-Base monitoring wells and golf course irrigation water supply wells screened in the Columbia and Yorktown aquifers and off-Base drinking water wells; all samples were analyzed for the six PFAS on the USEPA's Unregulated Contaminant Monitoring Rule 3 list. The SI results confirmed several source areas on-Base and identified migration of PFAS constituents off-Base into private drinking water wells. Concentrations in one off-Base drinking water sample exceeded the applicable screening values; however, not all source areas were thoroughly evaluated, and data collected were not sufficient to definitively assess transport. Consequently, an SI Addendum was recommended. The following objectives have been identified for this SI Addendum:

- Further define the lateral and vertical extent and evaluate the long-term temporal variability of PFAS contamination in groundwater in the Columbia and Yorktown aquifers both on- and off-Base and determine whether there is unacceptable risk to human and/or ecological receptors
- Refine the understanding of hydraulic characteristics of the aquifers and transport mechanisms for site contaminants
- If present, determine if PFAS provides an unacceptable risk to human health or ecological receptors[1] due to exposure to, soil, surface water, or sediment

Activities to be completed to accomplish these objectives include:

- Installing monitoring wells within the Columbia and Yorktown aquifers in known or suspected source areas, downgradient of known or suspected source areas, and along the perimeter of the Base

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[1] Potential unacceptable ecological risks will be evaluated when appropriate screening values are issued by USEPA.

- Collecting groundwater samples from existing and new monitoring wells installed in the Columbia and Yorktown aquifers
- Conducting slug testing and groundwater elevation survey from monitoring wells
- Collecting co-located surface and subsurface soil samples from known or suspected source areas
- Collecting co-located surface water and sediment samples from drainage areas downgradient of potential source areas and in the vicinity of outfalls from the Base
- Collecting drinking water samples from off-Base residences with private drinking water wells within the designated sampling radius

All samples collected will be analyzed for 18 PFAS compounds listed in EPA 537.1; sediment samples will also be analyzed for total organic carbon. This SAP consists of the 37 worksheets specific to the Navy's SAP guidance. All tables and figures are included following the worksheets. The field standard operating procedures for this work are in **Appendix A**, and the laboratory Department of Defense Environmental Laboratory Accreditation Program documentation is included as **Appendix B**. The July 2018 Partnering Meeting SAP scooping session presentation is included in **Appendix C.**

SAP Worksheets

Appendixes

Tables

Figures

Abbreviations and Acronyms

°C	degree(s) Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
AFFF	aqueous film-forming foam
AM	Activity Manager
AQM	Activity Quality Manager
bgs	below ground surface
Battelle	Battelle Memorial Institute
CA	corrective action
CAS	Chemical Abstract Service
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CH2M	CH2M HILL, Inc.
CLEAN	Comprehensive Long-term Environmental Action—Navy
DL	Detection Limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DV	Data Validator
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
ESV	ecological screening value
FD	Field Duplicate
FTL	Field Team Leader
GCAL	Gulf Coast Analytical Laboratories
H&S	health and safety
HCl	hydrochloric acid
HQ	hazard quotient
HSO	Health and Safety Officer
IB	Instrument Blank
ICAL	Initial Calibration
ICC	Initial Calibration Confirmation
ICV	Initial Calibration Verification
ID	identification
IDW	investigation-derived waste
IS	internal standards
ISC	Instrument Sensitivity Check
LCL	lower confidence limit
LCS	laboratory control sample
LIMS	Laboratory Information Management Systems
LOD	Limit of Detection

LOQ	Limit of Quantitation
MD	matrix duplicate
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
NEX	Naval Exchange
ng/L	nanogram per liter
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
NPCA	Norwegian Pollution Control Authority
ORP	oxidation-reduction potential
PAL	Project Action Limit
PC	Project Chemist
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFDA	Perfluorodecanoic acid
PFDoA	Perfluorododecanoic acid
PFHpA	Perfluoroheptanoic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PFTA	Perfluorotetradecanoic acid
PFTrDA	Perfluorotridecanoic acid
PFUnA	Perfluoroundecanoic acid
PM	Project Manager
PNA	perfluorononanoic acid
POC	point of contact
POL	petroleum, oils, and lubrican
PQL	project quantitation limit
PQO	project quality objective
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation

RSL	regional screening level
SAA	Source Area Assessment
SAP	Sampling and Analysis Plan
SI	Site Inspection
SOP	standard operating procedure
SPE	Solid Phase Extraction
SSC	Site Safety Coordinator
SSL	soil screening level
STC	Senior Technical Consultant
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
TBD	to be determined
TOC	total organic carbon
UCL	Upper Control Limit
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VDEQ	Virginia Department of Environmental Quality

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number:	Naval Air Station (NAS) Oceana, Basewide Per- and Polyfluoroalkyl Substances (PFAS) Site Inspection (SI) Addendum
Operable Unit:	Not applicable (N/A)
Contractor Name:	CH2M HILL, Inc. (CH2M)
Contract Number:	N62470-16-D-9000, Contract Task Order WE14
Contract Title:	Comprehensive Long-term Environmental Action—Navy (CLEAN) 9000

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the following guidance documents:
    - *Guidance for Quality Assurance Project Plans* (USEPA, 2002)
    - *Uniform Federal Policy for Quality Assurance Plans* (USEPA, 2005)
    - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
    - *Interim Per-and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)* (Navy, 2017)
    - *Environmental Restoration Program Manual* (Navy, 2018)
2. Identify regulatory program:
    - Resource Conservation and Recovery Act (RCRA), but following the Comprehensive Environmental Response Compensation, and Liability Act site management process
3. This is a project-specific SAP.
4. List dates if scoping sessions held:
    - May 30, 2018 and July 18, 2018
5. List organizational partners (stakeholders) and connection with lead organization:

Organization Partners/Stakeholders	Connection
U.S. Environmental Protection Agency (USEPA)	Lead Regulatory Agency
Virginia Department of Environmental Quality (VDEQ)	State Regulatory Agency
Department of Defense (DoD)	Land Owner
Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic	Lead Organization

6. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:
    - All required information is included in this SAP; therefore, the crosswalk table is not necessary for this project.
7. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.
    - None.

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	Email Address or Mailing Address
Angela Jones	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	757-341-0485	angela.jones1@navy.mil
Connor O'Loughlin	RPM	USEPA Region 3	215-814-3304	oloughlin.connor@epa.gov
Steve Mihalko	RPM	VDEQ	804-698-4202	stephen.mihalko@deq.virginia.gov
Bonnie Capito	Librarian	NAVFAC Atlantic	757-322-4785	bonnie.capito@navy.mil
Nathaniel Price	Activity Manager (AM)	CH2M	757-671-6280	nathaniel.price@ch2m.com
Juliana Dean	Project Manager (PM)	CH2M	757-671-6232	juliana.dean@ch2m.com
Anita Dodson	Program Chemist	CH2M	757-671-6218	anita.dodson@ch2m.com
Andrew Lairson	Project Chemist (PC)	CH2M	757-671-6297	andrew.lairson@ch2m.com
John Tomik	Activity Quality Manager (AQM)	CH2M	757-671-6259	john.tomik@ch2m.com
Laura Cook	Senior Technical Consultant (STC)	CH2M	757-671-6214	laura.cook1@ch2m.com
To be determined (TBD)	Field Team Leader (FTL)	CH2M	TBD	TBD
Kimberly Drag	Laboratory PM	Gulf Coast Analytical Laboratories (GCAL)	225-769-4900	kimberly.drag@gcal.com
Jonathan Thorn	Laboratory PM	Battelle Memorial Institute (Battelle)	781-681-5565	thorn@battelle.org
TBD	Data Validator (DV)	TBD	TBD	TBD

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number (optional)	Signature/Email Receipt
Nathaniel Price	CH2M/AM	757-671-6280	
John Tomik	CH2M/AQM	757-671-6259	
Andrew Lairson	CH2M/PC	757-671-6297	
Laura Cook	CH2M/STC	757-671-6214	
Juliana Dean	CH2M/PM	757-671-6232	
Anita Dodson	CH2M/Program Chemist	757-671-6218	
Roni Warren	CH2M/Human Health Risk Assessor	814-364-2454	
Bill Kappleman	CH2M/Ecological Risk Assessor	703-376-5152	
Angela Jones	Navy/RPM	757-341-0485	
Kenneth Bowers	Navy Chemist/Quality Assurance Officer (QAO)	757-322-8341	
Connor O’Loughlin	USEPA Region 3/RPM	215-814-3304	
Steve Mihalko	VDEQ/RPM	804-698-4202	
Jonathan Thorn	Battelle/PM	781-681-5565	
Kimberly Drag	GCAL/PM	704-607-7735	
TBD	TBD/DV	TBD	

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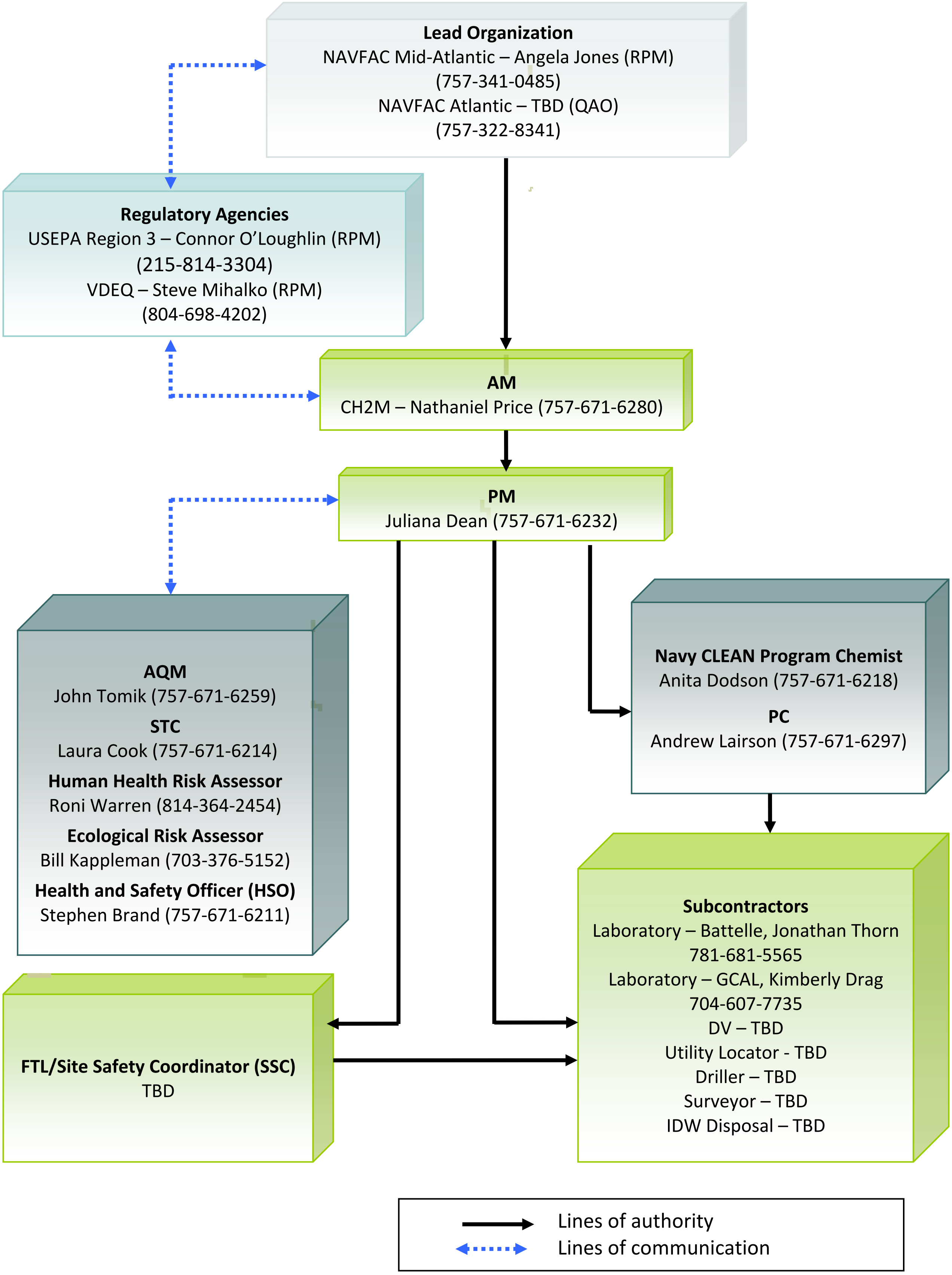
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure
Communication with NAVFAC (lead agency)	Navy RPM	Angela Jones	757-341-0485	Primary point of contact (POC) for Navy; communicates directly with VDEQ and USEPA as needed. Can delegate communication to other internal or external POCs.
Communication with VDEQ	VDEQ RPM	Steve Mihalko	804-698-4202	Primary POC for VDEQ; communicates directly with the Navy and USEPA as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with USEPA	USEPA RPM	Connor O’Loughlin	215-814-3304	Primary POC for USEPA; communicates directly with the Navy and VDEQ as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Department of the Navy (Navy) Quality Assurance (QA)/Quality Control (QC) input	Navy Chemist/QAO	Kenneth Bowers	757-322-8341	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.
Program QC	CH2M AQM	John Tomik	757-671-6259	Provides quality oversight to the project.
Program Oversight	CH2M STC	Laura Cook	757-671-6214	Provides technical oversight to the project.
Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations)	CH2M Program SAP reviewer	Katie Tippin	757-671-6258	Provides senior technical oversight of the SAP.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure
Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and VDEQ	CH2M AM	Nathaniel Price	757-671-6280	Primary POC for stakeholder agency managers; can delegate agency communication to other contract staff, as appropriate. All information and materials about the project will be forwarded to the Partnering Team by the AM. The AM oversees all NAS Oceana projects. If field changes occur during investigation activities, the AM will work with the Navy RPM to communicate the field changes to the Partnering Team via email and/or phone within 24 hours.
Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and VDEQ	CH2M PM	Juliana Dean	757-671-6232	If field changes occur during investigation activities, the PM will work with the Navy RPM to communicate the field changes to the Partnering Team via email and/or phone within 24 hours. All data will be communicated to the Partnering Team via email and meetings. The CH2M PM will communicate project-related information in a consistent manner. Standard monthly progress reports and invoices will be prepared and submitted to the Navy.
Health and Safety (H&S) expectations and procedures	CH2M HSO	Stephen Brand	757-671-6211	Review of the Health and Safety Plan. Direct communication (via email, telephone, hard copy, or in person, will be notified within 24 hours of incident) to/from Navy contractor project staff to ensure implementation of appropriate H&S procedures.
Implementation of sampling activities; SAP changes in the field; field corrective actions (CAs); daily field progress reports.	CH2M FTL	TBD	TBD	Documentation of deviations from SAP in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; groundwater sampling and well installation; deviations made only with approval from the contractor PM (**Worksheets #32** and **#32-1)**. The FTL will immediately notify the PM of any field issues that would negatively impact the ability to meet project data quality objectives or would negatively impact the project schedule. The AM or PM may notify the Navy RPM. The FTL will email or fax daily field progress reports to contractor PMs weekly; telephone communication with the PM will occur as needed.
Ensure staff H&S in the field	CH2M SSC	TBD	TBD	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or Email	Procedure
Data tracking from collection through upload to database. Management of analytical laboratory and data validation subcontractors. Analytical CAs/release of analytical data.	CH2M PC	Andrew Lairson	757-671-6297	Tracks data from sample collection through upload to the database, ensuring SAP requirements are met by laboratory and field staff. Will act as main POC for laboratory QAO. The CH2M AM and PM are informed within 24 hours to pass on communications to Navy and regulators as required. Analytical laboratory CAs will be identified by, or brought to the attention of, the PC as soon as they are discovered. Facilitates resolution on a same-day basis after consulting with the PM and AQM and the Navy chemist (if changes in the SAP are warranted) to ensure SAP requirements are met by the laboratory. Communicates with subcontractors by phone and follows up with email to document decisions and actions. If analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data such that the project completeness goal cannot be obtained, the PC will notify the project team including the Navy RPM and Navy QAO.
Reporting Laboratory Data Quality Issues	Laboratory PM (Battelle)	Jonathan Thorn	781-681-5565	All QA/QC issues with project filed samples will be reported by the laboratory to the PC within 1 business day. In the event of significant data quality issues, the AM will notify the Navy RPM. The RPM may notify the Navy chemist at their discretion.
	Laboratory PM (GCAL)	Kimberly Drag	704-607-7735	
Field and Analytical CAs	CH2M Program Chemist CH2M PC CH2M FTL	Anita Dodson Andrew Lairson TBD	757-671-6218 757-671-6297 TBD	The need for CA for field and analytical issues will be determined by the FTL and/or PC
Stop Work Order	CH2M AM	Nathaniel Price	757-671-6280	Any field member can immediately stop work if an unsafe condition that is immediately threatening to human health is observed. The field staff, FTL, or SSC, should notify the CH2M AM/PM immediately along with the Navy RPM. Ultimately, the FTL or AM/PM can stop work for a period. NAVFAC Mid-Atlantic can stop work at any time.
	FTL/SSC Field Team Members	TBD	TBD	
Reporting data quality issues	DV	TBD	TBD	The DV reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the PC within 14 calendar days.

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SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Angela Jones	RPM	NAVFAC	Coordinates all environmental activities at NAS Oceana.
Kenneth Bowers	NavyChemist/QAO	NAVFAC	Navy Review of SAP and QA input.
Nathaniel Price	AM	CH2M	Responsible for Environmental Restoration Program at NAS Oceana.
Juliana Dean	PM		Responsible for administration; coordinates staffing; monitors project performance; directs and oversees project staff.
John Tomik	AQM		Provides activity level quality review and guidance.
Laura Cook	STC		Provides senior technical oversight.
Anita Dodson	Program Chemist		Provides guidance during preparation of the SAP. Provides program-level review of SAP.
Katie Tippin	Program Level SAP Reviewer		Provides guidance during preparation of the SAP. Provides program-level review of SAP.
Andrew Lairson	PC		Prepares chemistry-specific SAP worksheets. Ensures proper data tracking and reporting and maintains communication with contracted laboratory. Responsible for coordination of laboratory deliverables. Ensures that laboratory adheres to requirements in the SAP.
Roni Warren	Human Health Risk Assessor		Provides senior technical support for investigative sampling and human health risk screening.
Bill Kappleman	Ecological Risk Assessor		Provides senior technical support for investigative sampling and ecological risk screening.
TBD	FTL		Supervises and coordinates all field activities and is responsible for overseeing subcontractors.
TBD	Field Team Member		Assists with sample collection and helping FTL.
Stephen Brand	HSO		Oversees H&S for field activities.
Jonathan Thorn	Laboratory PM	Battelle	Manages analytical projects from initiation to completion.
Kimberly Drag	Laboratory PM	GCAL	Manages analytical projects from initiation to completion
TBD	DV	TBD	Responsible for validation of environmental data.

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SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training beyond standard H&S training is required for this project.

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

Project Name: NAS Oceana Basewide PFAS SI Addendum Scoping Session **Projected Date(s) of Sampling:** Winter 2019 **PM:** Juliana Dean	**Site Name:** NAS Oceana **Site Location:** NAS Oceana, Virginia Beach, Virginia

Date of Session: May 30, 2017

Scoping Session Purpose: To obtain Team agreement on the sampling strategy for the basewide PFAS SI Addendum at NAS Oceana

Name	Project Role	Affiliation	Phone Number	Email Address
Angela Jones	Navy RPM	NAVFAC Mid-Atlantic	757-341-0485	angela.jones1@navy.mil
Steve Mihalko	VDEQ RPM	VDEQ	804-698-4202	stephen.mihalko@deq.virginia.gov
Christopher Vallone[a]	USEPA RPM	USEPA Region 3	215-814-3306	vallone.christopher@epa.gov
Rob Thomson	USEPA	USEPA Region 3	215-814-3357	thomson.bob@epa.gov
Laura Cook[b]	AM	CH2M	757-671-6214	laura.cook@ch2m.com
Juliana Dean	PM	CH2M	757-671-6232	juliana.dean@ch2m.com
Kathy Davies	Hydrogeologist	USEPA Region 3	215-814-3315	Davies.kathy@epa.gov
Laurel Boucher	Facilitator	Management Edge	703-407-1030	lboucher@up.net

Notes:

[a] Christopher Vallone was the USEPA RPM at the time of this scoping session. Connor O'Loughlin is the current RPM.

[b] Laura Cook was the AM at the time of this scoping session. Nathaniel Price is the current AM.

CH2M presented the objectives of the PFAS SI Addendum at NAS Oceana. The objectives include further defining the lateral and vertical extent of PFAS contamination, refining the hydraulic characteristics of the aquifer, and determining if PFAS contamination is present in media not previously investigated (e.g. soil, sediment, and surface water). The Team also reviewed ecological screening values from the available literature. The Team agreed to the following proposed sampling strategy:

- Install ten shallow and eight deep monitoring wells, including one deep well at Site 11 to the bottom of the Yorktown aquifer
- Complete a groundwater level survey of all new and existing monitoring wells
- Complete slug testing at three monitoring wells in the Yorktown aquifer
- Collect samples from all monitoring wells previously sampled for PFAS, all new monitoring wells installed as part of this investigation, and one existing well near the aqueous film forming foam (AFFF) holding tank at Solid Waste Management Unit (SWMU) 2B for the 14 PFAS compounds listed in the Navy's September 2017 guidance[2]
- Collect approximately eight co-located surface (0 to 6 inches below ground surface [bgs]) and subsurface (6 to 24 inches bgs) soil samples for 14 PFAS (five at Site 11, one near the hangars, one near the Fuel Tanks, and one near the Jet Test Cell)

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[2] The four additional PFAS compounds recently included the updated analytical method for PFAS, EPA 537.1, were added prior to submitting the Draft Final SAP in accordance with Navy guidance/policy.

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

- Collect approximately 23 co-located sediment and surface water samples for 14 PFAS analyte list
- Collect samples from existing petroleum, oils, and lubricant (POL) monitoring wells at the Naval Exchange (NEX) Gas Station and FITWING POL sites

The Team noted that the 1986 plane crash location had been revised based on additional documentation, and monitoring wells will be installed in the revised location. It was also noted that an additional residential sample was recently collected north of the Base with results just below the lifetime health advisory. At some point in time, the wells along the northern perimeter will need to be resampled as they had previously shown low-level detections.

The Team agreed to only sample surface water locations if standing water was present on the day of sampling. The Team agreed to the proposed approach with the potential for additional locations being added at potential AFFF holding tank locations once those locations are identified.

Action Items:

Navy will identify locations of additional AFFF holding tanks.

CH2M will continue preparing the SAP.

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

Project Name: NAS Oceana Basewide PFAS SI Addendum Scoping Session **Projected Date(s) of Sampling:** Winter 2019 **PM:** Juliana Dean			**Site Name:** NAS Oceana **Site Location:** NAS Oceana, Virginia Beach, Virginia	
Date of Session: July 18, 2018 **Scoping Session Purpose:** To obtain Team agreement on the updated sampling strategy for the Basewide PFAS SI Addendum at NAS Oceana				
Name	**Project Role**	**Affiliation**	**Phone Number**	**Email Address**
Angela Jones	Navy RPM	NAVFAC Mid-Atlantic	757-341-0485	angela.jones1@navy.mil
Steve Mihalko	VDEQ RPM	VDEQ	804-698-4202	stephen.mihalko@deq.virginia.gov
Christopher Vallone[a]	USEPA RPM	USEPA Region 3	215-814-3306	vallone.christopher@epa.gov
Rob Thomson	USEPA	USEPA Region 3	215-814-3357	thomson.bob@epa.gov
Laura Cook[b]	AM	CH2M	757-671-6214	laura.cook@ch2m.com
Juliana Dean	PM	CH2M	757-671-6232	juliana.dean@ch2m.com
Bill Kappleman	Ecological Risk Assessor	CH2M	703-376-5152	william.kappleman@jacobs.com
Kathy Davies	Hydrogeologist	USEPA Region 3	(215) 814-3315	davies.kathy@epa.gov
Matt Taynor	Biologist	USEPA/Biological Technical Assistance Group	(215) 814-3351	taynor.matthew@epa.gov
Dawn Ioven	Risk Assessor	USEPA Region 3	(215) 814-3320	Ioven.dawn@epa.gov
Jason Speicher	Risk Assessor	NAVFAC Mid-Atlantic	(215) 897-4914	jason.a.speicher@navy.mil

Notes:

[a] Christopher Vallone was one of the USEPA RPMs at the time of this scoping session. Connor O'Loughlin is the current RPM.

[b] Laura Cook was the AM at the time of this scoping session. Nathaniel Price is the current AM.

The Team began the scoping session by summarizing the groundwater flow results inferred from the groundwater level survey performed in June 2018. A supply well on the northern part of the Base had been shut off, resulting in a shift of groundwater flow to the northeast. In response to this, the Team agreed not to add more sampling areas off-Base, but to increase monitoring to determine concentration fluctuations.

The Team agreed to perform a Source Area Assessment (SAA) to identify source areas that may have been missed during the SI, and contingencies within the SI Addendum SAP would be created to allow for sampling at additional potential source areas that may be identified during the SAA. The Team discussed the available ESVs for PFAS analytes and agreed to include the Warminster/Willow Grove values, as well as the revised values calculated by CH2M, in **Worksheet #15** to ensure appropriate detection limits can be achieved. However, it was also agreed that the most recent guidance/literature would be used at the time the data were evaluated and that an ecological risk screening would not take place until promulgated ecological screening values are released.

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

After discussing the project action limits (PALs) and soil screening levels (SSLs) and the uncertainty involved with the screening limits, the Team agreed to not include the SSLs as PALs, but a qualitative assessment of leaching would be included in the report. All other PALs presented were agreed upon by the Team (**Appendix C**). The Team agreed to the sampling locations presented in the scoping session slides (**Appendix C**). Additionally, after confirming the sampling locations, the Team agreed to analyze for the list of 24 PFAS analytes as opposed to the 14 PFAS list.[3]

Finally, the Team agreed to use the NAS Oceana stormwater pollution prevention plan (SWPPP) to determine which sample locations are associated with which drainage areas of the facility, and that this information would be included in the SAP.

Action Items:

CH2M will include watershed information from the Oceana SWPPP in the SAP.

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[3] This analysis approach was later rescinded based on a Navy Headquarters directive requesting all current SAPs use the 14-PFAS analyte list previously mentioned.

SAP Worksheet #10—Conceptual Site Model

Installation Background

NAS Oceana (**Figure 1**) is in Virginia Beach, Virginia, and was established in 1943 as a small auxiliary airfield. Since 1943, NAS Oceana has grown to more than 16 times its original size and is now a 6,000-acre master jet base supporting a community of more than 9,100 Navy personnel and 11,000 dependents. The mission of NAS Oceana is to provide the personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment.

Physical Characteristics

Topography at NAS Oceana is relatively flat, with the elevation ranging from 5 to 25 feet above mean sea level with a gradual easterly slope. Surface runoff from the Base is directed to a system of drainage ditches and surface canals, which flow west to West Neck creek, north to London Bridge and Great Neck Creeks, and east to Owls Creek and Lake Rudee (CH2M, 2001).

NAS Oceana is on the outer edge of the Atlantic Coastal Plain physiographic province. The Atlantic Coastal Plain is a broad wedge of unconsolidated sediments that dip and thicken to the east. In the vicinity of NAS Oceana, the sediments consist of several thousand feet of unconsolidated sand, clay, silt, and gravel, and are underlain by granite basement rock. The sediments range in age from early Cretaceous to Recent. From oldest to youngest, the four geologic units underlying NAS Oceana are the Potomac Formation, Pamunkey Group, Chesapeake Group, and Columbia Group (Meng and Harsh, 1984).

The geologic units of concern in the environmental investigations at NAS Oceana are in the Chesapeake Group (only the youngest unit, the Yorktown Formation) and the Columbia Group. The Chesapeake Group has been differentiated into several units, which are, from oldest to youngest, the Calvert, Choptank, St. Mary’s, Eastover, and Yorktown formations. The subsurface at NAS Oceana consists of three stratigraphic units. The uppermost unit is a 4- to 8-foot-thick unit of fine sediments, mainly silty clays and silty sands, which is underlain by a 15- to 20-foot layer of poorly graded fine to medium sand with some silty lenses. The two units correspond to the Columbia Group sediments. The Columbia Group is underlain by the Yorktown Formation, which consists of silty sand interbedded with zones of cleaner sand. Shells and shell hash indicative of the top of the Yorktown Formation have been typically encountered at approximately 25 feet bgs.

Groundwater at NAS Oceana is generally within 4 to 10 feet of the ground surface. The surficial hydrogeologic unit consists of the Surficial aquifer, also known as the Columbia aquifer, which extends to a depth of approximately 17 to 30 feet bgs at the installation. The Yorktown-Eastover aquifer underlies this unit. No monitoring wells or water supply wells at the Base have been installed to the total depth of the Yorktown-Eastover aquifer, but the approximate thickness of the unit is 100 feet based on *The Virginia Coastal Plain Hydrogeologic Framework* (USGS, 2006).

Basewide groundwater flow at NAS Oceana is generally southwest in the southern half of the facility, to the northeast in the northern half, and to the west-northwest in the eastern portion of the Base. However, flow direction in the shallow Columbia aquifer is generally toward surface water bodies and drainage ditches (**Figure 2**). Therefore, the flow direction is highly variable due to complex drainage patterns. The Yorktown aquifer appears to follow the flow patterns of the Columbia aquifer with flow to the north at the northern half of the facility and to the southwest within the southern half of the facility (**Figure 3**).

SAP Worksheet #10—Conceptual Site Model (continued)

Background and Investigation History

The Basewide PFAS Site Inspection (SI) was completed in late 2016 to spring 2017. The objectives of the investigation were to:

- Determine whether PFAS are present at levels posing potentially unacceptable risks in groundwater in likely source areas and confirm suspected source areas at NAS Oceana
- Determine whether PFAS have migrated offsite and are present at levels exceeding human health screening criteria in offsite drinking water

The SI included collection of groundwater samples from the Columbia aquifer (**Figure 4**) and Yorktown aquifer (**Figure 5**) from Site 11, SWMU 26, the Aircraft Hangars and Maintenance Buildings, the 1996 Crash Site, and Jet Test Cell area; the 2007 Crash Site was included in the SI but was not investigated because the site was not accessible. All samples were analyzed for the six PFAS listed in USEPA's Unregulated Contaminant Monitoring Rule 3, which consisted of perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonic acid (PFHxS), and perfluorononanoic acid (PNA). Additional details are available in the SI report (CH2M, 2018), summarized in **Table 1**, and presented on **Figure 4** and **Figure 5**. PFOS and PFOA were screened against the lifetime health advisory of 70 nanograms per liter (ng/L), and PFBS were screened against the USEPA regional screening level (RSL) of 400,000 ng/L. There are no screening criteria for perfluorononanoic acid (PFNA), PFHxS, or PFHpA.

Additionally, samples were collected from seven off-Base drinking water wells and one on-Base golf course irrigation water supply well. One sample, collected from an off-Base private drinking water well to the north of the Base, had an exceedance of the lifetime health advisory for PFOS/PFOA. Additionally, one drinking water sample east of the Base had detections of PFOS/PFOA below the lifetime health advisory (**Figure 6**). The remaining five off-Base wells sampled did not have detections of PFAS. There were no detections of PFAS in the on-Base irrigation well.

PFAS Source Areas

The background and investigation history for source areas identified in the SI as having PFOS and/or PFOA detections and for newly identified potential PFAS source areas are summarized in **Table 1** and portrayed on **Figure 7**. Additional details are available in the SI report (CH2M, 2018). Additional source areas as well as additional information on currently known source areas will be documented in the Basewide PFAS SAA. Four additional areas were identified in this SI Addendum SAP. Two were included for investigation based on newly available data indicating that PFAS may be present in groundwater; one area was previously identified in the SI but with the incorrect location; the fourth area identified is a landfill with an adjacent pond that receives runoff from the hangar areas.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 1: Potential PFAS Source Areas

Source Areas	Details
Source Areas Investigated During SI	
Site 11, Fire Training Area	Site 11 was used for firefighting training twice per week from the 1960s to the 1980s. Initially, training exercises were performed on the abandoned runway. Waste fuel and oil were dumped onto the runway, ignited, and extinguished with AFFF. In 1969, the annual usage of AFFF was estimated to be 2,000 gallons. In the mid-1970s, the first fire training ring (SWMU 62, the Old Burn Pit) was installed with an earthen berm to contain runoff. After construction of the first ring, training exercises were performed within the earthen berm and runoff would occasionally flow onto surrounding soils. Disposal of this runoff is unknown. In the early 1980s, a second fire training ring (SWMU 63, the New Burn Pit) was installed on a concrete pad with a concrete berm and an oil/water separator to contain POL. In the 1990s, a third training ring was built to the north as a jet mock-up on a concrete pad with runoff collection devices. Historical documentation does not indicate that AFFF was used at the jet mock-up, but trucks were previously tested quarterly near this area by spraying AFFF onto the grass near the ring. In 2001, Site 11 (referred to as SWMU 11 in that report) was closed with no further action (CH2M, 2001). Site 11 is currently being evaluated for PFAS due to firefighting training activities historically conducted at the site. Specific areas identified within Site 11 for potential AFFF use include the firefighting training rings and the land application area to the southwest, where burned residues from the training area were potentially disposed. During the SI, samples were collected from seven monitoring wells screened in the Columbia aquifer and one monitoring well screened in the Yorktown aquifer Site 11. Concentrations of PFOS and/or PFOA exceeded the lifetime health advisory in all samples. No samples exceeded the RSL for PFBS. PFHpA, PFHxS, and PFNA[4] were detected in each of the groundwater samples collected at this site. The horizontal and vertical extent of contamination was not fully delineated during the SI.
1996 Crash Site	During the NAS Oceana Fire Department interviews (CH2M, 2015), interviewees indicated that a plane crashed in the woods on the Base in 1995. However, a local newspaper article indicated that the crash was in 1996 (Sizemore, 2012). This SAP refers to this crash as the 1996 crash. Interviewees could not recall whether there was an associated fire, and there is uncertainty associated with whether AFFF was used for this crash. The location of the crash was noted during the SI and the investigation was limited to the collection of a groundwater sample from an existing downgradient well, as shown in **Figure 4**. PFOA and PFOS were detected but did not exceed the lifetime health advisory. PFBS was detected but did not exceed the RSL. PFHpA, and PFHxS were also detected at this location.
2007 Crash Site	In 2007, a civilian plane crashed near Runway 5L during an air show practice, the location of which is shown on **Figure 7**. Interviewees during the NAS Oceana Fire Department interviews were not sure whether AFFF was used. AFFF is commonly used in response to plane crashes either to put out fires or to prevent spilled fuel from igniting.
Jet Test Cell Area	The Jet Test Cell (referred to as the Hush House) was first investigated in December 2003 as a result of a fuel release on November 24, 2003 (VDEQ, 2004). During training in the area around Building 1100, an accidental AFFF release occurred. Personnel called Oceana Base Environmental personnel and were told to spray down the concrete area into the grass. An AFFF holding tank is also located outside of the Jet Test Cell (Building 1116). During the SI, monitoring well JTC-MW-B was sampled and the total PFOS and PFOA concentration exceeded the lifetime health advisory. PFBS was detected at this location but not above levels exceeding the RSL. PFHpA, PFHxS, and PFNA were also detected during this investigation, although PFNA was only detected in one of the two wells sampled (JTC-MW-B). The horizontal and vertical extent was not delineated during the SI.

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[4] Data for PFHpA, PFHxS, and PFNA is beinch archived and will be evaluated when screening values become available.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 1: Potential PFAS Source Areas

Source Areas	Details
SWMU 26, Fire Station Burn Pit	SWMU 26, southeast of Building 220 (Fire Station), was used for firefighting training activities from the 1960s to the 1980s and consisted of a partially buried tank that was filled with waste fuel and oil, ignited, and extinguished. SWMU 26 was used for fire extinguisher training exercises from the 1960s to the 1980s. The RCRA Facility Assessment noted visible staining in a drainage ditch behind Building 220, and the Decision Document for the site notes that burned residue was pumped into the ditch (A. T. Kearney, 1989). The tank was removed from the ground by 1990. In 2001, SWMU 26 was closed with no further action (CH2M, 2001). During the SI, PFOS was detected in both the Columbia and Yorktown aquifer, and concentrations of PFOS and PFOA in the Columbia aquifer exceeded the lifetime health advisory, as shown on **Figure 4**. PFOA was not detected in the Yorktown aquifer. PFOS was detected in the Yorktown aquifer, but below concentrations exceeding the lifetime health advisory. PFBS was detected in the Columbia aquifer but not at levels exceeding the RSL. PFHpA, PFHxS, and PFNA were also detected in the Columbia aquifer, but only PFHxS was detected in the Yorktown aquifer.
Aircraft Hangars and Maintenance Buildings	Several aircraft hangars and maintenance buildings were identified as potential AFFF release areas during NAS Oceana Fire Department interviews completed in 2015 (CH2M, 2015). Several of these buildings are known to have AFFF holding tanks associated with them. The following releases have been identified and investigated: • Building 145 - AFFF was accidentally released into the parking lot. Personnel were advised to cover the storm drains and spray water to wash the AFFF onto the grass. A contractor was brought in to vacuum up remaining foam. The date of this release is unknown. • Hangar 500 - AFFF was released during an “activation” (which is technically not considered a “spill”) which used to occur monthly due to sensitive sensors. The sensors have been adjusted and there have been no additional activations. The date range of the monthly activations is unknown. During the SI, concentrations of PFOS and/or PFOA were detected in proximity to the two areas noted above in all seven wells) screened in the Columbia aquifer in the vicinity of the hangars with a total PFOA and PFOS concentration above the lifetime health advisory, as shown on **Figure 4**. PFBS was detected, but not above the RSL, and PFHpA, PFHxS, and PFNA were detected at all wells sampled during the investigation. The horizontal and vertical extent was not delineated during the SI. Additionally, the hangar area discharges to a water body near the Fifth Green Landfill before discharging to Outfall 001, as shown on **Figure 10**.
Potential Source Areas Included in the SI Addendum	
Source Areas	**Details**
1986 Crash Site	In 1986, a plane crashed off Oceana Boulevard inside the Base boundary. The NAS Oceana Fire Department interviews (CH2M, 2015) indicated that AFFF was probably used for this crash. The suspected area of the plane crash was investigated during the Basewide PFAS SI and PFAS analytes were not detected in a sample collected from a shallow monitoring well installed in the vicinity of the crash location. However, upon further review of historical documents, the location of the plane crash identified in the SI was determined to be incorrect and was revised to match that identified in a crash debris map, as shown on **Figure 7**.
Fifth Green Landfill	It is unlikely AFFF or PFAS-containing material was disposed of at the Fifth Green Landfill, as the landfill operated from 1954 to 1961. However, Fifth Green Landfill was identified as a potential PFAS source area, as the landfill is located within a golf course which was irrigated with groundwater containing PFAS. In addition, the adjacent pond receives storm water flow from areas surrounding the hangars.
NEX Gas Station, Auto Hobby Shop, and Car Wash	The NEX gas station is a site being investigated for petroleum releases under a separate regulatory program. Investigation-derived waste (IDW), consisting of purge water from the monitoring wells at this site, was analyzed for PFAS prior to disposal, and concentrations of PFOS and/or PFOA were detected in exceedance of the lifetime health advisory. It is unknown if the NEX Gas Station is the source of PFAS, or if PFAS concentrations could be a result of an upgradient source area or the adjacent auto hobby shop and car wash. Similar sites at other facilities had a history of using waxes or other maintenance fluids that contained PFAS and could be contributing to concentrations of PFAS at the NEX Gas Station.

SAP Worksheet #10—Conceptual Site Model (continued)

Table 1: Potential PFAS Source Areas

Source Areas	Details
POL Sites	Concentrations of PFOS and/or PFOA have been detected in investigation-derived waste samples from the following POL sites across the installation, listed below and shown on **Figure 7**: • F8/F9 • T-Line • FITWING • Fuel Farm

Potential Contaminant Sources, Transport Pathways, and Receptors

At NAS Oceana, the primary suspected source of PFAS is AFFF. When AFFF is released into the environment due to intentional or inadvertent discharge, it may migrate to groundwater via infiltration in soil. PFAS compounds are commonly found in groundwater and downgradient of release areas as they do not readily adsorb to soils. Currently, there are no known inhalation hazards associated with PFAS and no known dermal contact hazards associated with PFAS in groundwater; therefore, the potential human receptors of PFAS contamination are as follows:

Residents

- Current and future residents who use groundwater as a potable water source
- Future residents through dermal contact with surface soil or subsurface soil
- Future residents through incidental ingestion of surface soil, subsurface soil, sediment, and/or surface water

Workers

- Current and future industrial and construction workers through dermal contact with surface soil, subsurface soil, and/or sediment
- Current and future industrial and construction workers through incidental ingestion of surface soil, subsurface soil, sediment, and/or surface water

Trespassers/Visitors

- Current and future trespassers and visitors through dermal contact with surface soil and/or sediment
- Current and future trespassers and visitors through incidental ingestion of surface soil, sediment, and/or surface water

Groundwater is not typically an exposure medium for ecological receptors, but ecological exposures may occur if groundwater discharges to a surface water body. In addition, ecological receptors (such as terrestrial and aquatic plants; soil, aquatic, and benthic invertebrates; fish; amphibians; and reptiles) may be directly exposed to PFAS compounds present in surface and shallow subsurface soil, surface water, and/or sediment. There is also evidence that PFAS compounds may enter food webs and thus ecological receptors (such as birds and mammals), and humans, may be exposed to these constituents via this pathway.

SAP Worksheet #10—Conceptual Site Model (continued)

Groundwater is not currently used as a potable water supply on NAS Oceana. The Base and most properties surrounding the Base are connected to city water. However, based on utility records, some properties, including private residences as well as businesses, are not connected to the municipal water supply and may use groundwater as a drinking water source. Non-potable wells are also located southeast of the Base boundary at a privately-owned salvage yard and at a local campground, on the east side of the Base at the Natural Resources Building, and on the northern side of the Base at the Skeet and Trap Range. The possibility exists that people will accidentally use the water from these wells for potable purposes or incidentally ingest the water during nonpotable use. Irrigation wells are present at the Base golf course. The evaluation of future residential use of site groundwater as a drinking water supply is a conservative evaluation of potential off-site use of groundwater that could be impacted by the site as a drinking water supply since concentrations downgradient of the source(s) would be lower than those at the source(s).

An ecological risk screening was not performed as part of the SI. The SI recommended that a supplemental human health risk screening be conducted using the data collected during the SI Addendum.

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

Problem Statement and Objectives

The objectives, environmental questions, investigation approach, and project quality objectives (PQOs) for this SI Addendum are presented in **Table 2**.

Table 2. Problem Definitions/Objectives, Environmental Questions, and Project Quality Objectives

Problem Definition/ Objective	Environmental Question	General Investigation Approach	Project Quality Objective (PQO)
Further define the lateral and vertical extent and evaluate the long-term temporal variability of PFAS contamination in groundwater in both the Columbia and Yorktown aquifers both on and off-Base and determine whether there is unacceptable risk to human and/or ecological receptors.	What are the horizontal and vertical extents of PFOS/PFOA greater than the screening criteria at the sites identified in this SAP? What are the current concentrations of PFAS analytes within groundwater in both existing and newly installed monitoring wells? If PFAS analytes are present, do they pose potential unacceptable risks to human and/or ecological receptors[5]? Is PFAS present in off-Base private drinking water wells not previously sampled? Where off-Base private drinking water wells have been sampled, have the PFAS concentrations changed? If so, what are the changes in PFAS concentrations over time?	Approximately 10 new shallow wells will be installed and screened within the Columbia aquifer downgradient of the source areas at Site 11, Aircraft Hangers and Maintenance Buildings, SWMU 26, and the Jet Test Cell as well as at the revised location of the 1986 plane crash, and on the northeastern and, southwestern portions of the Base (**Figure 8**). Approximately 10 new deep wells will be installed and screened within the Yorktown aquifer around the facility. One of these wells, in proximity to Site 11 will be installed to the bottom of the Yorktown aquifer (approximately 100 feet bgs) (**Figure 9**). Groundwater samples will be collected from the 10 new shallow wells, 10 new deep wells, 48 existing shallow wells, and 7 existing deep wells (**Figures 8** and **9**) (See **Worksheet #17** for the sampling rationale). All samples will be analyzed for the 18 PFAS analytes. The existing wells are based upon the established NAS Oceana background monitoring well network and have previously been sampled for the Unregulated Contaminant Monitoring Rule 3 list of PFAS analytes. These wells will be resampled for the 18 PFAS analyte list and to determine if there is any fluctuation of the concentration of PFAS analytes within the monitoring well network and to assess the presence of analytes not previously analyzed. Drinking water samples will be collected semiannually from off-Base drinking water wells within a 1-mile radius of the known PFOS/PFOA exceedances of the lifetime health advisory in groundwater at Oceana, to provide additional data for temporal comparisons and evaluate spatial variability. Proposed locations are shown on **Figure 11**. Monitoring will be conducted for a minimum of 3 years.	If PFAS concentrations are detected within new sampling areas on-Base, the data will be used to conduct human health and ecological risk screenings[5] and to be used to scope additional investigation or action, such as the installation of and sample collection from additional monitoring wells or soil sample collection, if warranted. IF PFAS concentrations are not detected within the new sampling areas on-Base, no further action will be taken at that location. If PFOA and/or PFAS concentrations at a residence are non-detect or below the lifetime health advisory, monitoring will continue in accordance with this SAP. If PFOA and/or PFOS concentrations in drinking water at a residence are above the lifetime health advisory, an alternate drinking water source will immediately be provided, and the sampling area will be expanded to include parcels within ½-mile downgradient. The Partnering Team will evaluate long-term solutions.
Refine understanding of hydraulic characteristics of the aquifers and transport mechanisms for site contaminants.	What are the groundwater flow directions on site in the Columbia and Yorktown aquifers? What are the hydraulic characteristics on site for the Yorktown aquifer?	After the installation of additional wells around NAS Oceana, all new and existing wells presented in **Figures 8** and **9** will be gauged for the depth to groundwater, and groundwater contour maps will be created to further refine the groundwater flow direction on site within both the Columbia and Yorktown aquifers. Additional existing monitoring wells may be added to the groundwater elevation map, as needed. A slug test will be completed on at least three of the wells screened in the Yorktown aquifer to determine hydraulic conductivity and velocity of groundwater on site.	This information will be used to assess the potential for on- and off-Base migration of PFAS contamination and will be used to scope additional investigation or action, as warranted.
If present, determine if PFAS provides an unacceptable risk to human health or ecological receptors due to exposure to soil, surface water, or sediment.	What are the concentrations of PFAS analytes within surface water, sediment, and soil, and do these concentrations pose potential unacceptable risks to human and/or ecological receptors[2]?	Soil, surface water, and sediment samples will be collected from potential source areas and downgradient locations. Proposed soil sample locations are presented on **Figure 8** and proposed surface water and sediment locations on presented on **Figure 10**, which also depicts the defined drainage area boundaries for the facility (see **Worksheet #17** for the sampling rationale). Collect 8 co-located surface and subsurface soil samples and 28 co-located surface water and sediment samples to be analyzed for 18 PFAS analytes to assess whether potential unacceptable risk to human or ecological receptors is present. Sediment samples will also be analyzed for total organic carbon (TOC). Additional data may be warranted if new source areas, transport or migration pathways, or other relevant information is identified in the SAA, which is being conducted. Additional contingency soil, surface water, and/or sediment samples will be collected if warranted to achieve the objectives of this SI Addendum. If warranted, new sample locations will be presented to the Partnering Team prior to collection.	If potentially unacceptable risks are identified, the Partnering Team will reconvene to determine an appropriate path forward, which could include additional sampling, or a removal action. If PFAS concentrations do not pose a potential unacceptable risk to human and/or ecological receptors in any given media, no further action will be taken at that location. However, all PFAS data will be archived for future use, as needed.

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[5] Screening values for ecological receptors have not yet been released by the USEPA. A risk screening will not be completed until these values are released, and the groundwater/surface water interchange will be evaluated as part of this risk screening. The literature-based ecological screening values provided in **Worksheet #15** are included to ensure adequate analytical sensitivity.

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

What are the Project Action Limits (PALs)?

The PALs for data collected are provided in **Worksheet #15** and summarized as follows:

- **Groundwater** data will be screened against the following PALs:
  - **Human Health** – The USEPA lifetime health advisory for PFOA and PFOS is 70 ng/L individually; if both chemicals are detected then 70 ng/L is the lifetime health advisory for the cumulative concentration of the two chemicals. PFBS results will be compared to the current USEPA tap water RSL (based on a hazard quotient [HQ] of 1). The USEPA RSL calculator was used to calculate tap water RSLs for PFOS and PFOA (based on a HQ of 1). There are no PALs for any other analytes.
  - **Ecological** –The literature-based ecological screening values (ESVs) provided in **Worksheet #15** are included to ensure adequate analytical sensitivity and will not be used to conduct an ecological risk screening. The sources for these ESVs are included in **Appendix D.** No promulgated ESVs have been issued by the USEPA for PFAS at this time. The analytical data will be evaluated for potentially unacceptable risk to ecological receptors once ESVs are issued.
- **Drinking water** data will be screened against the following PALs:
  - **Human Health** – The USEPA lifetime health advisory for PFOA and PFOS is 70 ng/L individually; if both chemicals are detected then 70 ng/L is the lifetime health advisory for the cumulative concentration of the two chemicals. PFBS results will be compared to the current USEPA tap water RSL (based on a hazard quotient [HQ] of 1). There are no PALs for any other analytes.
- **Surface and Subsurface Soil** data will be screened against the following PALs:
  - **Human Health** –PFBS results will be compared to the current USEPA residential soil RSL (based on a HQ of 1). The USEPA RSL calculator was used to calculate residential soil RSLs for PFOS and PFOA (based on a HQ of 1). There are no PALs for any other analytes.
  - **Ecological** – Literature-based ESVs provided in **Worksheet #15** are included to ensure adequate analytical sensitivity. The sources for these ESVs are included in **Appendix D.** No formal ESVs have been issued by the USEPA for PFAS. The analytical data will be evaluated, for potentially unacceptable risk to ecological receptors once ESVs are issued. ESVs will only be applied to samples collected within 24 inches of the ground surface.
- **Surface Water** data will be screened against the following PALs:
  - **Human Health -** PFBS results will be compared to the current USEPA tap water RSL (based on a HQ of 1) multiplied by 10. The USEPA RSL calculator was used to calculate tap water RSLs for PFOS and PFOA (based on a HQ of 1), which will then be multiplied by 10. There are no PALs for any other analytes. The RSLs are multiplied by 10 to account for exposure to surface water, which would be much less than exposure to groundwater.
  - **Ecological** – Literature-based freshwater ESVs provided in **Worksheet #15** are included to ensure adequate analytical sensitivity. The sources for these ESVs are included in **Appendix D**. No formal ESVs have been issued by the USEPA for PFAS. The analytical data will be evaluated, for potentially unacceptable risk to ecological receptors once ESVs are issued.
- **Sediment** data will be screened against the following PALs:
  - **Human Health** – PFBS results will be compared to the current USEPA residential soil RSL (based on a HQ of 1) multiplied by 10. The USEPA RSL calculator was used to calculate residential soil RSLs for PFOS and PFOA (based on a HQ of 1), which was then be multiplied by 10. There are no PALs for any other analytes. The RSLs are multiplied by 10 to account for exposure to sediment, which would be much lower than exposure to soil.

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

- **Ecological** – Literature-based freshwater ESVs provided in **Worksheet #15** are included to ensure adequate analytical sensitivity. No formal ESVs have been issued by the USEPA for PFAS. The analytical data will be evaluated, for potentially unacceptable risk to ecological receptors once ESVs are issued.

What will the data be used for?

The data will be used by the Navy, its contractors, and the other stakeholder agencies to address the environmental questions and PQOs listed in **Table 2**.

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

Worksheets #14 #15, #17, and **#18** contain detailed information on the types of data needed for this project.

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

Worksheets #14, #17, and **#18** describe how the groundwater, drinking water, surface and subsurface soil, surface water, and sediment samples will be sampled and for what parameters. Detailed information on how data will be collected is provided on **Worksheet #14,** following the SOPs listed in **Worksheet #21.** The proposed sample locations are illustrated on **Figures 8, 9,** and **10**. The project schedule is provided on **Worksheet #16**.

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

None.

SAP Worksheet #12-1—Measurement Performance Criteria Table for Field QC Samples

Matrix: Drinking Water
Analytical Group: PFAS

QC Sample	Analytical Group[a]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria
Field Duplicate (FD)	PFAS	1 per 10 field samples	Precision	Relative Percent Difference (RPD) should be < 30%. Greater variability may be observed when field duplicates are within a factor of 2 of the LOQ. At these concentrations, field duplicates should have RPDs that are < 50%.
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤10 degrees Celsius (°C), not frozen.
Field Reagent Blank[b]		1 per field sample	Bias/Contamination	If the method analyte(s) found in the Field Sample is present in the Field Reagent Blank at a concentration greater than 1/3 the LOQ, then all samples collected with that Field Reagent Blank are invalid and must be recollected and reanalyzed.

Notes:

[a] Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

[b] The preservative Trizma is only required for aqueous samples from drinking water sources. Since the field samples are from drinking water sources, the laboratory supplied PFAS-free water for the PFAS Field Reagent Blank, as well as sample containers, will be pre-preserved with Trizma.

SAP Worksheet #12-2—Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater, Surface Water

Analytical Group: PFAS

QC Sample[a]	Analytical Group[b]	Frequency	DQIs	Measurement Performance Criteria
FD	PFAS	1 per 10 field samples	Precision	RPD ≤ 30% if both results are ≥ LOQ
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias / Contamination	No target compounds > ½ LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤ 10°C, not frozen
Field Reagent Blank[c]		One per site[d]	Bias / Contamination	No target compounds > ½ LOQ

Notes:

[a] Field QA/QC will be collected separately for each matrix.

[b] Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

[c] The preservative Trizma is only required for aqueous samples collected from chlorinated drinking water sources. Since the field samples are not from chlorinated drinking water sources, the laboratory supplied PFAS-free water for the PFAS Field Reagent Blank, as well as sample containers, do not contain Trizma.

[d] A site is defined as one of the potential source locations of PFAS noted in **Worksheet #10**. Perimeter wells will be treated collectively as one site.

SAP Worksheet #12-3—Measurement Performance Criteria Table for Field QC Samples

Matrix: Soil, Sediment

Analytical Group: PFAS

QC Sample[a]	Analytical Group[b]	Frequency	DQIs	Measurement Performance Criteria
FD	PFAS	1 per 10 field samples	Precision	RPD ≤ 35% if both results are ≥ LOQ
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot for disposable equipment	Bias / Contamination	No target compounds > ½ LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤ 10°C, not frozen
Field Reagent Blank[c]		Once per site[d]	Bias / Contamination	No target analytes detected > 1/2 LOQ

Notes:

[a] Field QA/QC will be collected separately for each matrix.

[b] Field QA/QC as described in this table will be collected and analyzed for each of the analytical groups listed.

[c] The preservative Trizma is only required for aqueous samples collected from chlorinated drinking water sources. Since the field samples are not from chlorinated drinking water sources, the laboratory supplied PFAS-free water for the PFAS Field Reagent Blank, as well as sample containers, do not contain Trizma.

[d] A site is defined as one of the potential source locations of PFAS noted in **Worksheet #10.**

SAP Worksheet #12-4—Measurement Performance Criteria Table for Field QC Samples

Matrix: Sediment

Analytical Group: WCHEM (TOC)

QC Sample	Analytical Group	Frequency	DQIs	Measurement Performance Criteria
Cooler Temperature Indicator	WCHEM (TOC)	1 per cooler to the laboratory	Representativeness	Temperature ≤ 6°C, not frozen

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

This worksheet identifies all secondary data and information that will be used for the project, including the originating source of the data. This worksheet documents how the existing data will be used and the limitations to the use of the existing data.

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Analytical data from monitoring well groundwater samples collected for the Oceana Basewide PFAS SI	*Final Basewide Per- and Polyfluoroalkyl Substances Site Inspection Report* (CH2M, 2018)	CH2M collected groundwater samples from multiple wells in PFAS source areas as part of the Oceana Basewide PFAS SI.	The groundwater analytical data from the SI was used to identify additional potential source areas as well as create a basis for installing additional monitoring wells, determine hydraulic characteristics of the Columbia aquifer, and to delineate the PFAS plume. The analytical data from the SI will be used in the risk screenings completed during the SI Addendum.	None.

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SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities at NAS Oceana is detailed below. All field work will be completed in accordance with the applicable standard operating procedures (SOPs) tabulated on **Worksheet #21** and provided in **Appendix A.**

Mobilization

Prior to mobilization, NAVFAC Mid-Atlantic, USEPA, and VDEQ will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, procurement of the following subcontractors to support investigation activities include[6]:

- Utility Locator
- Surveyor
- Driller
- IDW subcontractor
- Data validation subcontractor

Battelle and GCAL have been procured to provide laboratory analytical services. Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the field team mobilizes for field activities.

Prior to beginning any phase of work, the contractor and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the Health and Safety Plan.

Prior to beginning any intrusive activities, CH2M will coordinate utility clearance with Miss Utility of Virginia and the Base’s approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings.

Monitoring Well Installation and Development

Monitoring wells will be installed in various locations Basewide. Approximately 10 monitoring wells will be screened in the Columbia aquifer, and approximately 10 monitoring wells will be double cased deep wells, screened in the Yorktown aquifer. One of the deep wells, located at Site 11, will be installed to the bottom of the Yorktown aquifer. Wells will be installed in accordance with the SOPs. Monitoring wells will be installed using hollow stem auger or sonic drilling methods; all deep monitoring wells will be installed using sonic drilling. Shallow wells will be installed to a depth of approximately 15 to 20 feet bgs. It is assumed that the well screen interval will intersect the water table. Deep wells will be installed with the same process and screened at depths ranging from 50 to 60 feet bgs, except for the deeper well at Site 11 which is anticipated to be installed to a depth of approximately 100 feet bgs. No Teflon, Viton, or other PFAS-containing drilling materials will be used during well installation. Drilling greases will be vegetable-based formulations (such as Biolube).

During well installation, lithology data will be collected using 4-foot direct-push technology cores, collected continuously. Soil descriptions, including grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination, will be recorded as detailed in the SOP.

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[6] The Navy may contract multiple contractors to complete the tasks outlined in this SAP. All work will be conducted in accordance with the SOPs included in this SAP, regardless of the contractor who performs the work.

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

Wells will be constructed of 2-inch polyvinyl chloride (PVC) casing and 10-foot-long 0.010 machine-slotted screens based on soil lithology and the depth at which groundwater is encountered. Sand filter pack (DSI #1 or equivalent) will be added to a depth of 2 feet above the screened interval; 2 to 4 feet of bentonite pellets or chips will be added and then hydrated in the annular space above the sand pack. Bentonite materials will be PFAS-free. The remainder of the annular space will be grouted to the surface. Wells will be completed with steel stick-up casing and four protective bollards. Newly-installed monitoring wells will be developed in accordance with the SOP included in **Appendix A**.

Monitoring wells will be developed using a submersible pump (or equivalent) and surge block with no Teflon, Viton, or other PFAS-containing components. Development pumping and surging will not start until at least 24 hours after grouting of the well has been completed. Field parameters (conductivity, temperature, pH, dissolved oxygen [DO], oxidation-reduction potential [ORP], and turbidity) will be monitored during development. Field parameters will be collected once one volume of the sampling tubing and flow through cell has been purged. Wells should continue to be developed until a minimum of three well volumes have been removed and turbidity has been reduced to the extent practicable. If field parameters other than turbidity are stable and turbidity values continue to decrease after the removal of three well volumes, monitoring well development activities will continue until turbidity readings have stabilized. Water quality parameters have stabilized over three consecutive readings when subsequent measurements agree as follows:

- pH within 0.1 pH unit
- Conductivity within 3%
- DO within 10%
- ORP within 10 millivolts
- Turbidity measurement within 10% or is minimized to the extent practical for the well

Monitoring Well Groundwater Sampling

Groundwater samples will be collected from new and existing monitoring wells as presented on **Figures 8** and **9**. Groundwater samples will be collected using low-flow sampling methodology and in accordance with the SOPs. A peristaltic pump will be used to collect samples for wells with a sampling depth of 30 feet or shallower and a PFAS-free submersible pump will be utilized for wells screened at deeper depths. The peristaltic tubing will be set in the middle of the well screen. Teflon lined tubing will not be used during groundwater sampling to prevent cross contamination with groundwater while sampling for PFAS analytes.

Groundwater quality parameters (pH, conductivity, turbidity, DO, temperature, salinity, and ORP) will be collected during purging of each well using a water quality meter and a flow-through cell. Water quality readings will be collected once one volume of the sampling tube and flow through cell has been purged. Purging will continue until water quality readings collected 5 minutes apart are stabilized to within 10% of one another. Once parameters have stabilized, the flow-through cell will be disconnected, and samples will be collected into laboratory-prepared, pre-preserved sample bottles and packed on ice for overnight shipment to Battelle.

Soil Sampling

Surface Soil Samples

Surface soil samples will be collected from the locations presented on **Figure 8.** For this investigation, surface soil is defined as 0 to 6 inches bgs (or 0 to 0.5 foot bgs). Surface soil samples will be collected using a stainless-steel hand auger, shovel, fluorine-free plastic disposable scoop, post-hole digger or other appropriate tool following soil sampling protocol.

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

Shallow Subsurface Soil Samples

Subsurface soil samples will be collected from the locations presented on **Figure 8.** Shallow subsurface soil samples will be collected from a depth of 0.5 to 2 feet bgs. Samples will be collected using a stainless-steel hand auger, shovel, or post-hole digger following soil sampling protocol.

Surface Water Sampling

If surface water is present on the day of sampling, samples will be collected at locations identified on **Figure 10**. Prior to collection, water quality readings (pH, conductivity, turbidity, DO, temperature, salinity, and ORP) will be obtained with a Horiba U-52 or similar water quality meter, and water depth and flow rate will be measured. Surface water samples (if identified) will be collected with a peristaltic pump and disposable tubing. All surface water samples, if applicable, will be collected into laboratory-prepared, pre-preserved sample bottles and packed on ice for overnight shipment to the laboratory.

Sediment Sampling

Sediment samples will be collected at locations identified on **Figure 10**. Sediment samples will be collected from 0 to 6 inches bgs using a stainless-steel trowel, fluorine-free plastic disposable scoop, hand auger, or other appropriate tool, and will be collected regardless of whether or not water is present. All sediment samples will be collected into approved laboratory containers and analyzed for PFAS and TOC. Cross contamination of PFAS analytes in accordance with the SOP will be considered during sampling.

Drinking Water Sampling

Finished drinking water samples will be collected in accordance with the potable water sampling SOP Water will be sampled by first purging the water supply for 3 to 5 minutes. The sampling port is usually the port at the bottom of a pressure tank. In instances where there is no port, or the valve cannot be used without damage or leaking, the next closest pretreatment location will be selected. Samples will be collected directly into laboratory-provided containers. A field reagent blank is collected at the site of collection for the drinking water sample. The field reagent blank is collected by transferring deionized water containing Trizma preservative (prepared at the laboratory) from one bottle to another unpreserved sampling bottle. This blank is used to determine if PFAS analytes are in the air at the sampling location; if any contamination was introduced during the sample management and shipment process; and if there were any laboratory errors.

Water-level Survey

Following monitoring well installation and development, and prior to the start of groundwater sampling or following the completion of all groundwater sampling, a complete water-level survey at all site wells (new and previously existing) will be conducted in accordance with the appropriate SOP. An electronic water-level meter with a probe which is not coated with Teflon or other PFAS-containing substances will be used to measure the depth to water from the top of casing to the nearest 0.01 foot.

Slug Testing

Slug tests will be conducted on at least three site wells installed in the Yorktown aquifer to determine groundwater velocity in the Yorktown aquifer for the site. A slug test will be performed using solid PVC slugs with clean PFAS-free bailer rope. A solid 1.5-inch-diameter PVC slug filled with sand, or similar, will be used for the

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

testing. A pressure transducer, such as a MiniTroll transducer/data recorder capable of measuring to 0.01 foot, will be used along with an electronic recording device, such as a RuggedReader handheld personal computer (or similar personal data device), to obtain water-level readings during the slug testing activities. Water levels will be monitored using a 15-pound-per-square-inch pressure transducer and results will be recorded on a 1-second linear scale.

Prior to inserting the slug into the monitoring well, a static water-level measurement will be recorded, a transducer will be installed in the well approximately 1 foot above the total depth of the well, and the water level will be allowed to return to ambient conditions. Each slug-in test will be started by initiating the data recording on the personal digital assistant while simultaneously lowering the slug into the hole. To conduct the falling head test, the PVC slug will be quickly added to the well and the water level allowed to stabilize to within 90% of the original static water level. The rising head test will then be started by rapidly removing the PVC slug, which will cause a drop in the water level. The transducer and recording device will be used to record changes in pressure associated with water-level recovery. A slug test will be considered complete when water levels have recovered to 90% of its pretest level.

Occasional water-level measurements will also be recorded manually to track the progress of the tests and to provide a data backup. Each test will be performed three times in each well to ensure consistent data are collected. After the testing is completed, the results will be uploaded from the electronic recording device to a laptop computer. Data processing will be completed to convert the recorded head values to feet displacement.

Equipment Decontamination

Nondisposable sampling equipment will be decontaminated immediately after each use in accordance with the appropriate SOP. 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% isopropanol and distilled water solution and air-dried
3. Laboratory grade deionized water (laboratory certified PFAS-free)

Decontamination fluids will be contained in 55-gallon drums and disposed of offsite as described below.

Cross-contamination of PFAS in accordance with the SOP (**Appendix A**) will be considered during equipment decontamination.

Investigation-derived Waste Management

IDW is expected to consist of drill cuttings from the soil borings completed for monitoring well installations, purge water (from well development and groundwater sampling), and decontamination fluids. Aqueous and soil IDW will be contained in 55-gallon drums. If PFAS concentrations in aqueous IDW accumulated during field activities exceed the lifetime health advisory of 70 ng/L for individual or combined PFOA or PFOS analytes, the PFAS IDW SOP will be followed. A location at NAS Oceana will be identified prior to initiation of the fieldwork where IDW will temporarily be stored. IDW drums will be labeled in accordance with the SOP.

Disposable equipment, including personal protective equipment, will be decontaminated in accordance with the SOP included in **Appendix A** and disposed of with normal facility trash. The IDW subcontractor has not been selected for this sampling event. However, once the subcontractor is identified, the Navy will be notified.

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

PFAS Field Reagent Blank Collection

To collect a PFAS field reagent blank for non-drinking water samples, PFAS-free laboratory supplied water will be slowly poured directly into Trizma-free laboratory provided sample containers (**Worksheet #19**). The preservative Trizma is only required for aqueous samples collected from drinking water sources. Since the field samples are not from drinking water sources, the laboratory supplied PFAS-free water for the PFAS field reagent blanks for non-drinking water samples, as well as the sample containers, do not contain Trizma.

Surveying

Each new monitoring well will be surveyed by a licensed surveyor both vertically and horizontally using the Virginia State Plane Coordinate System. Specifically, the elevation for each monitoring well will be established at the top of the monitoring well's inner PVC casing (this elevation point will be designated by a permanent notch placed on the top of each well's inner casing) and at ground surface. The surveying subcontractor has not been selected for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

Analytical and Validation Tasks

- **Quality Control**
  - SOPs for field (**Appendix A**) and laboratory being performed will be implemented.
  - QC samples to be collected are outlined on **Worksheet #20**.
- **Analytical Tasks**
  - The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24** and **#25**).
  - The laboratory will process and prepare samples for analysis.
  - The laboratory will analyze samples as shown on **Worksheet #18**.
- **Procedures for recording data, including guidelines for recording and correcting data**
  - Project Assessment and Audit (**Worksheets #31** and **#32**)
  - Data Review
    - Data Validation (**Worksheets #35** and **#36**)
    - Data Usability Assessment (**Worksheet #37**)

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

Matrix: Drinking Water

Analytical Group: PFAS

All units are micrograms per liter (µg/L) (unless otherwise specified)

Analyte	CAS #	PALs[a]		PQL Goal[b]	Laboratory Limits			LFB and LFSM/ LFSMD Recovery Limits and RPD[c](%)		
		Tapwater RSL, HQ = 1.0	USEPA Lifetime Health Advisory		LOQ	LOD	DL	LCL	UCL	RPD[d]
PFOS	1763-23-1	0.401	0.07	0.035	0.00250	0.0005	0.00015	**70**	**130**	**30**
PFOA	335-67-1	0.401	0.07	0.035	0.00250	0.0005	0.00020	**70**	**130**	
PFBS	375-73-5	400	--	200	0.00250	0.00040	0.00012	**70**	**130**	
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	2991-50-6	--	--	--	0.00250	0.0005	0.00017	**70**	**130**	
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	2355-31-9	--	--	--	0.00250	0.0005	0.00020	**70**	**130**	
Perfluorodecanoic acid (PFDA)	335-76-2	--	--	--	0.00250	0.0004	0.00011	**70**	**130**	
Perfluorododecanoic acid (PFDoA)	307-55-1	--	--	--	0.00250	0.0005	0.00014	**70**	**130**	
Perfluoroheptanoic acid (PFHpA)	375-85-9	--	--	--	0.00250	0.0005	0.00023	**70**	**130**	
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	--	--	--	0.00250	0.0004	0.00012	**70**	**130**	
Perfluorohexanoic acid (PFHxA)	307-24-4	--	--	--	0.00250	0.00050	0.00023	**70**	**130**	
Perfluorononanoic acid (PFNA)	375-95-1	--	--	--	0.00250	0.0004	0.00012	**70**	**130**	
Perfluorotetradecanoic acid (PFTA)	376-06-7	--	--	--	0.00250	0.0005	0.00022	**70**	**130**	
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	--	--	--	0.00250	0.0004	0.00010	**70**	**130**	
Perfluoroundecanoic acid (PFUnA)	2058-94-8	--	--	--	0.00250	0.0004	0.00010	**70**	**130**	
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	919005-14-4	--	--	--	0.00250	0.00040	0.00012	**70**	**130**	
9-chlorohexadecafluoro-3-oxanone-1-sulfonic (9Cl-PF3ONS)	756426-58-1	--	--	--	0.00250	0.00040	0.00012	**70**	**130**	
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	763051-92-9	--	--	--	0.00250	0.00040	0.0001	**70**	**130**	
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	--	--	--	0.00250	0.00040	0.00009	**70**	**130**	
Total PFOS and PFOA	--	--	0.07	--	--	--	--	--	--	--

Notes:

[a] Refer to **Worksheet #11** for a discussion of PALs by matrix. RSLs for PFOS and PFOA were derived using USEPA's RSL calculator on July 10, 2018 and the RSL for PFBS is from the EPA RSL Table; all based on a target risk of 10-6 and target HQ of 1.

[b] Project quantitation limit (PQL) goals are equal to half of the minimum applicable screening level.

[c] Analytes detected below the LOQ must be 50-150% of the true value rather than 70-130% of the true value.

[d] RPDs for LFMS/LFMSD must be <30% for samples fortified at or above their native concentration. Greater variability may be observed when LFSMs are fortified at analyte concentrations that are within a factor of 2 of the LOQ. LFSMs fortified at these concentrations must have RPDs that are <50% for samples fortified at or above their native concentration.

Bolded values represent method specified limits, specific to EPA 537.1.

If PFOS and PFOA are both detected, then the sum of the results for that sample will be compared to the USEPA lifetime health advisory of 0.07 µg/L.

CAS = Chemical Abstract Service
DL = detection limit
LFB = Laboratory Fortified Blank
LFSM/ LFSMD = Laboratory Fortified Sample Matrix /Laboratory Fortified Sample Matrix Duplicate
MS = matrix spike
MSD = matrix spike duplicate
LCL = lower confidence limit
LCS = laboratory control sample
LOD = limit of detection
PQL = project quantitation limit
UCL = upper confidence limit

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

Matrix: Groundwater
Analytical Group: PFAS
All units are µg/L (unless otherwise specified)

Analyte	CAS #	PALs[a]						PQL Goal[b]	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD(%)		
		Tapwater RSL, HQ = 1.0	USEPA Lifetime Health Advisory	Surface Water ESVs	Willow Grove Surface Water ESVs (Aquatic Invertebrates)	Willow Grove Surface Water ESVs (Birds)	Willow Grove Surface Water ESVs (Mammals)		LOQ	LOD	DL	LCL	UCL	RPD
PFOS	1763-23-1	0.401	0.07	5.1[c]	5.1	0.047	0.0026	0.0013	0.005	0.0005	0.00019	**40**	**144**	**30**
PFOA	335-67-1	0.401	0.07	2,900[c]	2,900	--	--	0.035	0.005	0.0005	0.00018	**49**	**141**	
PFBS	375-73-5	400	--	24,000[c]	--	--	--	200	0.005	0.0005	0.00013	**56**	**134**	
NEtFOSAA	2991-50-6	--	--	--	--	--	--	--	0.005	0.001	0.00049	**51**	**131**	
NMeFOSAA	2355-31-9	--	--	--	--	--	--	--	0.005	0.0025	0.00056	**50**	**146**	
PFDA	335-76-2	--	--	--	--	--	--	--	0.005	0.0005	0.00016	**59**	**135**	
PFDoA	307-55-1	--	--	--	--	--	--	--	0.005	0.0005	0.00018	**75**	**131**	
PFHpA	375-85-9	--	--	--	--	--	--	--	0.005	0.0005	0.00016	**48**	**136**	
PFHxS	355-46-4	--	--	--	--	--	--	--	0.005	0.0005	0.00011	**52**	**128**	
PFHxA	307-24-4	--	--	--	--	--	--	--	0.005	0.0005	0.00019	**51**	**137**	
PFNA	375-95-1	--	--	--	--	--	--	--	0.005	0.001	0.00026	**58**	**122**	
PFTA	376-06-7	--	--	--	--	--	--	--	0.005	0.001	0.00025	**42**	**158**	
PFTrDA	72629-94-8	--	--	--	--	--	--	--	0.005	0.0005	0.00015	**42**	**148**	
PFUnA	2058-94-8	--	--	--	--	--	--	--	0.005	0.001	0.00029	**64**	**134**	
ADONA	919005-14-4	--	--	--	--	--	--	--	0.005	0.0004	0.00018	**70**	**130**	
9Cl-PF3ONS	756426-58-1	--	--	--	--	--	--	--	0.005	0.0004	0.0001	**70**	**130**	
11Cl-PF3OUdS	763051-92-9	--	--	--	--	--	--	--	0.005	0.0004	0.00018	**70**	**130**	
HFPO-DA	13252-13-6	--	--	--	--	--	--	--	0.005	0.0004	0.0002	**70**	**130**	
Total PFOS and PFAS	--	--	0.07	--	--	--	--	--	--	--	--	--	--	--

Notes:

[a] Refer to **Worksheet #11** for a discussion of PALs by matrix. RSLs for PFOS and PFOA were derived using USEPA's RSL calculator on July 10, 2018 and the RSL for PFBS is from the EPA RSL Table. ESVs used at the Warminster and Willow Grove site are included in conjunction with other literature-based values to ensure adequate analytical sensitivity. The most current ESVs will be used for data evaluation. No formal ESVs have been issued by USEPA for PFAS

[b] PQL goals are equal to half of the minimum applicable screening level.

[c] Giesy J.P., J.E. Naile, J.S. Khim, P.D. Jones, and J.L. Newsted. 2010. Aquatic toxicology of perfluorinated chemicals. *Reviews of Environmental Contamination and Toxicology*. 202:1–52.

Bolded values represent in-house limits.

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

Matrix: Surface Water
Analytical Group: PFAS
All units are µg/L (unless otherwise specified)

Analyte	**CAS #**	**PALs[a]**					**PQL Goal[b]**	**Laboratory Limits**			**LCS and MS/MSD Recovery Limits and RPD(%)**		
		RSLs Tap X 10 for SW HQ=1.0	**Surface Water ESVs**	**Willow Grove Surface Water ESVs (Aquatic Invertebrates)**	**Willow Grove Surface Water ESVs (Birds)**	**Willow Grove Surface Water ESVs (Mammals)**		**LOQ**	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
PFOS	1763-23-1	4.01	5.1[c]	5.1	0.047	0.0026	0.0013	0.005	0.0005	0.00019	**40**	**144**	**30**
PFOA	335-67-1	4.01	2,900[c]	2,900	--	--	2.005	0.005	0.0005	0.00018	**49**	**141**	
PFBS	375-73-5	4,000	24,000[c]	--	--	--	2000	0.005	0.0005	0.00013	**56**	**134**	
NEtFOSAA	2991-50-6	--	--	--	--	--	--	0.005	0.001	0.00049	**51**	**131**	
NMeFOSAA	2355-31-9	--	--	--	--	--	--	0.005	0.0025	0.00056	**50**	**146**	
PFDA	335-76-2	--	--	--	--	--	--	0.005	0.0005	0.00016	**59**	**135**	
PFDoA	307-55-1	--	--	--	--	--	--	0.005	0.0005	0.00018	**75**	**131**	
PFHpA	375-85-9	--	--	--	--	--	--	0.005	0.0005	0.00016	**48**	**136**	
PFHxS	355-46-4	--	--	--	--	--	--	0.005	0.0005	0.00011	**52**	**128**	
PFHxA	307-24-4	--	--	--	--	--	--	0.005	0.0005	0.00019	**51**	**137**	
PFNA	375-95-1	--	--	--	--	--	--	0.005	0.001	0.00026	**58**	**122**	
PFTA	376-06-7	--	--	--	--	--	--	0.005	0.001	0.00025	**42**	**158**	
PFTrDA	72629-94-8	--	--	--	--	--	--	0.005	0.0005	0.00015	**42**	**148**	
PFUnA	2058-94-8	--	--	--	--	--	--	0.005	0.001	0.00029	**64**	**134**	
ADONA	919005-14-4	--	--	--	--	--	--	0.005	0.0004	0.00018	**70**	**130**	
9Cl-PF3ONS	756426-58-1	--	--	--	--	--	--	0.005	0.0004	0.0001	**70**	**130**	
11Cl-PF3OUdS	763051-92-9	--	--	--	--	--	--	0.005	0.0004	0.00018	**70**	**130**	
HFPO-DA	13252-13-6	--	--	--	--	--	--	0.005	0.0004	0.0002	**70**	**130**	

Notes:

[a] Refer to **Worksheet #11** for a discussion of PALs by matrix. RSLs for PFOS and PFOA were derived using USEPA's RSL calculator on July 10, 2018 and the RSL for PFBS is from the EPA RSL Table. ESVs used at the Warminster and Willow Grove site are included in conjunction with other literature-based values to ensure adequate analytical sensitivity. The most current ESVs will be used for data evaluation. No formal ESVs have been issued by USEPA for PFAS

[b] PQL goals are equal to half of the minimum applicable screening level.

[c] Giesy J.P., J.E. Naile, J.S. Khim, P.D. Jones, and J.L. Newsted. 2010. Aquatic toxicology of perfluorinated chemicals. *Reviews of Environmental Contamination and Toxicology*. 202:1–52.

Bolded values represent in-house limits.

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

Matrix: Soil
Analytical Group: PFAS
All units are microgram per kilogram (µg/kg) (unless otherwise specified)

Analyte	**CAS #**	**PALs[a]**					**PQL Goal[b]**	**Laboratory Limits**			**LCS and MS/MSD Recovery Limits and RPD(%)**		
		RSLs Residential Soil HQ=1.0	**Soil ESVs (Plant)**	**Soil ESVs (Invertebrate)**	**Warminster and Willow Grove Soil ESVs (Terrestrial Plant)**	**Warminster and Willow Grove Soil ESVs (Invertebrate)**		**LOQ**	**LOD**	**DL**	**LCL**	**UCL**	**RPD**
PFOS	1763-23-1	1,260	4,600[c]	10,000[d]	39	100	19.5	5	1	0.27	**50**	**130**	**30**
PFOA	335-67-1	1,260	--	16,000[d]	--	160	80	5	1	0.5	**56**	**136**	
PFBS	375-73-5	1,260,000	--	--	--	--	630000	5	1	0.36	**57**	**145**	
NEtFOSAA	2991-50-6	--	--	--	--	--	--	5	2	0.57	**54**	**124**	
NMeFOSAA	2355-31-9	--	--	--	--	--	--	5	2.5	1.12	**52**	**146**	
PFDA	335-76-2	--	--	--	--	--	--	5	1	0.27	**55**	**141**	
PFDoA	307-55-1	--	--	--	--	--	--	5	0.5	0.24	**62**	**134**	
PFHpA	375-85-9	--	--	--	--	--	--	5	1	0.44	**60**	**128**	
PFHxS	355-46-4	--	--	--	--	--	--	5	0.5	0.22	**52**	**132**	
PFHxA	307-24-4	--	--	--	--	--	--	5	1	0.33	**45**	**135**	
PFNA	375-95-1	--	--	--	--	--	--	5	1	0.43	**54**	**130**	
PFTA	376-06-7	--	--	--	--	--	--	5	2	0.63	**34**	**162**	
PFTrDA	72629-94-8	--	--	--	--	--	--	5	1	0.28	**51**	**127**	
PFUnA	2058-94-8	--	--	--	--	--	--	5	1	0.41	**57**	**137**	
ADONA	919005-14-4	--	--	--	--	--	--	5	1	0.32	**70**	**130**	
9Cl-PF3ONS	756426-58-1	--	--	--	--	--	--	5	1	0.45	**70**	**130**	
11Cl-PF3OUdS	763051-92-9	--	--	--	--	--	--	5	1	0.4	**70**	**130**	
HFPO-DA	13252-13-6	--	--	--	--	--	--	5	2	0.57	**70**	**130**	

Notes:

[a] Refer to **Worksheet #11** for a discussion of PALs by matrix. RSLs for PFOS and PFOA were derived using USEPA's RSL calculator on July 10, 2018 and the RSL for PFBS is from the EPA RSL Table. ESVs used at the Warminster and Willow Grove site are included in conjunction with other literature-based values to ensure adequate analytical sensitivity. The most current ESVs will be used for data evaluation. No formal ESVs have been issued by the USEPA for PFAS

[b] PQL goals are equal to half of the minimum applicable screening level.

[c] Beach, S.A., J.L. Newsted, K. Coady, and J.P. Giesy. 2006. Ecotoxicological Evaluation of Perfluorooctanesulfonate (PFOS). *Reviews of Environmental Contamination and Toxicology*. 186:133-174.

[d] Norwegian Pollution Control Authority (NPCA). 2008. *Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway*. TA-2444/2008. December.

Bolded values represent in-house limits.

SAP Worksheet #15-5—Reference Limits and Evaluation Table for Solid Media

Matrix: Sediment
Analytical Group: PFAS
All units are µg/kg (unless otherwise specified)

Analyte	CAS #	PALs[a]			PQL Goal[b]	Laboratory Limits			LCS and MS/MSD Recovery Limits and RPD(%)		
		RSLs Res Soil X 10 for SD HQ=1.0	Fresh Sediment ESVs	Willow Grove Sediment ESVs		LOQ	LOD	DL	LCL	UCL	RPD
PFOS	1763-23-1	12,600	220	84	42	5	1	0.27	**50**	**130**	**30**
PFOA	335-67-1	12,600	--	--	6300	5	1	0.5	**56**	**136**	
PFBS	375-73-5	12,600,000	--	--	6300000	5	1	0.36	**57**	**145**	
NEtFOSAA	2991-50-6	--	--	--	--	5	2	0.57	**54**	**124**	
NMeFOSAA	2355-31-9	--	--	--	--	5	2.5	1.12	**52**	**146**	
PFDA	335-76-2	--	--	--	--	5	1	0.27	**55**	**141**	
PFDoA	307-55-1	--	--	--	--	5	0.5	0.24	**62**	**134**	
PFHpA	375-85-9	--	--	--	--	5	1	0.44	**60**	**128**	
PFHxS	355-46-4	--	--	--	--	5	0.5	0.22	**52**	**132**	
PFHxA	307-24-4	--	--	--	--	5	1	0.33	**45**	**135**	
PFNA	375-95-1	--	--	--	--	5	1	0.43	**54**	**130**	
PFTA	376-06-7	--	--	--	--	5	2	0.63	**34**	**162**	
PFTrDA	72629-94-8	--	--	--	--	5	1	0.28	**51**	**127**	
PFUnA	2058-94-8	--	--	--	--	5	1	0.41	**57**	**137**	
ADONA	919005-14-4	--	--	--	--	5	1	0.32	**70**	**130**	
9Cl-PF3ONS	756426-58-1	--	--	--	--	5	1	0.45	**70**	**130**	
11Cl-PF3OUdS	763051-92-9	--	--	--	--	5	1	0.4	**70**	**130**	
HFPO-DA	13252-13-6	--	--	--	--	5	2	0.57	**70**	**130**	

Notes:

[a] Refer to **Worksheet #11** for a discussion of PALs by matrix. RSLs for PFOS and PFOA were derived using USEPA's RSL calculator on July 10, 2018 and the RSL for PFBS is from the EPA RSL Table. ESVs used at the Warminster and Willow Grove site are included in conjunction with other literature-based values to ensure adequate analytical sensitivity. The most current ESVs will be used for data evaluation. No ESVs have been issued by the USEPA for PFAS.

[b] PQL goals are equal to half of the minimum applicable screening level.

[c] Norwegian Pollution Control Authority (NPCA). 2008. *Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway*. TA-2444/2008. December.

Bolded values represent in-house limits.

SAP Worksheet #15-6—Reference Limits and Evaluation Table

Matrix: Sediment
Analytical Group: WCHEM

Analyte	CAS[1]	Project Indicator Limit	Laboratory Limits (milligrams per kilogram)			LCS and MS/MSD Recovery Limits and RPD(%)		
			LOQ	LOD	DL	Accuracy Control Limit		RPD
Total Organic Carbon	TOC	--	**250**	**200**	**153**	**90**	**110**	**20**

Notes:

[1] Some CAS numbers are contractor-specific.

Bolded values represent in-house limits

TOC is being performed to determine if sediment ESVs for PFAS can be TOC normalized.

SAP Worksheet #16—Project Schedule/Timeline Table

Activities	**Dates**	
	Anticipated Date(s) of Initiation	**Anticipated Date of Completion**
Submit Pre-Draft SAP		January 2019
Base and Navy Review of SAP	January 2019	February 2019
Prepare and submit Draft SAP	February 2019	March 2019
USEPA and VDEQ Review of SAP	March 2019	May 2019
Prepare and submit Final SAP	May 2019	May 2019
Anticipated Fieldwork	May 2019	June 2019

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SAP Worksheet #17—Sampling Design and Rationale

Matrix	Depth of Samples	Analyses	Method	Approximate Number of Samples	Strategy and Rationale
Groundwater	Middle of screen (**Worksheet #18**)	PFAS (**Worksheet #15**)	**LCMSMS Compliant with Quality Systems Manual (QSM) 5.1 Table B-15**	38	Groundwater samples will be collected from shallow and deep monitoring wells to evaluate and monitor concentrations of PFAS and further delineate the extent of PFAS contamination from potential and known source areas. Samples will be collected from existing and newly installed monitoring wells as presented on **Figures 8** and **9** and as follows: • Site 11 – 7 existing shallow monitoring wells: OW11-MW1, OW11-MW4, OW11-MW5, OW11-MW6, OW11-MW7, OW11-MW8, and OW11-MW9 – 1 existing deep monitoring well: OW11-MW10D – 1 new deep monitoring well: OW11-MW11D • Fuel Farm, F8/F9 – 2 existing shallow monitoring wells: OC-F8F9-MW-F4 and 203-MW19, – 1 new shallow monitoring well: OCPOL-MW31 – 1 new deep monitoring well: OCPOL-MW31D • Aircraft Hangers and Maintenance Buildings – 14 existing shallow monitoring wells: OW2C-MW19, OW2C-MW24, OW2C-MW25, OW2C-MW05, FTWG-MW-02, OW2E-MW19, OW2E-MW09R, OW26-MW1, OW2B-MW41, MW49, MW50, MW51, MW52, and MW53 – 1 existing deep monitoring well: OW26-MW1D • 1996 Crash Site – 1 new shallow monitoring well: OC-MW16 • 1986 Crash Site (Revised Location) – 1 new shallow monitoring wells: OC-MW09 – 1 new deep well: OC-MW09D • Jet Test Cell – 1 existing shallow monitoring well: JTC-MW-B • Fifth Green Landfill – 2 existing shallow monitoring wells: OW07-MW04 and OW07-MW02 – 2 existing deep monitoring wells: OW07-MW04D and OW07-MW03D • NEX Gas Station, Auto Hobby Shop, and Car Wash – 2 existing shallow monitoring wells: NEX-MW-C and NEX-MW13 Additional groundwater samples may be collected if warranted to achieve the objectives of this SI Addendum.
	Middle of screen (**Worksheet #18**)	PFAS (**Worksheet #15**)	**LCMSMS Compliant with QSM 5.1 Table B-15**	17	Groundwater samples will be collected from shallow and deep monitoring wells to evaluate concentrations of PFAS downgradient from potential and known source areas. Samples will be collected from existing and newly installed monitoring wells as presented on **Figure 8** and as follows: • 6 existing shallow monitoring wells: OC-MW03, OC-MW04, MW-BG06, MW-BG07, MW-BG11, MW-BG12 • 6 new shallow monitoring well: OC-MW08, OC-MW11, OC-MW12, OC-MW13, OC-MW15, and OC-MW17 • 5 new deep monitoring well: OC-MW08D, OC-MW11D, OC-MW12D, OC-MW13D, and OC-MW15D
	Middle of screen **(Worksheet #18)**	PFAS (**Worksheet #15**)	**LCMSMS Compliant with QSM 5.1 Table B-15**	21	Groundwater samples will be collected from 17 shallow monitoring wells and 6 deep monitoring wells to evaluate and monitor concentrations of PFAS at the perimeter of the Base to determine areas with the potential for offsite migration and background concentrations where sampling locations are upgradient from expected source areas. Samples will be collected from existing and newly installed monitoring wells as presented on **Figures 8** and **9** and as follows: • 14 existing shallow monitoring wells: MW-BG04R, MW-BG05, MW-BG09, MW-BG10, OW08-MW01, OC-MW02, OC-MW01, MW-BG01, MW-BG13, OCPOL-MW29, OCPOL-MW27, OCPOL-MW25, OCPOL-MW23, and OC-MW07. • 2 new shallow monitoring wells: OC-MW10 and OC-MW14. • 3 existing deep monitoring wells: OC-MW02D, OC-MW05D, and OC-MW07D • 2 new deep monitoring wells: OC-MW10D and OC-MW14D

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

Matrix	Depth of Samples	Analyses	Method	Approximate Number of Samples	Strategy and Rationale
Surface Soil	0 to 6 inches bgs	PFAS (**Worksheet #15**)	LCMSMS Compliant with QSM 5.1 Table B-15	8	Eight surface soil samples will be collected from source areas with the highest detections of PFOS/PFOA during the SI to evaluate and determine the potential impact of PFAS in surface soil. One sample will be collected from SWMU 26, five samples will be collected from Site 11, one sample will be collected from the POL Fuel Tank area, and one sample will be collected from the Jet Test Cell. Proposed sample locations are presented on **Figure 8**. Additional contingency soil samples will be collected if warranted to achieve the objectives of this SI Addendum.
Subsurface Soil	6 to 24 inches bgs	PFAS (**Worksheet #15**)	LCMSMS Compliant with QSM 5.1 Table B-15	8	Eight subsurface soil samples (co-located with surface soil samples) will be collected from potential source areas to evaluate and determine the potential impact of PFAS contamination in subsurface soil. Proposed sample locations are presented on **Figure 8**. Additional contingency soil samples will be collected if warranted to achieve the objectives of this SI Addendum.
Surface Water	First encountered surface water	PFAS (**Worksheet #15**)	LCMSMS Compliant with QSM) 5.1 Table B-15	28	Twenty-eight surface water samples (co-located with sediment samples) will be collected from within drainage ditches and depositional areas downgradient of potential source areas and in the vicinity of stormwater outfalls for the Base, to evaluate the potential impact of PFAS to surface water. Proposed sample locations are presented in **Figure 10.**
Sediment	0 to 6 inches bgs	PFAS (**Worksheet #15**) TOC	USEPA 9060A, SM 5310 B-2011/WL-057	28	Twenty-eight sediment samples (co-located with surface water samples) will be collected from within drainage ditches and depositional areas downgradient of potential source areas and in the vicinity of stormwater outfalls for the Base, to evaluate the potential impact of PFAS to sediment. Proposed sample locations are presented in **Figure 10.**
Drinking Water	not applicable	PFAS (**Worksheet #15**)	USEPA Method 537	TBD	Drinking water samples will be collected semiannually (or at a frequency agreed to by the Partnering Team) from private off-Base drinking water wells within 1 mile downgradient of the known PFOS and/or PFOA exceedances of the lifetime health advisory in groundwater at Oceana, to provide additional data for temporal comparisons and evaluate spatial variability. Proposed locations are shown on **Figure 11**. The duration of the monitoring period will be conducted for at least 3 years but may be conducted longer.

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

Sampling Station	Sample ID[a]	Matrix	Depth of Screened Interval (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
Existing Monitoring Wells						
OW11-MW1	OW11-GW1-MMYY	GW	8-18	PFAS	2 (FD)	**Worksheet #21**
	OW11-GW1P-MMYY					
OW11-MW4	OW11-GW4-MMYY		10-20		3 (MS/MSD)	
	OW11-GW4-MMYY-MS					
	OW11-GW4-MMYY-MSD					
OW11-MW5	OW11-GW5-MMYY		10-21		1	
OW11-MW6	OW11-GW6-MMYY		10-22		1	
OW11-MW7	OW11-GW7-MMYY		10-23		1	
OW11-MW8	OW11-GW8-MMYY		10-24		1	
OW11-MW9	OW11-GW9-MMYY		10-25		1	
OW11-MW10D	OW11-GW10D-MMYY		50-60		1	
OC-F8F9-MW-F4	OC-F8F9-MW-F4-MMYY		Unknown[b]		1	
203-MW19	203-MW19-MMYY		10-20		1	
OW2C-MW19	OW2C-MW19-MMYY		10-20		2 (FD)	
	OW2C-MW19P-MMYY					
OW2C-MW24	OW2C-MW24-MMYY		13-23		1	
OW2C-MW25	OW2C-MW25-MMYY		3-18		1	
OW2C-MW05	OW2C-MW05-MMYY		6-16		1	
FTWG-MW-02	FTWG-MW-02-MMYY		3-13		1	
OW2E-MW19	OW2E-MW19-MMYY		9-19		1	
OW2E-MW09R	OW2E-MW09R-MMYY		4-19		1	
OW26-MW1	OW26-MW1-MMYY		10-20		1	

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

Sampling Station	Sample ID[a]	Matrix	Depth of Screened Interval (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
OW26-MW1D	OW26-MW1D-MMYY	GW	50-60	PFAS	1	
OW2B-MW41	OW2B-MW41-MMYY		10-20		1	
OW2B-MW49	OW2B-MW49-MMYY		10-20		2 (FD)	
	OW2B-MW49P-MMYY					
OW2B-MW50	OW2B-MW50-MMYY		10-20		3 (MS/MSD)	
	OW2B-MW50-MMYY-MS					
	OW2B-MW50-MMYY-MSD					
OW2B-MW51	OW2B-MW51-MMYY		10-20		1	
OW2B-MW52	OW2B-MW52-MMYY		10-20		1	
OW2B-MW53	OW2B-MW53-MMYY		10-20		1	
JTC-MW-B	JTC-MW-B-MMYY		3-13		1	
OW07-MW02	OW07-MW02-MMYY		8-18		1	
OW07-MW03D	OW07-MW03D-MMYY		38-48		1	
OW07-MW04	OW07-MW04-MMYY		8-18		1	
OW07-MW04D	OW07-MW04D-MMYY		45-55		1	
NEX-MW-C	NEX-MW-C-MMYY		4-14		2 (FD)	
	NEX-MW-CP-MMYY					
NEX-MW13	NEX-MW13-MMYY		5-15		1	
OC-MW03	OC-MW03-MMYY		10-20		1	
OC-MW04	OC-MW04-MMYY		13-23		1	
MW-BG06	MW-BG06-MMYY		10-20		1	
MW-BG07	MW-BG07-MMYY		10-20		1	
MW-BG11	MW-BG11-MMYY		10-20		1	

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

Sampling Station	Sample ID[a]	Matrix	Depth of Screened Interval (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
MW-BG12	MW-BG12-MMYY		10-20		1	
MW-BG04R	MW-BG04R-MMYY		10-20		1	
MW-BG05	MW-BG05-MMYY		10-20		1	
MW-BG09	MW-BG09-MMYY		10-20		2 (FD)	
	MW-BG09P-MMYY					
MW-BG10	MW-BG10-MMYY		10-20		3 (MS/MSD)	
	MW-BG10-MMYY-MS					
	MW-BG10-MMYY-MSD					
OW08-MW1	OW08-GW01-MMYY		10-20		1	
OC-MW02	OC-MW02-MMYY		10-20		1	
OC-MW02D	OC-MW02D-MMYY		50-60		1	
OC-MW01	OC-MW01-MMYY		10-20		1	
MW-BG01	MW-BG01-MMYY		10-20		1	
MW-BG13	MW-BG13-MMYY		10-20		1	
OCPOL-MW23	OCPOL-MW23-MMYY		4-14		1	
OCPOL-MW25	OCPOL-MW25-MMYY		4-14		1	
OCPOL-MW27	OCPOL-MW27-MMYY		3.5-13.5		2 (FD)	
	OCPOL-MW27P-MMYY					
OCPOL-MW29	OCPOL-MW29-MMYY		2.5-12.5		1	
OC-MW07	OC-MW07-MMYY		10-20		1	
OC-MW07D	OC-MW07D-MMYY		50-60		1	
OC-MW05D	OC-MW05D-MMYY		50-60		1	

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

Sampling Station	Sample ID[a]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
Proposed Monitoring Wells						
OW11-MW11D	OW-MW11D-MMYY	Groundwater	TBD	PFAS	1	**Worksheet #21**
OCPOL-MW31	OCPOL-MW31-MMYY				1	
OCPOL-MW31D	OCPOL-MW31D-MMYY				1	
OC-MW08	OC-MW08-MMYY				3 (MS/MSD)	
	OC-MW08-MMYY-MS					
	OC-MW08-MMYY-MSD					
OC-MW08D	OC-MW08D-MMYY				1	
OC-MW09	OC-MW09-MMYY				1	
OC-MW09D	OC-MW09D-MMYY				2 (FD)	
	OC-MW09DP-MMYY					
OC-MW10	OC-MW10-MMYY				1	
OC-MW10D	OC-MW10D-MMYY				1	
OC-MW11	OC-MW11-MMYY				1	
OC-MW11D	OC-MW11D-MMYY				1	
OC-MW12	OC-MW12-MMYY				1	
OC-MW12D	OC-MW12D-MMYY				1	
OC-MW13	OC-MW31-MMYY				1	
OC-MW13D	OC-MW13D-MMYY				1	
OC-MW14	OC-MW14-MMYY				1	
OC-MW14D	OC-MW14D-MMYY				2 (FD)	
	OC-MW14DP-MMYY					
OC-MW15	OC-MW15-MMYY				1	
OC-MW15D	OC-MW15D-MMYY				1	

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

Sampling Station	Sample ID[a]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
OC-MW16	OC-MW16-MMYY	Groundwater	TBD	PFAS	1	
OC-MW17	OC-MW17-MMYY				1	**Worksheet #21**
Surface and Subsurface Soil Sampling						
OW11-SO15	OW11-SS15-000H-MMYY	Surface Soil	0 – 0.5	PFAS	2 (FD)	**Worksheet #21**
	OW11-SS15P-000H-MMYY					
	OW11-SB15-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
OW11-SO16	OW11-SS16-000H-MMYY	Surface Soil	0 – 0.5		1	
	OW11-SB16-0H02-MMYY	Subsurface Soil	0.5 – 2		2 (FD)	
	OW11-SB16P-0H02-MMYY					
OW11-SO17	OW11-SS17-000H-MMYY	Surface Soil	0 – 0.5		1	
	OW11-SB17-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
OW11-SO18	OW11-SS18-000H-MMYY	Surface Soil	0 – 0.5		1	
	OW11-SB18-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
OW11-SO19	OW11-SS19-000H-MMYY	Surface Soil	0 – 0.5		3 (MS/MSD)	
	OW11-SS19-000H-MMYY-MS					
	OW11-SS19-000H-MMYY-MSD					
	OW11-SB19-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
OW26-SO04	OW26-SS04-000H-MMYY	Surface Soil	0 – 0.5		1	
	OW26-SB04-0H02-MMYY	Subsurface Soil	0.5 – 2		3 (MS/MSD)	
	OW26-SB04-0H02-MMYY-MS					
	OW26-SB04-0H02-MMYY-MSD					
203SO-01	203SS-01-000H-MMYY	Surface Soil	0 – 0.5		1	
	203SB-01-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
JTC-SO01	JTC-SS01-000H-MMYY	Surface Soil	0 – 0.5		1	

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

Sampling Station	Sample ID[a]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
	JTC-SB01-0H02-MMYY	Subsurface Soil	0.5 – 2		1	
Sediment Sampling						
OC-SWSD01	OC-SD01-MMYY	Sediment	0 – 0.5	PFAS, TOC (note that field QC is not required for TOC)	2 (FD)	**Worksheet #21**
	OC-SD01P-MMYY					
OC-SWSD02	OC-SD02-MMYY				3 (MS/MSD)	
	OC-SD02-MMYY-MS					
	OC-SD02-MMYY-MSD					
OC-SWSD03	OC-SD03-MMYY				1	
OC-SWSD04	OC-SD04-MMYY				1	
OC-SWSD05	OC-SD05-MMYY				1	
OC-SWSD06	OC-SD06-MMYY				1	
OC-SWSD07	OC-SD07-MMYY				1	
OC-SWSD08	OC-SD08-MMYY				1	
OC-SWSD09	OC-SD09-MMYY				1	
OC-SWSD10	OC-SD10-MMYY				1	
OC-SWSD11	OC-SD11-MMYY				2 (FD)	
	OC-SD11P-MMYY					
OW07-SWSD16	OW07-SD16-MMYY				1	
OW03-SWSD14	OW03-SD14-MMYY				1	
OW03-SWSD15	OW03-SD15-MMYY				1	
OW03-SWSD16	OW03-SD16-MMYY				1	
OW11-SWSD04	OW11-SD04-MMYY				1	
OW2E-SWSD01	OW2E-SD01-MMYY				1	
OW2E-SWSD02	OW2E-SD02-MMYY				1	

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

Sampling Station	Sample ID[a]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
OW2E-SWSD03	OW2E-SD03-MMYY				1	
OW2E-SWSD04	OW2E-SD04-MMYY				1	
OW2E-SWSD05	OW2E-SD05-MMYY				2 (FD)	
	OW2E-SD05P-MMYY					
OW2C-SWSD01	OW2C-SD01-MMYY				3 (MS/MSD)	
	OW2C-SD01-MMYY-MS					
	OW2C-SD01-MMYY-MSD					
OW2C-SWSD02	OW2C-SD02-MMYY				1	
OW2C-SWSD03	OW2C-SD03-MMYY				1	
OW2B-SWSD31	OW2B-SD31-MMYY				1	
OW2B-SWSD32	OW2B-SD32-MMYY				1	
OW2B-SWSD33	OW2B-SD33-MMYY				1	
OW2B-SWSD34	OW2B-SD34-MMYY				1	
Surface Water Sampling						
OC-SWSD01	OC-SW01-MMYY	Surface Water	First encountered surface water	PFAS	2 (FD)	**Worksheet #21**
	OC-SW01P-MMYY					
OC-SWSD02	OC-SW02-MMYY				3 (MS/MSD)	
	OC-SW02-MMYY-MS					
	OC-SW02-MMYY-MSD					
OC-SWSD03	OC-SW03-MMYY				1	
OC-SWSD04	OC-SW04-MMYY				1	
OC-SWSD05	OC-SW05-MMYY				1	
OC-SWSD06	OC-SW06-MMYY				1	
OC-SWSD07	OC-SW07-MMYY				1	

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

Sampling Station	Sample ID[a]	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples	Sampling SOP Reference
OC-SWSD08	OC-SW08-MMYY				1	
OC-SWSD09	OC-SW09-MMYY				1	
OC-SWSD10	OC-SW10-MMYY				1	
OC-SWSD11	OC-SW11-MMYY				2 (FD)	
	OC-SW11P-MMYY					
OW07-SWSD16	OW07-SW16-MMYY				1	
OW03-SWSD14	OW03-SW14-MMYY				1	
OW03-SWSD15	OW03-SW15-MMYY				1	
OW03-SWSD16	OW03-SW16-MMYY				1	
OW11-SWSD04	OW11-SW04-MMYY				1	
OW2E-SWSD01	OW2E-SW01-MMYY				1	
OW2E-SWSD02	OW2E-SW02-MMYY				1	
OW2E-SWSD03	OW2E-SW03-MMYY				1	
OW2E-SWSD04	OW2E-SW04-MMYY				1	
OW2E-SWSD05	OW2E-SW05-MMYY				2 (FD)	
	OW2E-SW05P-MMYY					
OW2C-SWSD01	OW2C-SW01-MMYY				3 (MS/MSD)	
	OW2C-SW01-MMYY-MS					
	OW2C-SW01-MMYY-MSD					
OW2C-SWSD02	OW2C-SW02-MMYY				1	
OW2C-SWSD03	OW2C-SW03-MMYY				1	
OW2B-SWSD31	OW2B-SW31-MMYY				1	
OW2B-SWSD32	OW2B-SW32-MMYY				1	
OW2B-SWSD33	OW2B-SW33-MMYY				1	

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

Sampling Station	**Sample ID[a]**	**Matrix**	**Depth (feet bgs)**	**Analytical Group**	**Number of Samples**	**Sampling SOP Reference**
OW2B-SWSD34	OW2B-SW34-MMYY				1	
Drinking Water Sampling						
OC-RWXX	OC-RWXX-MMYY	DW	N/A	PFAS	TBD	**Worksheet #21**
OC-RWXX	OC-RWXXPP-MMYY	Duplicate	N/A	PFAS	1	**Worksheet #21**
Drinking Water QC Samples						
OC-QC	OC-FBXX-MMYY	QC	N/A	PFAS	1 per normal drinking water sample	**Worksheet #21**
QC Samples						
OC-QC	OC-EB-MMDDYY	QC	N/A	PFAS	**Worksheet #12**	**Refer to Worksheet #21**
	OC-FB-MMDDYY		N/A		**Worksheet #12**	

Notes:

[a] Additional sample identification (ID) instructions are as follows:
- Field duplicates will have "P" added after the sample number, for example: OC-SW21P-MMYY
- For all sample IDs, "MMYY" will be replaced with the two-digit month and year in which the sample was collected.
- Equipment blanks and field reagent blanks will be identified with the two-digit month, day, and year, for example: OC-EB-MMDDYY.

[b] Total well depth identified as 30 feet bgs; screened interval is unknown.

Please note that additional samples may be added pending analytical results

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Preparation and Analytical Method / SOP Reference	Containers	Minimum Sample Amount Required for Analysis	Preservation Requirements	Maximum Holding Time
Drinking Water	PFAS	USEPA Method 537.1/5-371-04	Two X 250-milliliter Polypropylene bottle with polypropylene screw cap	250 milliliters	Samples are stored at or below 10°C until extraction; 5 grams per liter of Trizma	14 days to extraction; 28 days after extraction to analysis
Groundwater, Surface Water	PFAS	LCMSMS Compliant with Quality Systems Manual (QSM) 5.1 Table B-15/Extraction SOP 5-370-07, Analysis SOP 5-369-06	Two X 250-milliliter High-Density Polyethylene bottle	250 milliliters	Samples are stored at or below 10°C until extraction	14 days to extraction; 28 days after extraction to analysis
Soil, Sediment	PFAS	LCMSMS Compliant with QSM 5.1 Table B-15/Extraction SOP 5-370-07, Analysis SOP 5-369-06	One 8-ounce High-Density Polyethylene jar	30 grams	Samples are stored at or below 10°C until extraction or frozen	14 days to extraction (1 year if frozen); 28 days after extraction to analysis
Sediment	TOC	USEPA 9060A, SM 5310 B-2011/WL-057	One 4-ounce Polyethylene or Amber Glass Jar	0.1 gram	Cool, 0-6°C	28 days

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of FDs[a]	No. of MS/MSD Pairs[a]	No. of Equipment Blanks[a]	Number of Field Reagent Blanks[a]	Total No. of Samples to Lab[a]
Drinking Water	PFAS	TBD	TBD	TBD	TBD	TBD	TBD
Groundwater	PFAS	75	8	4	7	2	100
Surface Water	PFAS	28	3	2	3	1	39
Surface Soil	PFAS	8	1	1	1	1	13
Subsurface Soil	PFAS	8	1	1	1	1	13
Sediment	PFAS	28	3	2	3	1	39
	TOC	28	--	--	--	--	28
Groundwater	PFAS	TBD	TBD	TBD	TBD	TBD	TBD
Surface Water	PFAS	TBD	TBD	TBD	TBD	TBD	TBD
Surface Soil	PFAS	TBD	TBD	TBD	TBD	TBD	TBD
Subsurface Soil	PFAS	TBD	TBD	TBD	TBD	TBD	TBD
Sediment	PFAS	TBD	TBD	TBD	TBD	TBD	TBD

Notes:

[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.

- FDs are collected at a frequency of 1 per 10 field samples per matrix. FDs will not be collected for in situ groundwater.
- MS/MSD pairs are collected at a frequency of 1 per 20 samples per matrix sent to the laboratory (including duplicates).
- Equipment Blanks for deconned equipment are collected once per day of sampling, per type of equipment. Equipment Blanks for disposable equipment are collected once per lot.
- Field reagent blanks for non-drinking water samples will be collected one per week and will not contain the preservative Trizma.
- Field reagent blanks for drinking water samples will be collected one per normal sample.

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SAP Worksheet #21—Project Sampling SOP References Table

Title, Revision Date, and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
Drinking Waters Sampling when Analyzing for PFAS, QCed and Reviewed 9/2018	CH2M	Sample bottles, gloves, non-Teflon tubing, sampling equipment and clothing without potential to contain PFAS, as per SOP	No	
Decontamination of Personnel and Equipment, QCed and revised 10/2018	CH2M	Deionized water, distilled water, potable water, 2.5% Liquinox and water solution, methanol, plastic pails, 55-gallon drum for waste, nitrile gloves, decontamination pad, steam cleaner	No	
Disposal of Waste Fluids and Solids, QCed and reviewed 10/2018	CH2M	Fluids-55-gallon drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids-55-gallon drum, tools to secure drum, plastic sheets, labels, marking pen	No	
Decontamination of Drilling Rigs and Equipment, QCed and reviewed 10/2018	CH2M	Steam cleaner, potable water, Liquinox, buckets, brushes, distilled water, methanol, deionized water, aluminum foil	No	
Logging of Soil Borings, QCed and reviewed 10/2018	CH2M	Pens (not Sharpie), tape measure, loose leaf paper, clipboard, spatula, HCl, 10% solution, squirt bottle, rock or soil color chart, grain size chart, hand lens, Unified Soil Classification System index charts and tables	No	
Preparing Field Log Books, QCed and reviewed 10/2018	CH2M	Loose leaf paper and clip board, pen (not Sharpies or other PFAS-containing pens)	No	
Chain-of-Custody. QCed and reviewed 10/2018	CH2M	Chain-of-custody, pen (not Sharpies or other PFAS-containing pens)	No	
Locating and Clearing Underground Utilities, QCed and revised 10/2018	CH2M	Utility location subcontractor to provide all equipment, phone number for Miss Utility	No	
Equipment Blank and Field Blank Preparation, QCed and reviewed 10/2018	CH2M	Plastic sample bottles, nitrile gloves, blank liquid, preservatives	Yes[1]	
Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using A Water Quality Parameter Meter with Flow-through Cell, QCed and reviewed 10/2018	CH2M	Water Quality Parameter Meter such as a Horiba U-22 Water Quality Monitoring System or YSI with flow-through cell, distilled water in squirt bottle, Horiba U-22 Auto-Calibration Standard Solution	No	
Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III, QCed and revised 10/2018	CH2M	Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump, Horiba U-22 or equivalent water quality meter, flow-through cell, generator, water-level indicator, disposable PFAS-free tubing, plastic sheeting, well construction information, calibration container and stopwatch, sample containers, shipping supplies, loose leaf paper and clipboard	No	
Water-Level Measurements, QCed and reviewed 10/2018	CH2M	PFAS-free electronic water-level meter with 100-foot tape, interface probe	No	
General Guidance for Monitoring Well Installation, QCed and reviewed 10/2018	CH2M	Drilling rig, PFAS-free well construction materials, development equipment	No	
Installation of Monitoring Wells by Sonic Drilling, QCed and reviewed 10/2018	CH2M	Sonic Drill Rig, PFAS-free bentonite, cement-bentonite grout, Schedule 40 PVC, factory-slotted well screen, PVC cap, silica sand, well casing (flush-mount or stickup), surge block, pump, 55-gallon drum, Horiba U-22, water level	No	
Soil Sampling for PFAS, QCed and reviewed 11/2018	CH2M	Stainless steel auger and extensions, stainless steel spoon or spatula, pin flags, measuring tape and PFAS free shipping materials	No	
Surface Water Sampling for PFAS, QCed and reviewed 11/2018	CH2M	Gloves, sample containers, meters for DO, pH, etc. and PFAS-free shipping materials	No	
Sediment Sampling for PFAS, QCed and reviewed 11/2018	CH2M	Sample collection device, stainless steel spoon, measuring tape, materials for classifying soils, sample jars, PFAS-free shipping materials	No	
Groundwater Sampling for PFAS, QCed and reviewed 11/2018	CH2M	Flow-through cell, water level indicator, filter (if necessary), adjustable rate, PFAS-free pump, Teflon- and Vitonfree tubing, plastic sheets, well construction info, measuring cup, bucket, PFAS-free sample containers and PFAS-free shipping materials	No	

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

Title, Revision Date, and / or Number	**Originating Organization of Sampling SOP**	**Equipment Type**	**Modified for Project Work? (Yes/No)**	**Comments**
Sampling Contents of Tanks and Drums, QCed and reviewed 10/2018	CH2M	Drum/tank, sampling instrument, gloves, plastic sheets, labels, monitoring instrument	No	
Direct-Push-Groundwater Sample Collection for Per- and Polyfluoroalkyl Substances, QCed and reviewed 11/2018	CH2M	Direct-push technology sampling rods and retractable stainless-steel screen without Teflon, Viton, or other PFAS components, Teflon- and Viton-free tubing, PFAS-free shipping materials, PFAS-free sample containers	No	
Management of Liquid Waste Containing Per- and Polyfluoroalkyl Substances (PFAS), QCed and reviewed 11/2018	CH2M	N/A	No	

Notes:

[1] Field reagent blanks will be collected in place of field blanks. Laboratory-supplied, PFAS-free water will be used in place of ASTM Type II or lab grade water to prepare the PFAS Field Reagent Blank.

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
Horiba U-22 pH probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	pH reads 4.0 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	010_Waterqual HoribaU22	**Worksheet #21** and **Appendix A**
Horiba U-22 Specific conductance probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Conductivity reads 4.49 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	010_Waterqual HoribaU22	**Worksheet #21** and **Appendix A**
Horiba U-22 Turbidity probe	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Turbidity reads 0 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	010_Waterqual HoribaU22	**Worksheet #21** and **Appendix A**
Horiba U-22 DO and Temperature Probes	Calibration and verification of calibration	Calibrate daily, before use and verify as needed	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	010_Waterqual HoribaU22	**Worksheet #21** and **Appendix A**
Horiba U-22	Maintenance – Check mechanical and electronic parts, verify system continuity, check battery, and clean probes Calibration check	Daily before use, at the end of the day, and when unstable readings occur	Stable readings after 3 minutes pH reads 4.0 ± 3% Conductivity reads 4.49 ± 3% Turbidity reads 0 ± 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	FTL	010_Waterqual HoribaU22	**Worksheet #21** and **Appendix A**

Notes:

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

[b] References from **Worksheet #21**.

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Laboratory Performing Analysis	Variance to QSM	Modified for Project Work?
5-371-04	Analysis of Poly and Perfluorlyalkyl Substances in Drinking Water Samples by Liquid Chromatography and Tandem Mass Spectrometry (LC-MS/MS) Following USEPA Method 537.1, January 21, 2019	Definitive	DW/PFAS	LC-MS/MS	Battelle	No	No
5-369-06	PFAS Analytical, 5/11/2018, revision 6	Definitive	GW, SW, SO, SD/PFAS	LC-MS/MS	Battelle	No	No
5-370-07	PFAS sample preparation, 10/16/2018, revision 6	--	GW, SW, SO, SD/PFAS	--	Battelle	No	No
6-010-18	Sample Receipt, Custody, 4/5/2018, and Handling, revision 18	--	--	--	Battelle	No	No
WL-057	SOP for Total Organic Carbon (TOC), 05/09/18, Revision 07.1	Screening	SO, SD / TOC	TOC Analyzer	GCAL	No	No
SAD-001	Sample Receiving and LIMS Log-In, 01/05/2017, Revision 28	--	--	--	GCAL	No	No
SAD-002	Sample Chain of Custody and Sample Integrity, 10/18/2017, Revision 15.1	--	--	--	GCAL	No	No
SD-902	Sample Receipt and Internal Control, 09/17, Revision 12.	--	--	--	GCAL	No	No
SD-903	Sample Disposal, 09/17, Revision 6.	--	--	--	GCAL	No	No

Notes:

DoD Environmental Laboratory Accreditation Program (ELAP) certification is required for analyses that will generate definitive data. Battelle's DoD ELAP certification expires February 28, 2021. GCAL's DoD ELAP current certification expires December 27, 2020. Updated DoD ELAP accreditation letters (or extension letters) will document that certification does not lapse.

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
LC-MS/MS (PFAS)[2]	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 (e.g., AFFF formulations). Inline SPE is acceptable. Samples of known high PFAS concentrations can be prepared by serial dilution instead of SPE, with documented project approval.	--	Analyst and laboratory project manager	5-369
	Soil and Sediment Sample Presentation	Each sample and associated batch QC samples.	Entire sample received by the laboratory must be homogenized prior to subsampling.	--	Analyst and laboratory project manager	5-369
	Sample Cleanup Procedure using ENVI-Carb™ or equivalent	Each sample and associated batch QC samples. Not applicable to AFFF formulation samples.	Removal of interferences from matrix	--	Analyst and laboratory project manager	5-369
	Mass Calibration	Initially prior to use and after performing major maintenance, as required to maintain documented instrument sensitivity and stability performance.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer. Entire range needs to be mass calibrated.	--	Analyst and laboratory project manager	5-369
	Tune Check	When the masses fall outside of the ±0.5 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 tune check repeated.	Analyst and laboratory project manager	5-369
	Mass Spectral Acquisition Rate	Each analyte, extracted internal standard analyte, and injection internal standard analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	--	Analyst and laboratory project manager	5-369
	Calibration, Calibration Verification, and Spiking Standards	All analytes	Standards containing both branched and linear isomers must be used when commercially available. If not available, the total response of the analyte must be integrated (i.e., accounting for peaks that are identified as linear and branched isomers) and quantitated using a calibration curve which includes the linear isomer only for that analyte (e.g., PFOA).	--	Analyst and laboratory project manager	5-369
	Ion Transitions (Parent-> Product)	Prior to method implementation	The chemical derivation of the ion transitions, both those used for quantitation and those used for confirmation, must be documented. Two transitions and the ion transition ratio per analyte shall be monitored and documented with the exception of PFBA and PFPeA. 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 (e.g., alternate transition was used due to observed interferences).	--	Analyst and laboratory project manager	5-369

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
	Initial Calibration (ICAL)	At instrument set-up and after ICV or CCV failure, prior to sample analysis.	The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation). If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation. (Internal Standard Quantitation) S/N Ratio: ≥ 10:1 for all ions used for quantification. For analytes having a promulgated standard, (e.g., HA levels for PFOA and PFOS), the qualitative (confirmation) transition ion must have a S/N Ratio of ≥ 3:1. The %RSD of the RFs for all analytes must be <20%. Linear or nonlinear calibrations must have $r^2 \geq 0.99$ for each analyte. Analytes must be within 70-130% of their true value for each calibration standard.	Correct problem and repeat ICAL.	Analyst and laboratory project manager	5-369
	Instrument Sensitivity Check (ISC)	Prior to analysis and at least once every 12 hours.	Analyte concentrations must be at LOQ; concentrations must be within ±30% of their true values.	Correct problem, rerun ISC. If problem persists, repeat ICAL.	Analyst and laboratory project manager	5-369
	Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis	Concentration of each analyte must be ≤ ½ the LOQ.	Correct problem, rerun ICV. If problem persists, repeat ICAL.	Analyst and laboratory project manager	5-369
	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% of their true value.	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 corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.	Analyst and laboratory project manager	5-369
	Instrument Blanks (IB)	Immediately following the highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte < ½ the LOQ	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 acceptance criteria are not met after the highest standard which is not included in the calibration, the standard cannot be used to determine the highest concentration in samples at which carry over does not occur. If acceptance criteria are not met after sample, additional instrument blanks must be analyzed until acceptance criteria are met. Additional samples shall not be analyzed until acceptance criteria are met.	Analyst and laboratory project manager	5-369

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
LC-MS/MS (PFAS for Drinking Water)[3]	Mass Spectral Acquisition Rate	Each analyte, extracted internal standard analyte, and injection internal standard analyte.	A minimum of 10 spectra scans are acquired across each chromatographic peak.	--	Analyst and project manager	5-371
	Ion Transitions (Parent-> Product)	Prior to method implementation	See Attachment 2 of SOP 5-371	--		
	Signal to noise ratio	Required for all ion transitions used for quantification	Minimum signal to noise ratio of 3:1	--		
	Peak Asymmetry Factor	Calculate the peark asymmetry factor for the first two eluting chromatographic peaks in a mid-level ICAL standard every time a calibration curve is generated	Peak asymmetry factor of 0.8 – 1.5	--		
	Initial Calibration (ICAL)	Prior to analysis of samples	R^2> 0.99 for each analyte. Minimum 5 point linear calibration, 1/x weighting. Each target and labelled analyte must be recovered between 70% and 130% of true value (50% and 150% for the low point). Internal standard area for the first point and last point of the calibration must be less than 20% RPD.	If these requirements are not met for the ICAL, corrective action is performed, and the calibration is repeated.		
	Initial Calibration Check (ICC)	Immediately after the ICAL	Target and surrogate concentrations must be between 70% and 130% of the true value. Internal standards area within 50-150% of the average area in the ICAL.	If the criteria are not met, reanalyze the ICC. If the second ICC fails, a new ICAL must be performed or justification for continuing must be documented.		
	Continuing Calibration Verification (CCV)	Beginning of each sample analysis sequence (if not preceded by an ICAL and ICC), after 10 injections during analysis sequence, and at the end of each batch.	Target and surrogate concentrations must be between 70% and 130% of the true value (50% and 150% for the low point). IS area within 70-140% of the area of the last CCV. IS area within 50-150% of the average area in the ICAL.	When a CCV fails to meet any of the above criteria, two additional CCV's are analyzed consecutively. If both additional CCV's pass criteria, the samples can be reported. If either of the two additional CCV's fail criteria or cannot be analyzed all samples that were analyzed after the prior acceptable CCV must be re-analyzed. If a CCV fails because a target analyte exceeded the acceptance limit defined above (over response only) and that analyte was not detected in any samples, then the samples do not need to be reanalyzed. In all other cases, the sample must be reanalyzed after an acceptable CCV has been established or justification for continuing is approved by the project manager and documented.		
TOC Analytzer (TOC)[4]	Initial Calibration (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, QA Manager	WL-043, WL-057
	Independent Calibration Verification (ICV)	Immediately following the ICAL	±10% (90-110% of true value)	Instrument maintenance, reanalysis of ICV or initial calibration or re-preparation of the standards		
	Continuing Calibration Verification (CCV)	Each day that an ICAL is not performed a CCV must be performed before sample analysis, also analyze every 10 samples ant at the end of analytical batch	±10 % (90-110% of true value)	Instrument maintenance, reanalysis of ICV or initial calibration or re-preparation of the standards		
	Continuing Calibration Blank (CCB)	Analyzed after every 10 samples or more frequently and at the end of analytical batch	Concentration must be less than the LOQ	Correct problem; recalibrate instrument		

Notes:

[1] Refer to **Worksheet #23** for a complete reference to relevant analytical SOPs.

[2] The specifications in this table meet the requirements of DoD QSM v.5.1 Table B-15 for PFAS. For TOC specifications are as per the lab's SOPs.

[3] The specifications in this table meet the requirements of USEPA Method 537.1

[4] The specifications in this table are from the laboratory SOP and analytical method.

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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	Corrective Action	Responsible Person	SOP Reference
LC/MS/MS	Clean Curtain Plate	LC/MS/MS	Visual inspection of 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	5-369-06, 5-371-04
LC/MS/MS	Preventative Maintenance	LC/MS/MS	Degradation of instrument performance	Every six months or when instrument performance deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards (IS) 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.	Analyst	5-369-06, 5-371-04
LC/MS/MS	Replace analytical column	LC/MS/MS	Review peak shape, retention times, and peak separation on ICAL, ICC, and CCV samples.	Performed when chromatography deteriorates	ICAL within acceptance criteria on **Worksheet #24** and internal standards (IS) recovery within acceptance criteria on **Worksheet #28**	Replace analytical column. Reanalyze samples with new ICAL, ICC, ISC, and instrument blank.	Analyst	5-369-06, 5-371-04
Balance	Verification	Weight	--	Daily	± 0.02 gram or ± 0.1% of calibration weight used (whichever is greater)	Refer to manufacturer's instruction manual	Analyst	5-369-06, 5-371-04
Balance	Calibration	Weight	--	Annually	Per manufacturer	Remove from service, repair, replace	Analyst	5-369-06, 5-371-04
Pipette	Verification	Volume	--	Daily	± 2% difference from true value, < 1% relative standard deviation (n=3)	Remove from service, repair, replace	Analyst	5-369-06, 5-371-04
Pipette	Calibration	Volume	--	Quarterly	Per manufacturer	Remove from service, repair, replace	Analyst	5-369-06, 5-371-04
TOC Analyzer (TOC)	Change injection needle, change catalyst	TOC/ DOC	Monitor instrument performance via CCV	As Needed	No instrument error message	Clean or replace as necessary	Analyst/ Supervisor	WL-057

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SAP Worksheet #26—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team/CH2M **Sample Packaging (Personnel/Organization):** FTL/ CH2M **Coordination of Shipment (Personnel/Organization):** FTL/ CH2M **Type of Shipment/Carrier:** Overnight Carrier/ FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Logins/Battelle, GCAL **Sample Custody and Storage (Personnel/Organization):** Logins/Battelle, GCAL **Sample Preparation (Personnel/Organization):** Inorganic and Organic Prep/Battelle, GCAL **Sample Determinative Analysis (Personnel/Organization):** Analysts/ Battelle, GCAL
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 45 **Sample Extract/Digestate Storage** (No. of days from extraction/digestion): 45 **Microbial Sample Storage** (No. of days from sample collection): Not applicable.
SAMPLE DISPOSAL
Personnel/Organization: Sample Custody Personnel/Battelle, GCAL **Number of Days from Analysis:** 45

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SAP Worksheet #27—Sample Custody Requirements Table

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. Labels will be taped to the containers to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples <6 °C (<10 °C for PFAS) until the laboratory receives them.

The chain-of-custody form will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, with the air bill number indicated on the chain-of-custody form (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M.

See **Worksheet #21** for SOPs containing sample custody guidance.

All PFAS samples will be shipped to Battelle.

All TOC will be sent to Gulf Coast Analytical Laboratories.

Laboratory custody procedures can be found in the laboratory SOPs, which are referenced in **Worksheet #23**.

Sample Identification Procedures:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler's initials. The field logbook will identify the sample ID with the location and 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 form and **Worksheet #18**. The laboratory will send sample log-in forms to the PC to check that sample IDs and parameters are correct.

Chain-of-Custody Procedures:

Chain-of-custody forms 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, preservative information, analysis method, and comments. The chain-of-custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems (LIMS) database for each sample.

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Drinking Water
Analytical Group: PFAS
Analytical Method/SOP Reference: USEPA Method 537.1/5-371-04

QC Sample	Frequency / Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Surrogates	Every field sample, standard, blank, and QC sample	Within 70% to 130% of true value.	Correct the problem, if required, re-prep and reanalyze the samples. If insufficient sample is available to reprocess, report as suspect / SIS recovery	Analyst and Laboratory Project Manager	Accuracy	Same as Method / SOP QC Acceptance Limits
Internal Standards	Every field sample, standard, blank, and QC sample	Peak areas within ± 50% of the average area of the ICAL and 70-140% from the most recent CCV.	If peak areas are unacceptable, correct the problem and re-analyze. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags.		Accuracy	
Method Blank/Procedural Blank	Daily or 1 per batch of 20 samples, whichever is more frequent	No analyte at a concentration greater thatn 1/3 LOQ.	Correct the problem, if required, re-prep and reanalyze the Method Blank/Procedural Blank and all the QC samples and field samples processed with the contaminated blank.		Bias/Contamination	
Laboratory Fortified Blank (LFB)	1 per batch of 20 samples	Spiked between low, medium, and high concentrations. All recoveries between 70%-130% (50% - 150% for the low point of the calibration).	Correct the problem, then re-prep and reanalyze the LFB and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.		Accuracy/Bias/Precision	
Laboratory Fortified Sample Matrix (LFSM)	1 per batch of 20 samples	For samples fortified at or above their native concentration, recoveries should range between 70-130%, except for low-level fortification near or at the method reporting limit (MRL) (within a factor of 2-times the MRL concentration) where 50-150% recoveries are acceptable.	Contact the client as to additional measures to be taken.		Accuracy/Bias/Precision	
Laboratory Fortified Sample Matrix Duplicate (LFSMD)	1 per batch of 20 samples	RPDs for duplicate LFSMs should be ≤30% for samples fortified at or above their native concentration. Greater variability may be observed when LFSMs are fortified at analyte concentrations that are within a factor of 2 of the MRL. LFSMs fortified at these concentrations should have RPDs that are ≤50% for samples fortified at or above their native concentration.	Examine the project-specific requirements. Contact the client as to additional measures to be taken		Accuracy/Bias/Precision	

Notes:

USEPA Method 537.1 is the basis for specifications on this table.

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Groundwater, Surface Water, Soil, Sediment

Analytical Group: PFAS

Analytical Method/SOP Reference: LCMSMS Compliant with QSM 5.1 Table B-15/5-369-06

QC Sample	Frequency / Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Extracted Internal Standards	Every field sample, standard, blank, and QC sample	Added to sample prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to samples prior to analysis. Extracted Internal Standard Analyte recoveries must be within 50% to 150% of the true value.	If recoveries are acceptable for QC samples, but not field samples, the field samples must be reprepped and reanalyzed (greater dilution may be needed). If recoveries are unacceptable for QC samples, correct problem, and reanalyze all associated failed field samples. If recoveries are unacceptable for the QC samples, correct the problem, and reanalyze all associated field samples.	Analyst and Laboratory Project Manager	Accuracy	Same as Method/SOP QC Acceptance Limits
Injection Internal Standards	Every field sample, standard, blank, and QC sample	Added to aliquot of sample dilutions, QC samples, and standards just prior to analysis. Peak areas must be within -50% to +50% of the area measured in the ICAL midpoint standard. On days when ICAL is not performed, the peak areas must be within -50% to +50% of the peak area measured in daily initial CCV.	If peak areas are unacceptable, analyze a second aliquot of the extract or sample if enough extract remains. If there is not enough extract, reanalyze the first aliquot. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags.		Accuracy	
Method Blank	One per preparatory batch	No analyte at a concentration greater than ½ LOQ or 1/10th of any sample concentration or 1/10th of regulatory limit (whichever is greater).	Correct the problem, if required, re-prep and reanalyze the Method Blank and all the QC samples and field samples processed with the contaminated blank.		Bias/Contamination	
LCS	One per preparatory batch	See **Worksheet #15**	Correct the problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.		Accuracy/Bias/Precision	
MS	One per preparatory batch. Not required for aqueous samples prepared by serial dilution instead of SPE.	See **Worksheet #15**	Examine the project-specific requirements. Contact the client as to additional measures to be taken.		Accuracy/Bias/Precision	
MSD or Matrix Duplicate (MD)	For MSD: One per preparatory batch. For MD: Each aqueous sample prepared by serial dilution instead of SPE.	For MSD: Sample spiked with all analytes at a concentration ≥ LOQ and ≤ the mid-level calibration concentration. For MSD: Use in-house LCS limits if project limits are not specified. RPD ≤ 30% (between MS and MSD or sample and MD).	Contact the client as to additional measures to be taken.		Accuracy/Bias/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 70-130%of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70-130% acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met.		Accuracy/Bias/Precision	

Notes:

DoD QSM v5.1 Table B-15 is the basis for specifications on this table.

SAP Worksheet #28-3—Laboratory QC Samples Table

Matrix: Sediment
Analytical Group: TOC
Analytical Method/SOP Reference: SW-846 9060A/WL-057

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch, maximum of 20 samples	Concentration shall not be > 1/2 the LOQ or 1/10 the amount of sample	The source of contamination should be investigated, and samples should be reanalyzed. If, additional sample is not available, report with narrative.	Analyst, Supervisor, QA Manager	Bias/Contamination	Same as Method/SOP QC Acceptance Limits
LCS	One per preparatory batch, maximum of 20 samples	90-110%	If LCS fails to meet lab 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) if deemed necessary by the laboratory.	80-120%	If recovery is outside control limits and a lab error suspected, repeat the MS determination. If the LCS is within control limits and the matrix interference is indicated, analyze a post digestion spike and report results with a narrative.		Accuracy/Bias	
DUP/MSD	One pair per batch (assuming sufficient volume exists) if deemed necessary by the laboratory.	RPD should be ≤20 %	Investigate the source of the precision error. A source of precision error in the DUP/MSD may be the homogenous nature of the sample. If lab error is suspected, repeat analysis. If matrix issue is indicated, report with a narrative.		Precision	

Notes:

Lab SOPs are the basis for specifications on this table.

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained[a]
• Field Notes • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic data deliverable (EDDs) • Identification of QC Samples • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes and drilling logs • Water quality parameters • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • 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 (stored on disk) • Data Validation Reports • CA Forms • Method Detection Limit Study Information	• Field data deliverables (field notes, chain-of-custody forms, air bills, EDDs) will be kept on CH2M's local intranet server. • Field parameter data will be loaded with the analytical data into Data Warehouse. • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. • Electronic data from the laboratory will be loaded into the Data Warehouse and Naval Installation Restoration Information System.

Notes:

[a] Offsite documents, except for analytical laboratory data, are archived with Iron Mountain Inc., which is headquartered at 1000 Campus Drive. Collegeville, PA 19426. Analytical laboratory data are archived with the Federal Records Center.

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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
Drinking Water	PFAS	See **Worksheet #18**	EPA 537.1/ 5-371-04	14 days	Battelle Memorial Institute 141 Longwater Drive, Suite 202 Norwell, MA 02061 (614) 458-6917 POC: Jon Thorn
Groundwater	PFAS		LCMSMS Compliant with QSM 5.1 Table B-15/ 5-369-06	28 days	
Surface Water	PFAS				
Soil	PFAS				
Sediment	PFAS				
	TOC		EPA 9060A, SM 5310 B-2011/WL-057		Gulf Coast Analytical Laboratories 7979 Innovation Park Dr. Baton Rouge, LA, 70820 (225) 214-7068 POC: Liz Martin

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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)
Offsite Laboratory Technical Systems Audit (applies to definitive data only)	Laboratory must have current DoD ELAP accreditation letter, which will identify the period of performance. The laboratory must be re-evaluated prior to expiration of period of performance.	External	Third-party accrediting body	Third-party accrediting body	Respective Laboratory QAO	Respective Laboratory QAO	Third-party accrediting body
Field Performance Audit	One during each sampling event	Internal	CH2M	PM CH2M	FTL CH2M	PM CH2M	PM CH2M
Safe Behavior Observation	One during each sampling event	Internal	CH2M	SSC CH2M	Field Team Member observed CH2M	HSO CH2M	SSC CH2M
Field Document Review	Daily during each sampling event	Internal	CH2M	PM or Task Manager CH2M	FTL CH2M	PM CH2M	PM CH2M

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Project Review	Checklist	Juliana Dean, PM, CH2M	Within 1 week of audit	Memorandum	John Tomik, AQM	Within 1 week of receipt of CA Form
Laboratory CA	Written Audit Report	Andrew Lairson, Project Chemist, CH2M	As soon as possible after initial finding.	Memorandum	Anita Dodson, Program Chemist	Within 2 months of receipt of initial notification
Safe Behavior Observation	Safe Behavior Observation Form	TBD SSC, CH2M	Within 1 week of Safe Behavior Observation	Memorandum	TBD Field Team Member, CH2M	Immediately
Field Document Review	Markup copy of field documentation	TBD FTL, CH2M	Within 1 day of review	Verbal and Memorandum	TBD FTL, CH2M	Within 1 day of receipt of markup

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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: ____

____

____

Sequence of CA: (including date implemented, action planned and personnel/data affected) ________________

____

____

____

____

____

____

CA implemented by: ____ **Date** ____________________________

CA initially approved by: _______________________________________ **Date** ____________________________

Follow-up date: ____

Final CA approved by: ____ **Date** ____________________________

Information copies to:

Anita Dodson/CH2M Navy CLEAN Program Chemist

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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 #32-3—Safe Behavior Observation Form

☐ Federal or ☐ Commercial Sector (check one)		☐ Construction or ☐ Consulting (check one)	
Project Number:		Client/Program:	
Project Name:		Observer:	Date:
Position/Title of worker observed:		Background Information/comments:	
Task/Observation Observed:			

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current and accurate Pre-Task Planning/ Briefing (for example, Project Safety Plan, Safety Training and Consulting, Activity Hazard Analysis, Pre-task Safety Plan, tailgate briefing, as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work approach/habits			
Attitude			**Observer's CAs/Comments:**
Focus/attentiveness			
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/line of fire			**Observed Worker's CAs/Comments:**
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			
Other…			

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SAP Worksheet #33—Quality Assurance Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Final SI Addendum Report	Post-field Event	October 2019	Juliana Dean/CH2M	Stakeholders, see **Worksheet #4**

The Report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project activities to SAP requirements/procedures
- Status of project schedule
- Deviations from the SAP and approved amendments to SAP
- Results of data review activities (how much usable data were generated)
- CAs if needed and their effectiveness
- Data usability with regard to precision, accuracy, representativeness, completeness, comparability, and sensitivity
- Limitations on data use

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

Data Review Input	Description	Responsible for Verification or Validation[a]	Step I / IIa / IIb [a]	Internal/ External[b]
Field Notes	Field notes will be reviewed internally and placed into the project file for archival at project closeout.	FTL / CH2M	Step I	Internal
Chain-of-Custody 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 form will be initialed by the reviewer, a copy of the chains-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chains-of-custody will also be reviewed for adherence to the SAP by the project chemist.	FTL / CH2M PC / CH2M	Step I	Internal & External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project chemist in the form of laboratory logins.	PC / CH2M	Step I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the project chemist. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	PC / CH2M	Step I	External
Electronic Data Deliverables	DDs will be compared against hardcopy laboratory results (10% check). If discrepancies between the EDD and hardcopy data package are encountered a deeper review of 25% will be conducted.	PC / CH2M	Step I	External
Case Narrative	Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages.	DV / TBD	Step I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Respective Laboratory QAO	Step I	Internal
Laboratory Data	The data will be verified for completeness by the project chemist. 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.	PC / CH2M	Step I	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If corrective actions are required, a copy of the documented corrective action 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 corrective action forms will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the site manager will be notified to ensure action is taken.	PM / CH2M PC / CH2M	Step I	Internal
Corrective Action Reports	Corrective action reports will be reviewed by the project chemist or PM and placed into the project file for archival at project closeout.	PM / CH2M PC / CH2M	Step I	External
Laboratory Methods	During the pre-validation check, ensure that 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.	PC / CH2M	Step IIa	External
Target Compound List and Target Analyte List	During the pre-validation check, ensure that the laboratory reported all analytes from each analysis group as per **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 project manager is notified via email.	PC / CH2M	Step IIa	External
Reporting Limits	Ensure the laboratory met the project-designated quantitation limits as per **Worksheet #15**. If quantitation limits were not met, the reason will be determined and documented.	PC / CH2M	Step IIb	External
Field SOPs	Ensure that all field SOPs were followed.	FTL /CH2M	Step I	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory QAO	Step IIa	Internal
Raw Data	10% Stage 4 review of raw data to confirm laboratory calculations and manual integrations. For a recalculated result, the DV attempts to re-create 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% difference. The remaining 90% of data will receive Stage 2B review.	DV / TBD	Step IIa	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	FTL / CH2M	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	DV / TBD	Step IIa	External

SAP Worksheets #34 through #36—Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification or Validation[a]	Step I / IIa / IIb [a]	Internal/ External[b]
Documentation of Field QC Sample Results	Establish that all required QC samples were run and met limits.	PC / CH2M	Step IIa	Internal
DoD ELAP Evaluation	Ensure each laboratory is DoD ELAP Certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC / CH2M	Step I	External
Analytical data for PFAS in all samples	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**). 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 “United States Department of Defense General Data Validation Guidelines” (DoD, 2018a) will be applied as appropriate. As specific modules for the analytical methods in this project are published, the DVs will refer to those modules for guidance. In the meantime, if specific guidance is not given for these methods in the General Data Validation Guidelines, the DV may adapt the guidance from "National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.4)" (USEPA, 2017b), and "National Functional Guidelines for Inorganic Superfund Data Review (ISM02.4)" (USEPA, 2017a) may also be applicable. For drinking water samples, the data validator will reference “EPA Data Review and Validation Guidelines for Perfluoroalkyl Substances (PFASs) Analyzed Using EPA Method 537” (USEPA, 2018).	DV / TBD	Step IIa and IIb	External
Analytical data for WCHEM, in all samples	Wet chemistry will not undergo third-party data validation but are subject to all other data review protocols detailed above.	N/A	Step IIa and IIb	N/A

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 measurement performance criteria in the SAP (both sampling and analytical). 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 corrective action needed. This memo will be sent to the laboratory, or applicable party, and maintained in the project file.

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

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 PQL goals in **Worksheet #15** were achieved. If PQLs 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 R and in most cases is not considered usable for project decisions. 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.
    - UJ = Analyte not detected. QL may be inaccurate or imprecise.
    - J+ = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
    - J- = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
    - X = Recommend rejected result by DV.
    - R = Rejected result by project team. Result not reliable. Project team as a whole will determine if the final qualifier will become an R qualifier for rejection or will be qualified as estimated with one of the qualifiers listed above.
- If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to the sample detection limit 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 DV are:
    - N = Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.
    - NJ = Qualitative identification 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. These checks include comparison of hardcopy data and qualifiers to the EDD. Once the data has 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.
- Describe the evaluative procedures used to assess overall measurement error associated with the project.
- To assess whether a sufficient quantity of acceptable data is available for decision making, the data will be compared to a 95% completeness goal and will be reconciled with Measurement Performance Criteria following validation and review of DQIs.

SAP Worksheet #37—Usability Assessment (continued)

- If significant biases are detected with laboratory QA/QC samples it will be evaluated to assess impact on decision-making. Low biases will be described in 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 Addendum Report.
- The SI Addendum Report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the NAS Oceana Partnering Team who, as a whole, will evaluate the data usability according to project objectives.

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Figures

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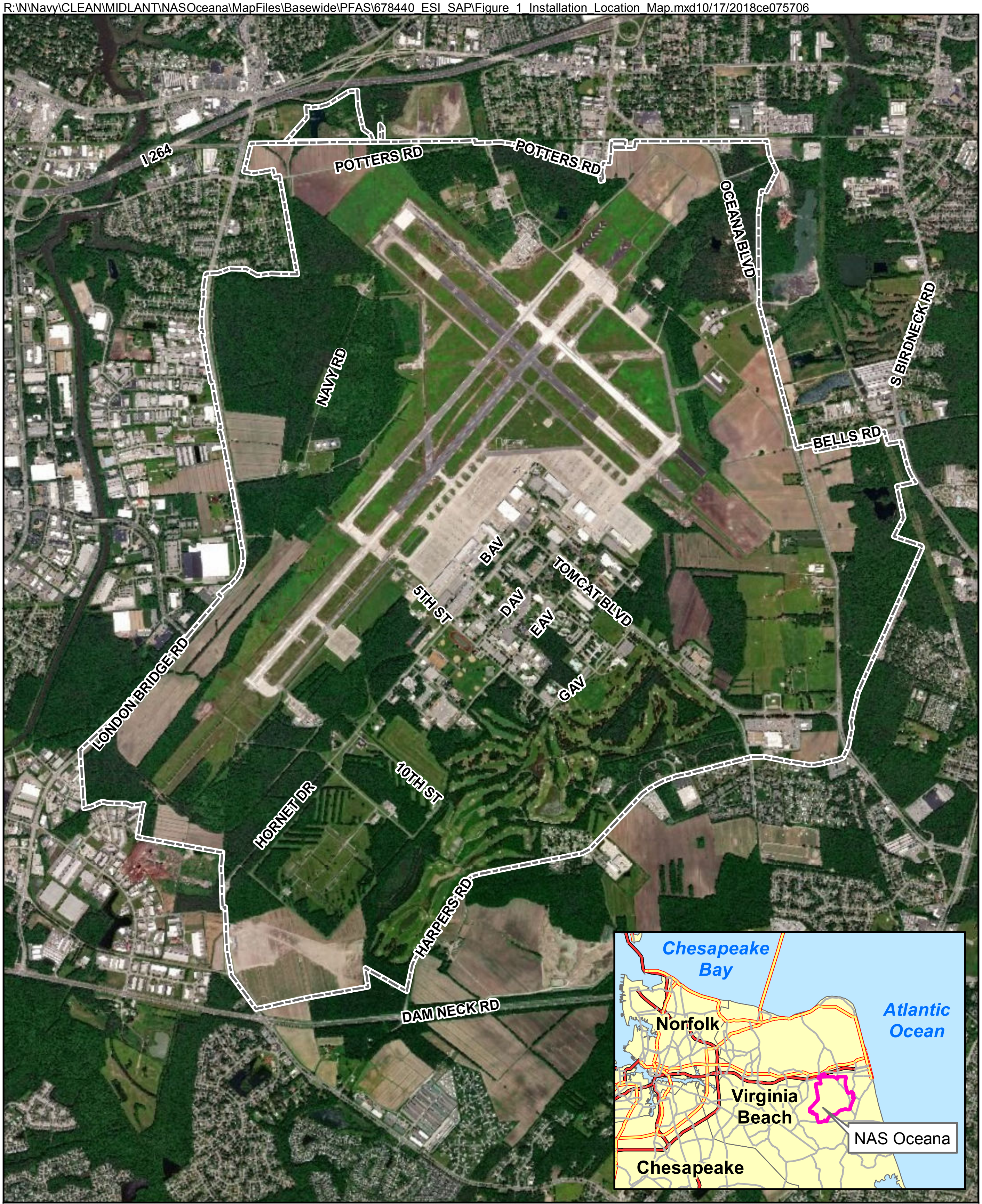

Legend

▭ NAS Oceana Boundary

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Imagery Source: ©2017, Esri

Figure 1
Installation Location Map
NAS Oceana
Virginia Beach, Virginia

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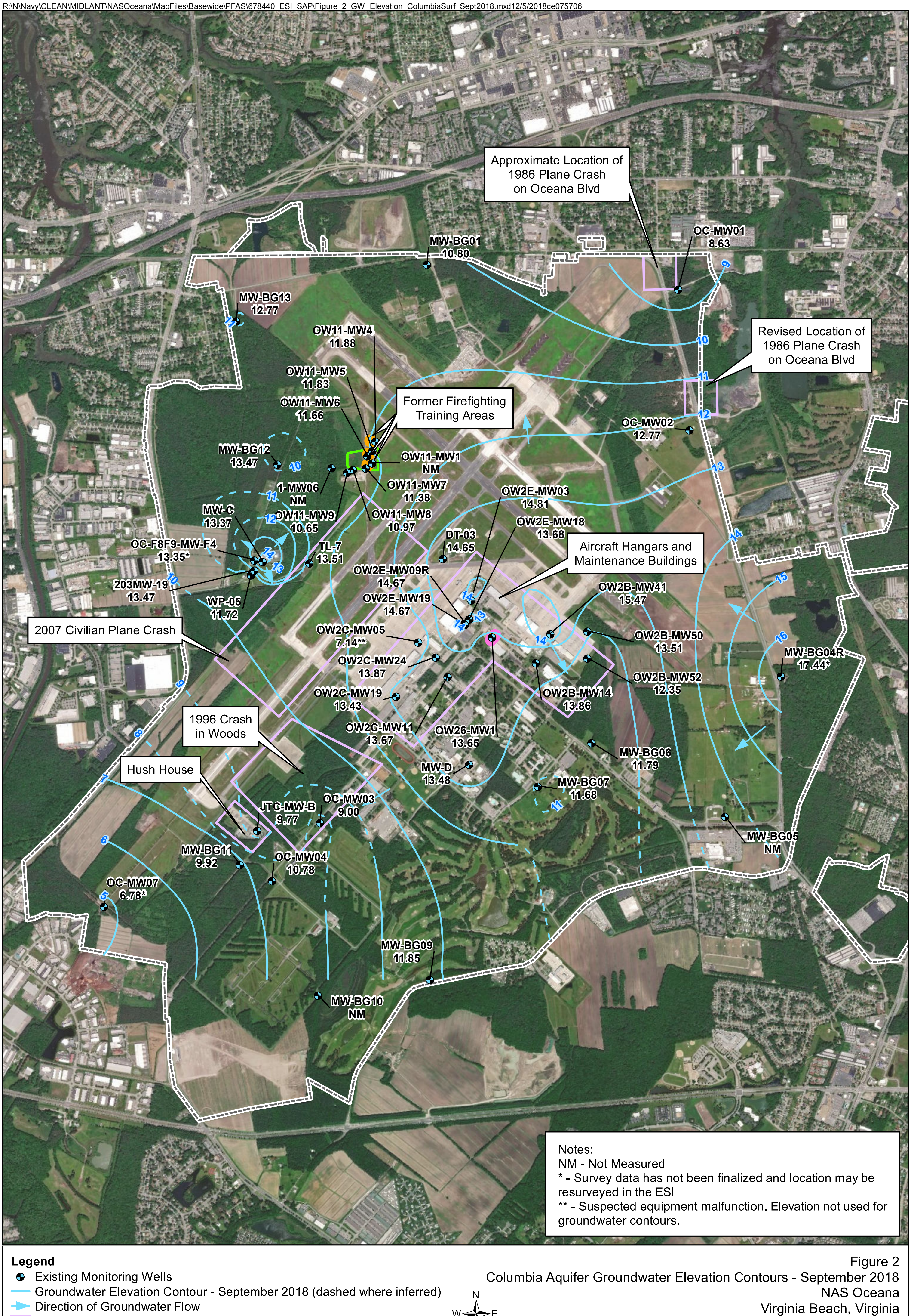

Notes:
NM - Not Measured
* - Survey data has not been finalized and location may be resurveyed in the ESI
** - Suspected equipment malfunction. Elevation not used for groundwater contours.

Legend
- ● Existing Monitoring Wells
- — Groundwater Elevation Contour - September 2018 (dashed where inferred)
- → Direction of Groundwater Flow
- ☐ Potential AFFF Release Areas
- ☐ Fire Fighting Training Areas
- ☐ Site 11 Boundary
- ☐ SWMU 26 Boundary
- ☐ Installation Boundary

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Imagery Source: ©2017 Esri

Figure 2
Columbia Aquifer Groundwater Elevation Contours - September 2018
NAS Oceana
Virginia Beach, Virginia

ch2m

R:\N\Navy\CLEAN\MIDLANT\NASOceana\MapFiles\Basewide\PFAS\678440_ESI_SAP\Figure_3_GW_Elevation_Yorktown_Sept2018.mxd12/5/2018ce075706

Notes:
Survey data has not been finalized and locations may be resurveyed in the ESI

Legend

- ● Existing Monitoring Wells
- — Groundwater Elevation Contour - September 2018 (dashed where inferred)
- → Direction of Groundwater
- ☐ Potential AFFF Release Areas
- ☐ Fire Fighting Training Areas
- ☐ Site 11 Boundary
- ☐ SWMU 26 Boundary
- ☐ Installation Boundary

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Imagery Source: ©2017 Esri

Figure 3
Yorktown Aquifer Groundwater Elevation Contours - September 2018
NAS Oceana
Virginia Beach, Virginia

ch2m

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	OW11-MW5
	10/25/2016
PFOA	**4,100**
PFOS	**69,500 J**
Total PFOA/PFOS	**73,600**

	MW-BG01
	10/31/2016
PFOA	**13.5**
PFOS	**20.2**
Total PFOA/PFOS	**33.7**

	OW11-MW4
	10/26/2016
PFOA	**1,540**
PFOS	**33,200 J**
Total PFOA/PFOS	**34,740**

	OW11-MW6
	10/26/2016
PFOA	**11,300**
PFOS	**101,000 J**
Total PFOA/PFOS	**112,300**

	MW-BG13*
	10/26/2016
PFOS	**28.7**

	OW11-MW8
	10/25/2016
PFOA	**5,360**
PFOS	**18,800**
Total PFOA/PFOS	**24,160**

	MW-BG12
	10/26/2016
PFOA	**10.2**
PFOS	**46.5**
Total PFOA/PFOS	**56.7**

	OW11-MW9*
	10/25/2016
PFOA	**10,100**
PFOS	**116,000 J**
Total PFOA/PFOS	**126,100**

	OC-F8F9-MW-F4
	4/4/2017
	No Detections

	OW11-MW1
	10/25/2016
PFOA	**11,600**
PFOS	**217,000 J**
Total PFOA/PFOS	**228,600**

	OW11-MW7
	10/25/2016
PFOA	**18,700**
PFOS	**296,000 J**
Total PFOA/PFOS	**314,700**

	203MW-19
	11/1/2016
PFOA	**5.75 J**
PFOS	**7.17 J**
Total PFOA/PFOS	**12.92**

	OC-MW01
	11/1/2016
PFOA	**4.92 J**
PFOS	**8.16 J**
Total PFOA/PFOS	**13.08**

	OC-MW02
	11/1/2016
	No Detections

	OW2B-MW41
	11/1/2016
PFOA	**222**
PFOS	**63.1**
Total PFOA/PFOS	**285.1**

	OW2E-MW09R
	2/23/2017
PFOA	**134**
PFOS	**103**
Total PFOA/PFOS	**237**

	OW2E-MW19
	11/1/2016
PFOA	**413**
PFOS	**263**
Total PFOA/PFOS	**676**

	OW2C-MW05
	2/23/2017
PFOA	**42.9**
PFOS	**249**
Total PFOA/PFOS	**292**

	OW26-MW1*
	11/1/2016
PFOA	**22,600**
PFOS	**471,000**
Total PFOA/PFOS	**493,600**

	MW-BG04R
	8/10/2017
PFOA	**4.72 J**

	OW2C-MW25
	2/23/2017
PFOA	**1100**
PFOS	**44,500 J**
Total PFOA/PFOS	**45,600**

	OW2C-MW19	
	11/1/2016	2/23/2017
PFOA	**546**	**268**
PFOS	**2,430**	**1,340**
Total PFOA/PFOS	**2,976**	**1,608**

	MW-BG06
	10/28/2016
PFOS	**11.4**

	OW2C-MW24
	2/23/2017
PFOA	**1540**
PFOS	**78.7**
Total PFOA/PFOS	**1,619**

	OC-MW03
	11/1/2016
PFOA	**15.6**
PFOS	**33.4**
Total PFOA/PFOS	**49**

	MW-BG05*
	10/28/2016
PFOA	**2.02 J**

	OC-MW07
	4/4/2017
PFOA	**0.685 J**
PFOS	**3.63 J**
Total PFOA/PFOS	**4.315**

	MW-BG07
	10/28/2016
PFOA	**1.65 J**
PFOS	**29.2**
Total PFOA/PFOS	**30.85**

	MW-BG11
	10/31/2016
PFOS	**15.6**

	MW-BG09
	10/31/2016
PFOA	**3.15 J**

	JTC-MW-B
	11/1/2016
PFOA	**12.6**
PFOS	**4,020**
Total PFOA/PFOS	**4,032.6**

	MW-BG10
	11/2/2016
PFOS	**1.23 J**

	USEPA Lifetime Health Advisory
Total PFOS/PFOA	70

	OC-MW04
	10/31/2016
PFOA	**6.84 J**
PFOS	**39.6**
Total PFOA/PFOS	**46.44**

Notes:
All units are ng/L (nanograms per liter)
J - Estimated result
* - Field duplicate collected at this location; the greater of the results is shown
Bold text indicates a detection
Shading indicates exceedance of the USEPA Lifetime Health Advisory

Legend
- ⊗ Monitoring Wells with PFOS/PFOA Detections
- ⊗ Monitoring Wells with PFOS/PFOA Exceedances
- ⊗ Monitoring Wells with No PFOS/PFOA Detections
- — Non-Core Target Treatment Area (2004)
- - - - Core Target Treatment Area (2004) (Core)
- → Direction of Groundwater Flow
- — Groundwater Elevation Contour - November 2017 (dashed where inferred)
- 🟩 Total PFOA/PFOS above USEPA Lifetime Health Advisory of 70 ng/L.
- ☐ Potential AFFF Release Areas
- ☐ Fire Fighting Training Areas
- ☐ Site 11 Boundary
- ☐ SWMU 26 Boundary
- ☐ Installation Boundary

Imagery Source: Esri, 2017

Figure 4
PFOS/PFOA Concentrations in the Columbia Aquifer
NAS Oceana
Virginia Beach, Virginia

ch2m

	OC-MW05D*
	4/3/2017
PFOS	**2.42 J**

	OCSTR-WL01
	12/22/2016
	No Detections

	OC-MW02D
	4/3/2017
PFOA	**8.98**

	OW11-MW10D
	4/4/2017
PFOA	**61.3**
PFOS	**578**
Total PFOA/PFOS	**639.3**

	OW26-MW01D
	4/3/2017
PFOS	**10.1**

	OC-MW07D
	4/4/2017
	No Detections

	USEPA Lifetime Health Advisory
Total PFOS/PFOA	70

Notes:
All units are ng/L (nanograms per liter)
J - Estimated result
* - Field duplicate collected at this location; the greater of the results is shown
Bold text indicates a detection
Shading indicates exceedance of the USEPA Lifetime Health Advisory

Legend
- ⊗ On-Base Non-Potable Well
- ⊗ Monitoring Wells with PFOS/PFOA Detections
- ⊗ Monitoring Wells with PFOS/PFOA Exceedances
- ⊗ Monitoring Wells with No PFOS/PFOA Detections
- Non-Core Target Treatment Area (2004)
- Core Target Treatment Area (2004) (Core)
- Direction of Groundwater Flow
- Groundwater Elevation Contour - November 2017 (dashed where inferred)
- 🟩 Total PFOA/PFOS above USEPA Lifetime Health Advisory of 70 ng/L.
- ☐ Potential AFFF Release Areas
- ☐ Fire Fighting Training Areas
- ☐ Site 11 Boundary
- ☐ SWMU 26 Boundary
- ☐ Installation Boundary

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Imagery Source: Esri, 2016

Figure 5
PFOS/PFOA Concentrations in the Yorktown Aquifer
NAS Oceana
Virginia Beach, Virginia

ch2m:

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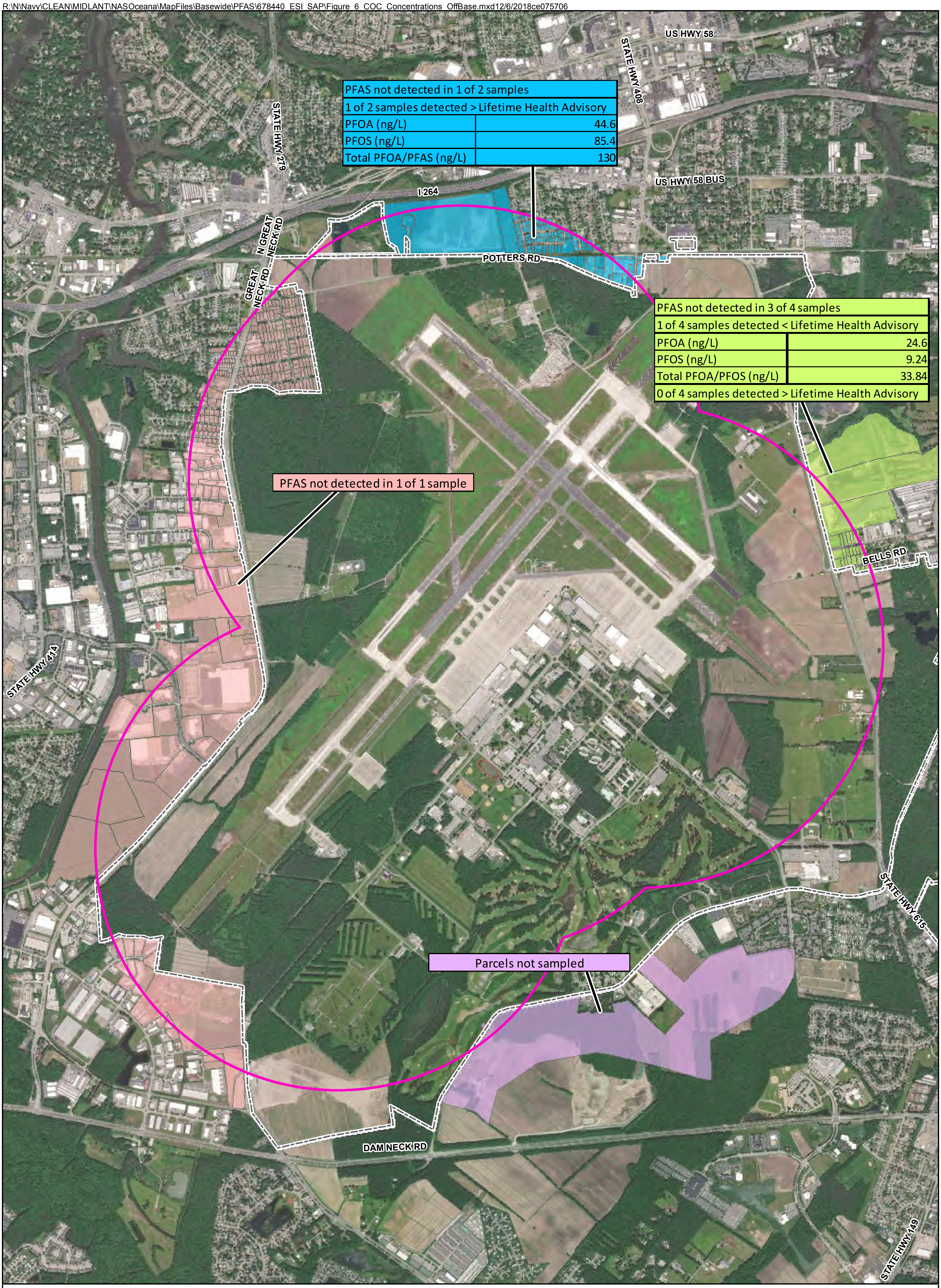

PFAS not detected in 1 of 2 samples	
1 of 2 samples detected > Lifetime Health Advisory	
PFOA (ng/L)	44.6
PFOS (ng/L)	85.4
Total PFOA/PFAS (ng/L)	130

PFAS not detected in 3 of 4 samples	
1 of 4 samples detected < Lifetime Health Advisory	
PFOA (ng/L)	24.6
PFOS (ng/L)	9.24
Total PFOA/PFOS (ng/L)	33.84
0 of 4 samples detected > Lifetime Health Advisory	

Legend

▭ Sampling Area
▭ Installation Boundary

Off-Base Parcels

🟩 East
🟦 North
🟪 South
🟥 West

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Imagery Source: ©2017 Esri

Figure 6
PFOS/PFOA Concentrations in Potable Wells Sampled from Parcels Located Off-Base
NAS Oceana
Virginia Beach, Virginia

ch2m

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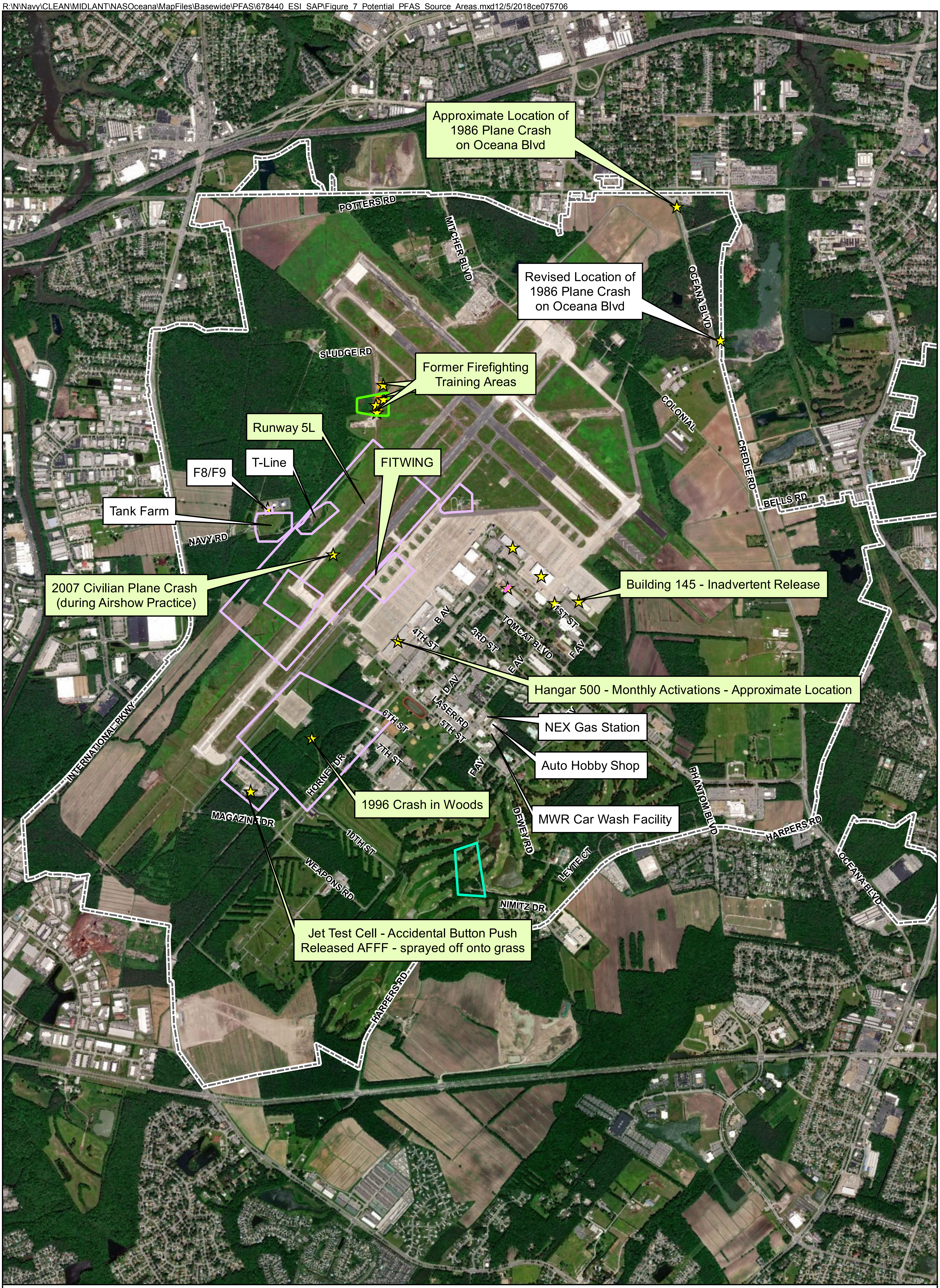

Legend

★ AFFF Release Locations
▭ Potential AFFF Release Areas
▭ Fire Fighting Training Areas
▭ Site 11 Boundary
▭ SWMU 26 Boundary
▭ Fifth Green Landfill
▭ Installation Boundary

Green label indicates areas previously investigated during the SI

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Imagery Source: ©2017 Esri

Figure 7
Potential PFAS Source Areas
NAS Oceana
Virginia Beach, Virginia

ch2m

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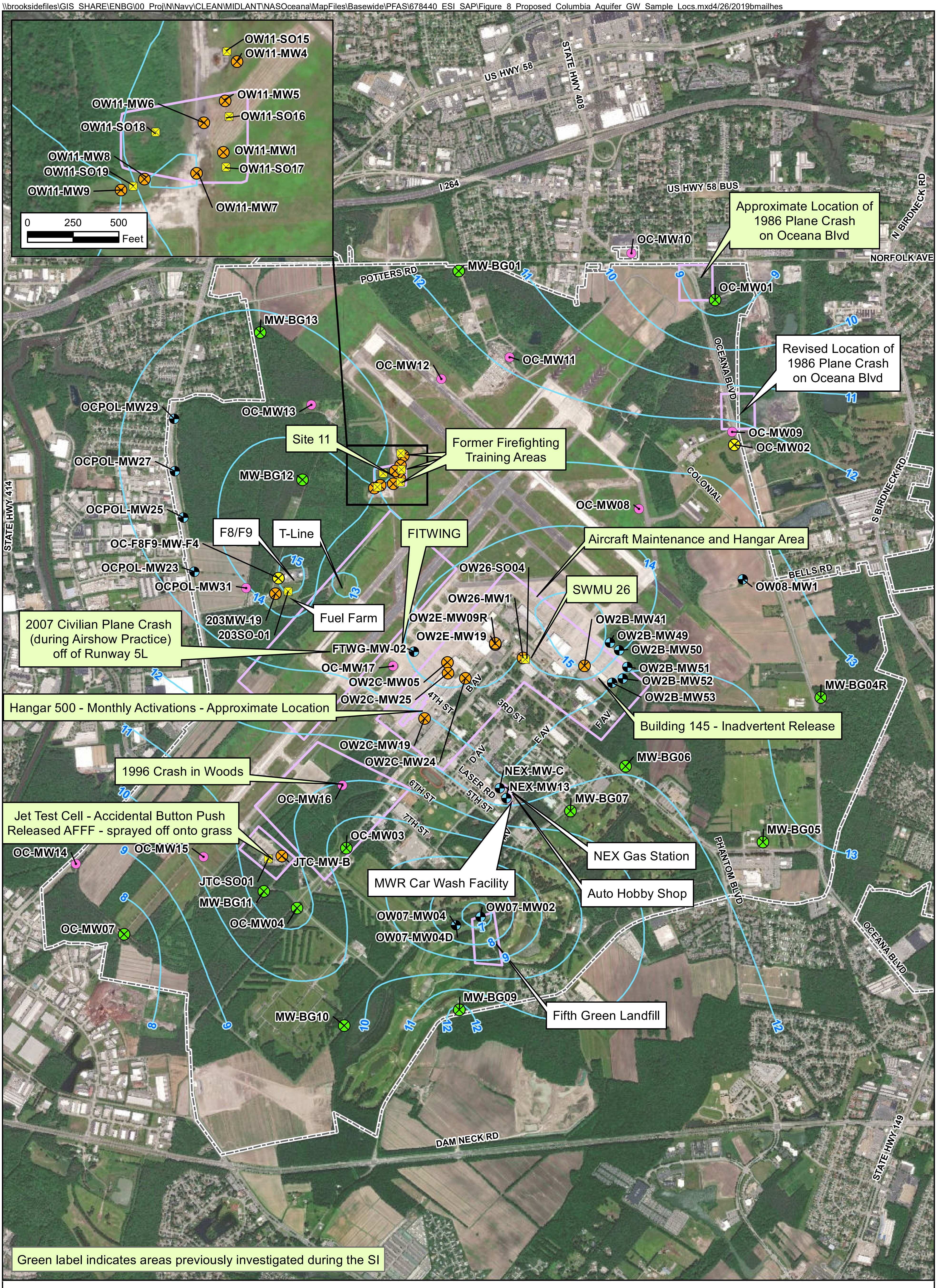

Legend

- ● Proposed Shallow Well
- ☒ Proposed Surface Soil and Subsurface Soil Sample Location
- ● Existing Shallow Well
- ⊗ Monitoring Wells with PFOS/PFOA Detections
- ⊗ Monitoring Wells with PFOS/PFOA Exceedances
- ⊗ Monitoring Wells with No PFOS/PFOA Detections
- — Groundwater Elevation Contour - February 2019 (dashed where inferred)
- → Groundwater Flow Direction
- ☐ Approximate Extent of Potential Source Area
- ☐ Installation Boundary

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Imagery Source: ©2017 Esri

Figure 8
Proposed Columbia Aquifer Groundwater and Soil Sample Locations
NAS Oceana
Virginia Beach, Virginia

ch2m

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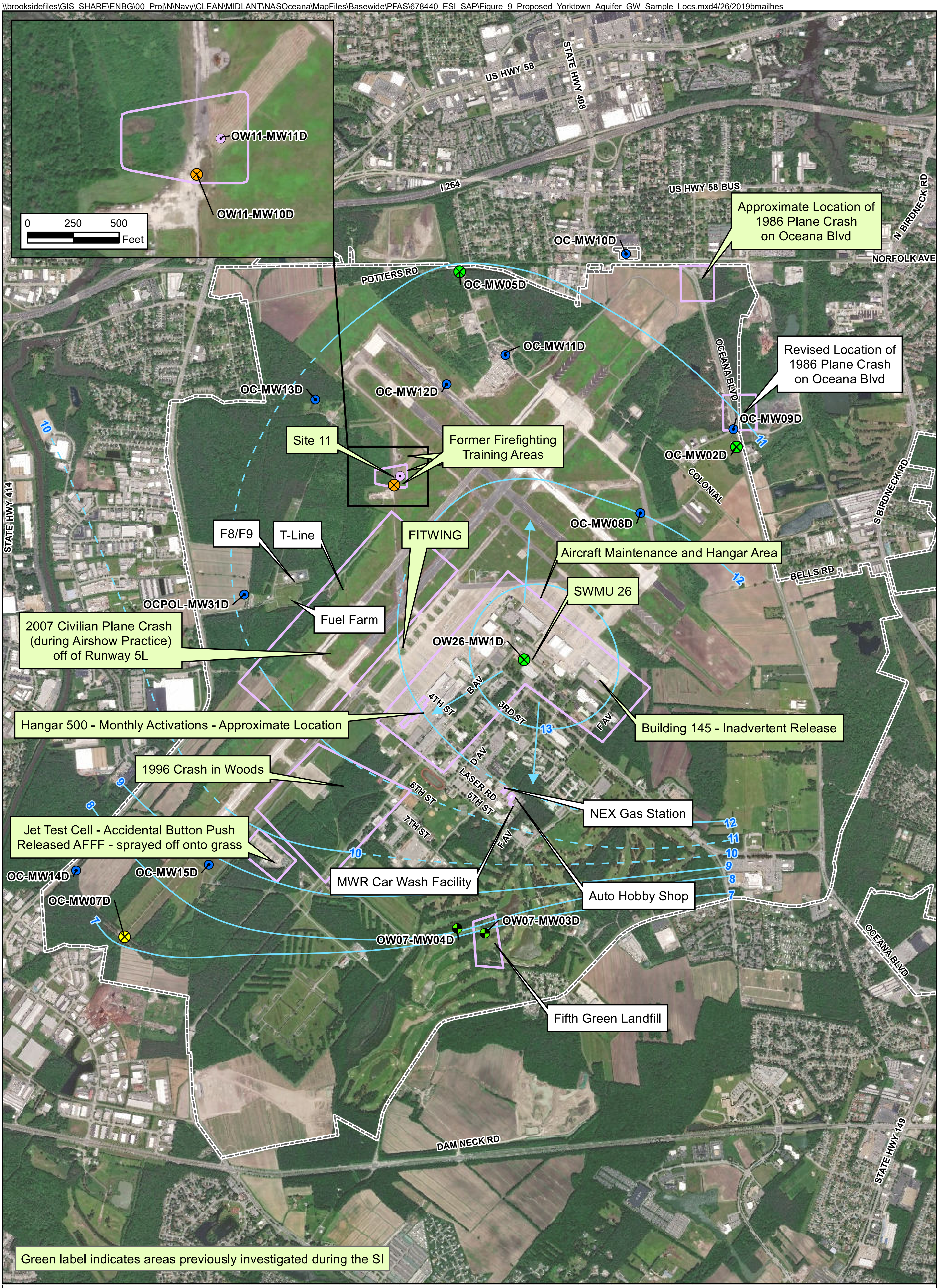

Legend

- ● Proposed Deep Well
- ● Proposed Yorktown Well
- ◐ Existing Deep Well
- ⊗ Monitoring Wells with PFOS/PFOA Detections
- ⊗ Monitoring Wells with PFOS/PFOA Exceedances
- ⊗ Monitoring Wells with No PFOS/PFOA Detections
- — Groundwater Elevation Contour - February 2019 (dashed where inferred)
- → Groundwater Flow Direction
- ▭ Approximate Extent of Potential Source Area
- ▭ Installation Boundary

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Imagery Source: ©2017 Esri

Figure 9
Proposed Yorktown Aquifer Groundwater
Sample Locations
NAS Oceana
Virginia Beach, Virginia

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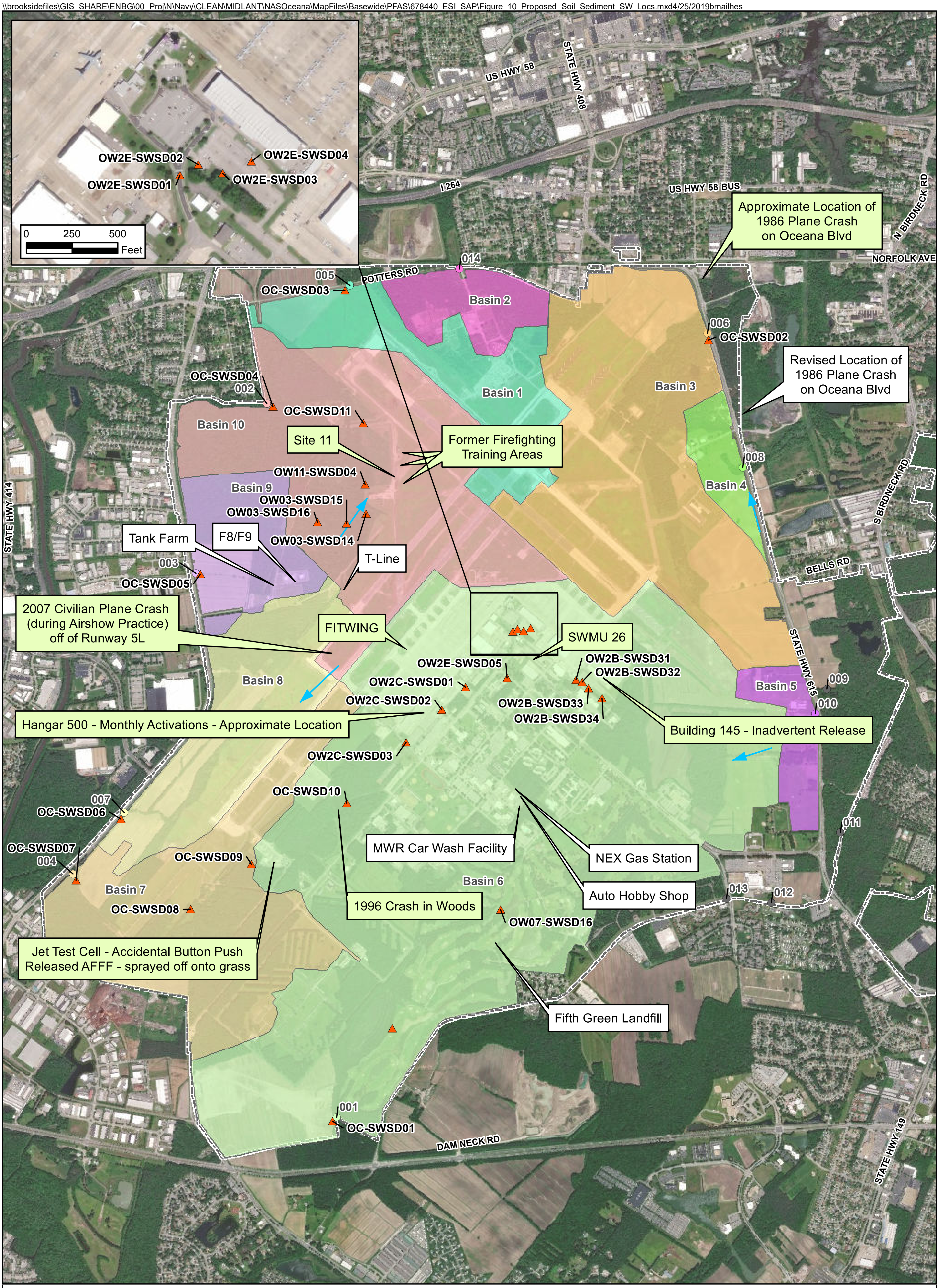
\\brooksidefiles\GIS SHARE\ENBG\00 Proj\N\Navy\CLEAN\MIDLANT\NASOceana\MapFiles\Basewide\PFAS\678440 ESI SAP\Figure 10 Proposed Soil Sediment SW Locs.mxd4/25/2019bmailhes



Legend

- ▲ Proposed Surface Water and Sediment Sample Location
- ⬚ Installation Boundary

Outfall Locations

- ● 001
- ● 002
- ● 003
- ● 004
- ● 005
- ● 006
- ● 007
- ● 008
- ● 009, 011, 012, 013
- ● 010
- ● 014

Drainage Basins

- 🟩 Basin 1
- 🟪 Basin 2
- 🟧 Basin 3
- 🟩 Basin 4
- 🟪 Basin 5
- 🟩 Basin 6
- 🟨 Basin 7
- 🟨 Basin 8
- 🟪 Basin 9
- 🟥 Basin 10

Green label indicates areas previously investigated during the SI

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Imagery Source: ©2017 Esri

Figure 10
Drainage Basins, Outfall Locations, and
Proposed Surface Water and
Sediment Sample Locations
NAS Oceana
Virginia Beach, Virginia

\\brooksidefiles\GIS_SHARE\ENBG\00_Proj\N\Navy\CLEAN\MIDLANT\NASOceana\MapFiles\Basewide\PFAS\678440_ESI_SAP\Figure_11_Proposed_Drinking_Water_Sample_locs.mxd4/25/2019bmailhes

Legend

🟪 Sampling Area

🟨 Parcels within Sampling Area

⬚ Installation Boundary

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Imagery Source: Esri, 2017

Figure 11
Proposed Drinking Water Sampling Locations
NAS Oceana
Virginia Beach, Virginia

ch2m:

Appendix A
Field Standard Operating Procedures

STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Drinking Water Sampling when Analyzing for Per- and Polyfluoroalkyl Substances (PFASs)

I. Purpose and Scope

This SOP provides guidelines for drinking water sample collection for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS), aka perfluorinated compounds (PFCs), including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) via EPA Method 537 (not modified).

Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000.

II. Equipment and Materials

Equipment and Materials Required

- Drinking water sample containers (polypropylene bottle with polypropylene screw cap and Trizma preservative)
- Laboratory pre-filled polypropylene bottles containing field reagent blank water and Trizma preservative
- Field Reagent Blank sample containers (polypropylene bottle with polypropylene screw cap and no preservative)
- Shipping supplies (labels, coolers, and ice)
- Loose leaf paper without waterproof coating
- Clip board
- Pen (not Sharpie)
- Nitrile or latex gloves

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect drinking water samples should not contain any fluorinated compounds, including polytetrafluoroethylene (PTFE), 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

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

Sample bottles should be polypropylene in accordance with Method 537. PFAS have a tendency to adhere to glass surfaces. Contact the project manager (PM) if the lab sends glass bottles. Sample vials should not have PTFE/Teflon® lined bottles or caps.

III. Procedures and Guidelines

A. Setup

1. Obtain well construction information from homeowner, if available, in accordance with homeowner questionnaire developed for your project.

2. Record personnel onsite, address, homeowner name, and designated sample ID in the field logbook. Sample IDs should not contain identifying information about the property location due to potential privacy issues, so be sure both address and designated ID are carefully recorded for tracking. Sample IDs and addresses on the sample bottles and in the sample notebook must be checked by both field team members and the address in the field notebook should be confirmed with the homeowner or resident.

3. As feasible, select a sampling collection point prior to any treatment system installed by the homeowner. For example, if the homeowner has a point of use reverse osmosis or granular activated carbon filter in their kitchen sink, collect at the bathroom sink. If there is a point of entry filtration system, ask if there is a sampling port between the well and the system. If there is no way to bypass the existing treatment system without disconnecting pump components or potentially damaging the system, collect a treated sample and note that the sample was collected post-treatment. Avoid collecting samples through hoses. Instead, disconnect the hose and sample from the spigot if an outside collection station is selected.

3. Wash hands before sampling with dish detergent and don nitrile gloves.

4. Open the cold water tap and allow the system to flush for three to five minutes. Do not open bottles until you are ready to sample. Do not sample from the hot water tap, as a hot water sample may have been contained for in a hot water heater and may not reflect water quality of water drawn directly from the private well.

B. Sample Collection

Once flushing is complete, samples can be collected.

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

1. Turn the tap off briefly. Remove the cap from the sample bottle. Position the sample bottle under the tap and turn the tap on.
2. Fill the bottle, taking care not to flush out the sample preservative. Samples do not need to be collected headspace free.
3. After collecting the sample, cap the bottle and agitate by hand until the preservative is dissolved.
4. Pack the sample on ice immediately for shipment to the offsite laboratory.

C. Field Reagent Blank Collection

A field reagent blank is required at each drinking water sampling location and is to be collected immediately following collection of the drinking water sample. The steps to complete collection of the field reagent blank are as follows:

1. A preserved field reagent blank for each sample location will be provided by the laboratory along with empty bottles for the field reagent blanks. While still at the drinking water sample collection point, open the preserved field reagent blank water bottle and an empty unpreserved sample bottle.
2. Pour the preserved reagent blank water from the preserved bottle into the unpreserved blank container.
3. Be sure the field reagent blank bottle is labeled and will be labeled and packed in the same cooler as the associated drinking water sampling for shipment to the offsite laboratory.

V. 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

STANDARD OPERATING PROCEDURE

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
- Concentrated (V/V) pesticide grade isopropanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol 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 (“Tyveks”) 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 pump 1 gallon of Liquinox® solution through the sampling pump.
5. Rinse with 1 gallon of 10% isopropanol solution pumped through the pump. (DO NOT USE ACETONE). (Optional)
6. Rinse with 1 gallon of tap water. (deionized water may be substituted for tap water)
7. Rinse with 1 gallon of deionized water.
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. Rinse with distilled or potable water and isopropanol solution (DO NOT USE ACETONE). (Optional)
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. 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, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. 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.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

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, 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

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
- Phosphate-free detergent such as Liquinox®
- 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:

   a. Rinse with tap water
   b. Rinse with de-ionized water
   c. Solvent rinse with isopropanol (Optional)
   d. 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

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 (attached), 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 (attached).

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 or consistency
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)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.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*.

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books 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.

III. Equipment and Materials

- Log book
- Indelible pen

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. 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.

3. 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."

4. 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.

5. Daily entries will be made chronologically.

6. 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.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. 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.

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.

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 CH2M 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 CH2M to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

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
- Utility location subcontractors (hired by us)

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 CH2M 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

CH2M 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 CH2M as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M) 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 CH2M-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 CH2M 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. 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 CH2M, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 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 CH2M HILL 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 CH2M HILL 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 CH2M HILL (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 CH2M HILL.

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. CH2M HILL 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 CH2M HILL, 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 CH2M HILL 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 CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL 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 CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL'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 CH2M Hill 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
- Utility location subcontractors (hired by CH2M HILL)

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 “One Call” Services for Public Utility Mark-outs

Miss Utility or “One Call” service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The “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 Ms. 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 "One Call" services are free to the public. Note that the "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 "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 CH2M HILL 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, CH2M HILL 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, CH2M HILL 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			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

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 CH2M HILL 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.

CH2M HILL In-house Utility Location Experts

Steve Saville/KNV

Home Office Phone – 720-261-5367

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

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 notebook 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.

STANDARD OPERATING PROCEDURE

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 ^{o}C	+/- 1.0 ^{o}C
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.

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meter to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Air monitoring equipment
- Personal protective equipment
- Flow-through cell with inlet/outlet ports and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Purged water containers
- Sample containers
- Waste container labels
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Aluminum foil
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.

2. Calibrate instruments according to manufacturer's instructions.

3. Record well number, site, date, and condition in the field logbook.

4. Place plastic sheeting on the ground surrounding well head. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. Do not let any downhole equipment touch the ground.

5. Open the well and begin screening breathing zone with air monitoring device until sampling is complete, in accordance with the HASP.

6. All sampling equipment and any other equipment to be placed in the well must cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

7. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the tubing to the pump. Lower the pump slowly into the well and set it at approximately the middle of the screen, or wetted screen interval, and at least two feet above the bottom of the well to avoid disturbance of sediment. Submersible pumps should be lowered by the suspension cable rather than the discharge tubing.

8. Insert the water quality measurement probes into the flow-through cell and place in a shaded area. The purged groundwater must enter the flow through the cell by the lower port and exit via the upper port. Wrap exposed tubing and the flow through cell in aluminum foil to minimize heat loss/gain due to environmental conditions.

9. Generators and fuel, if used, must be located at least 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Begin purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

11. Contain purged water for placement in labeled 55-gallon drum or tank, as appropriate.

12. The water level should be monitored frequently during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum

capabilities of the pump (0.1- to 0.2-liter per minute) to minimize water level drawdown.

13. During purging, the field parameters must be measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

    - pH: within 0.1 pH units
    - Specific conductance: within 3 percent
    - Dissolved oxygen: within 10 percent
    - Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
    - ORP: within 10 mV
    - Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The pump should be allowed to operate at the same rate as the purge cycle until sampling begins, whereupon the discharge should be reduced to 0.1 L/m.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers.

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

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus. VOC vials should be capped slowly to prevent introduction of air bubbles in the sample. Once capped, the VOC vial should be inverted and tapped to detect the presence of air bubbles.

5. Immediately upon collection, all samples for chemical analysis are to be labeled and placed on ice.

6. Re-usable equipment must be cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, must be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, field screening, field chemistry, sampling method), volume of water purged prior to sampling, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.
2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization. Submersible pumps used in large diameter wells

should be equipped with a shroud to force water flow across the pump motor to dissipate heat build-up.

- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
  - Inspect sampling pump regularly and replace as warranted
  - Inspect quick-connects regularly and replace as warranted
  - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

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

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)
2. Well-construction materials (i.e., surface casing, screens, riser, casing, caps, bottom plugs, centering guides, sand, bentonite, grout, and surface-finish materials)
3. Development equipment

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.

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
- Override casings and core barrel

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

- Pure, additive-free bentonite pellets

- Pure, additive-free powdered bentonite

- 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)

DRAFT FINAL STANDARD OPERATING PROCEDURE – NAVY CLEAN PROGRAM

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 QSM 5.1 Table B-15. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

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.
- 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.

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:

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 field notebook/clipboard.

      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. Make sure to stake location after sample collection in case professional surveying is to be completed.

f. Repeat 1c and 1e above until all samples are collected from the area.

g. Or, a GPS unit can be used to identify each location based on map coordinates, if available.

2. For non-grid samples:

   a. 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).

   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. Make sure to stake location after sample collection in case professional surveying is to be completed.

   e. Repeat 2a through 2d 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.

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 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.

D. To collect 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:

   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. 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.

E. 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.

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.

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, 2017. Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs). September.

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

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 QSM 5.1 Table B-15. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Materials and Equipment

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
- 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

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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.

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.

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. 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.

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.

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.

DRAFT FINAL NAVY CLEAN STANDARD OPERATING PROCEDURE

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 QSM 5.1 Table B-15. Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

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.

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.

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.

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.

DRAFT FINAL STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

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 QSM 5.1 Table B-15. 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 under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

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])
  - 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

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[1] Geotech and Waterra offer PFAS free bailer options

    - 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

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).

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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.

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.

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. 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).

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 have been shown to be fluorine free.

V. 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, 2017. *Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs).* September

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

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 Multi RAE 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:

<u>Drum</u>

Glass tube – Procedure 1

COLIWASA	–	Procedure 2

<u>Storage Tank and Tank Trailer</u>

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).

Uses

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.

Procedures for Use

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.

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

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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.

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.

DRAFT FINAL STANDARD OPERATING PROCEDURE – Navy CLEAN PROGRAM

Direct-Push Groundwater Sample Collection for Per- and Polyfluoroalkyl Substances

I. Purpose and Scope

This SOP provides guidelines for groundwater sample collection using direct-push (e.g., Geoprobe®) for samples that will be analyzed for per- and polyfluoroalklyl substances (PFAS) via LC/MS/MS Compliant with QSM 5.1 Table B-15.

Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000. Materials, equipment, and procedures may vary; refer to the Sampling and Analysis Plan and operator's manuals for specific details.

II. Equipment and Materials

Equipment and Materials Required

- Direct-push (e.g., Geoprobe®) sampling rods and retractable stainless-steel screen without PFAS-containing components (Avoid Teflon, Viton, PTFE and all other fluorinated compounds)
- PFAS-free tubing (avoid Teflon, Viton, PTFE and other fluorinated compounds) and stainless-steel foot valve
  - High density polyethylene tubing (unlined)
  - Masterflex tubing for peristaltic pumps, Cole Parmer C-Flex (06424 series) and Tygon E-3603 (06509 series) are suitable options
- Peristaltic pump
- Pre-cleaned sample containers
- Air monitoring and water quality instruments (as needed)
- Personal protective equipment
- Groundwater sample containers (high density polyethylene [HDPE] with HDPE screw cap [no Teflon caps])
- PFAS-free shipping labels (if available[1]) materials
- Loose leaf paper or a wire-bound notebook without waterproof coating
- Metal clipboard
- Pen (not Sharpie)
- Nitrile or Latex gloves
- Laboratory prepared deionized, certified PFAS-free water for field blank collection

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] 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.

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.

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

1. Decontaminate slotted lead rod and other downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment* and this SOP.
2. Drive lead probe rod to the desired sampling depth, and withdraw rods 2 to 3 feet to expose the retractable screen to the aquifer formation. Ensure that the screened lead rod has been inserted to the desired sampling depth.
3. Insert the stainless-steel foot valve into the end of the polyethylene sampling tubing and insert tubing through the rods or insert peristaltic pump tubing through rods, depending on which method is used.
4. Purge groundwater and monitor water quality parameters until stable prior to sampling.
5. Fill all sample containers. Samples should be collected in accordance with SOP *Groundwater Sampling when Analyzing for Per- and Polyfluoroalkyl Substances (PFAS)***.** Affix labels after bottles have been closed; collect only one sample at a time to avoid mislabeling.

6. Remove polyethylene sampling tubing from the rods. Remove the foot valve and discard polyethylene tubing. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required. Verify that the borehole made during sampling activities has been properly backfilled.

Equipment Decontamination

Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations. Do not use water from the facility (e.g. fire hydrants) if there is a possibility that the water available is contaminated with PFAS.

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

Water quality meters typically do not contain PFAS. However, consistent with general sampling SOPs, disconnect the water quality meter prior to sampling.

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

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

I. Purpose and Scope

This SOP provides guidelines for managing waste containing per- and polyfluoalklyl substances (PFAS) in accordance with the *Interim Per- and Polyfluoralkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/September 2017 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.

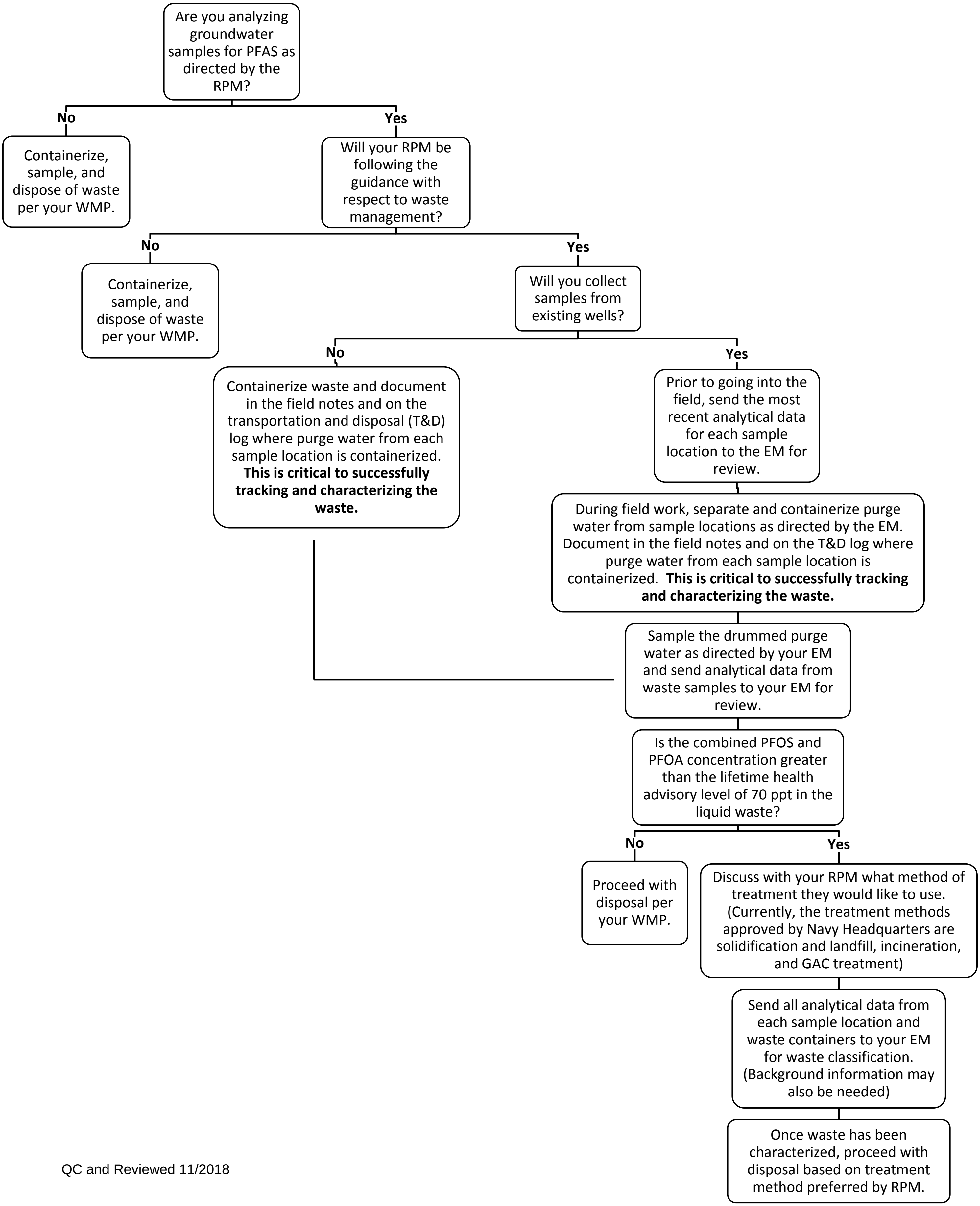
Standard procedures for managing liquid waste during PFAS investigation are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000.

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.

ch2m



Are you analyzing groundwater samples for PFAS as directed by the RPM?

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.

QC and Reviewed 11/2018

Appendix B
Laboratory Department of Defense ELAP Accreditation Letter

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 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.1.1 February 2018 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:*
November 17, 2016	December 20, 2018	February 28, 2021

Accreditation No.:	*Certificate No.:*
91667	L18-588

Tracy Szerszen
Tracy Szerszen
President/Operations Manager

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 17025:2005 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 5.1 Table B-15	LC/MS/MS	Perfluoro-1-octanesulfonamide (PFOSA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Sodium perfluoro-1-pentanesulfonate (PFPeS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-nonanesulfonate (PFNS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-heptanesulfonate (PFHpS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-ethylperfluoro-octanesulfonamidoacetic acid (NEtFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorohexane sulfonate (4:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorooctane sulfonate (6:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	1H,1H,2H,2H-Perfluorodecane sulfonate (8:2FTS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-butanoic Acid (PFBA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 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 5.1 Table B-15	LC/MS/MS	Perfluoro-n-pentanoic acid (PFPeA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-hexanoic acid (PFHxA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-heptanoic Acid (PFHpA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-octanoic Acid (PFOA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorononanoic acid (PFNA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-decanoic Acid (PFDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-undecanoic acid (PFUnA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-dodecanoic acid (PFDoA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-tridecanoic acid (PFTrDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-n-tetradecanoic acid (PFTeDA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-methylperfluoro-1-octanesulfonamidoacetic acid (NMeFOSAA)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-butanesulfonic Acid (PFBS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-hexanesulfonic Acid (PFHxS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-octanesulphonic Acid (PFOS)
Aqueous/Solids/Tissues	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoro-1-decanesulfonate (PFDS)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
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)
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)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 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	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
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 8270D MOD	GC-MS	1,4-Dichlorobenzene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	1-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	1-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,5'-Octachlorobiphenyl (BZ 194)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (BZ 207)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',6,6'-Octachlorobiphenyl (BZ 197)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4',6-Heptachlorobiphenyl (BZ 171)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (BZ 208)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6-Octachlorobiphenyl (BZ 198)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5',6'-Octachlorobiphenyl (BZ 199)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,5'-Heptachlorobiphenyl (BZ 172)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6,6'-Octachlorobiphenyl (BZ 200)

Certificate of Accreditation: Supplement

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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 8270D MOD	GC-MS	2,2',3,3',4,5',6,6'-Octachlorobiphenyl (BZ 201)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6-Heptachlorobiphenyl (BZ 173)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5,6'-Heptachlorobiphenyl (BZ 174)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5',6-Heptachlorobiphenyl (BZ 175)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5',6'-Heptachlorobiphenyl (BZ 177)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,5'-Hexachlorobiphenyl (BZ 130)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,6,6'-Heptachlorobiphenyl (BZ 176)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4,6-Hexachlorobiphenyl (BZ 131)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',4-Pentachlorobiphenyl (BZ 82)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,5',6,6'-Octachlorobiphenyl (BZ 202)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,5',6-Heptachlorobiphenyl (BZ 178)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6,6'-Heptachlorobiphenyl (BZ 179)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6-Hexachlorobiphenyl (BZ 134)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5,6'-Hexachlorobiphenyl (BZ 135)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',5-Pentachlorobiphenyl (BZ 83)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',6,6'-Hexachlorobiphenyl (BZ 136)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3',6-Pentachlorobiphenyl (BZ 84)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,3'-Tetrachlorobiphenyl (BZ 40)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5,5',6-Octachlorobiphenyl (BZ 203)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5,5'-Heptachlorobiphenyl (BZ 180)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5',6-Heptachlorobiphenyl (BZ 183)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5-Hexachlorobiphenyl (BZ 137)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',5'-Hexachlorobiphenyl (BZ 138)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6,6'-Heptachlorobiphenyl (BZ 184)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6-Hexachlorobiphenyl (BZ 139)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4',6'-Hexachlorobiphenyl (BZ 140)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,4'-Pentachlorobiphenyl (BZ 85)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5,5',6-Heptachlorobiphenyl (BZ 185)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,5',6-Heptachlorobiphenyl (BZ 187)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5,5'-Hexachlorobiphenyl (BZ 141)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,5'-Hexachlorobiphenyl (BZ 146)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5,6,6'-Heptachlorobiphenyl (BZ 188)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5',6-Hexachlorobiphenyl (BZ 149)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5',6-Hexachlorobiphenyl (BZ 144)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4,5'-Pentachlorobiphenyl (BZ 87)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',5'-Pentachlorobiphenyl (BZ 97)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4',6-Pentachlorobiphenyl (BZ 91)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4-Tetrachlorobiphenyl (BZ 41)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,4'-Tetrachlorobiphenyl (BZ 42)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5,5',6-Hexachlorobiphenyl (BZ 151)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5,5'-Pentachlorobiphenyl (BZ 92)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5',6-Pentachlorobiphenyl (BZ 95)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5-Tetrachlorobiphenyl (BZ 43)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,5'-Tetrachlorobiphenyl (BZ 44)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,6'-Tetrachlorobiphenyl (BZ 46)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3,6-Tetrachlorobiphenyl (BZ 45)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',3-Trichlorobiphenyl (BZ 16)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5,5'-Hexachlorobiphenyl (BZ 153)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5,6'-Hexachlorobiphenyl (BZ 154)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',5-Pentachlorobiphenyl (BZ 99)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',6,6'-Hexachlorobiphenyl (BZ 155)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4',6-Pentachlorobiphenyl (BZ 100)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,4'-Tetrachlorobiphenyl (BZ 47)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5,5'-Pentachlorobiphenyl (BZ 101)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5-Tetrachlorobiphenyl (BZ 48)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,5'-Tetrachlorobiphenyl (BZ 49)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6,6'-Pentachlorobiphenyl (BZ 104)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6'-Tetrachlorobiphenyl (BZ 51)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4,6-Tetrachlorobiphenyl (BZ 50)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',4-Trichlorobiphenyl (BZ 17)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5,5'-Tetrachlorobiphenyl (BZ 52)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5,6'-Tetrachlorobiphenyl (BZ 53)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',5-Trichlorobiphenyl (BZ 18)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',6,6'-Tetrachlorobiphenyl (BZ 54)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2',6-Trichlorobiphenyl (BZ 19)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,2'-Dichlorobiphenyl (BZ 4)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,5',6-Octachlorobiphenyl (BZ 205)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5,6-Heptachlorobiphenyl (BZ 190)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5',6-Heptachlorobiphenyl (BZ 191)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5-Hexachlorobiphenyl (BZ 156)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 157)

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4',6-Hexachlorobiphenyl (BZ 158)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5,5',6-Heptachlorobiphenyl (BZ 193)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5,6-Hexachlorobiphenyl (BZ 163)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',5',6-Hexachlorobiphenyl (BZ 164)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4',6-Pentachlorobiphenyl (BZ 110)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,3',4'-Tetrachlorobiphenyl (BZ 56)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',5,6-Hexachlorobiphenyl (BZ 166)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',5-Pentachlorobiphenyl (BZ 114)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5-Pentachlorobiphenyl (BZ 118)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4',5'-Pentachlorobiphenyl (BZ 123)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4',6-Pentachlorobiphenyl (BZ 115)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4,4'-Tetrachlorobiphenyl (BZ 60)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,4'-Tetrachlorobiphenyl (BZ 66)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5,5'-Pentachlorobiphenyl (BZ 124)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5',6-Pentachlorobiphenyl (BZ 125)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4',5-Tetrachlorobiphenyl (BZ 63)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4,5-Tetrachlorobiphenyl (BZ 67)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',5-Tetrachlorobiphenyl (BZ 70)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4',6-Tetrachlorobiphenyl (BZ 64)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4',6-Tetrachlorobiphenyl (BZ 71)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,4'-Trichlorobiphenyl (BZ 22)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4-Trichlorobiphenyl (BZ 25)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',4'-Trichlorobiphenyl (BZ 33)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',5-Trichlorobiphenyl (BZ 26)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,5-Trimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3,6-Trichlorobiphenyl (BZ 24)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3',6-Trichlorobiphenyl (BZ 27)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3-Dichlorobiphenyl (BZ 5)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,3'-Dichlorobiphenyl (BZ 6)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4',5-Tetrachlorobiphenyl (BZ 74)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4',6-Tetrachlorobiphenyl (BZ 75)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,4'-Trichlorobiphenyl (BZ 28)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4,5-Trichlorobiphenyl (BZ 29)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4',5-Trichlorobiphenyl (BZ 31)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 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 8270D MOD	GC-MS	2,4,6-Trichlorobiphenyl (BZ 30)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4',6-Trichlorobiphenyl (BZ 32)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDD
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDE
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-DDT
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4-Dichlorobiphenyl (BZ 7)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,4'-Dichlorobiphenyl (BZ 8)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,5-Dichlorobiphenyl (BZ 9)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2,6-Dimethylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Chlorobiphenyl (BZ 1)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Chloronaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Methylnaphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	2-Methylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4',5-Pentachlorobiphenyl (BZ 126)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,4'-Tetrachlorobiphenyl (BZ 77)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',4,5,5'-Pentachlorobiphenyl (BZ 127)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3',5,5'-Tetrachlorobiphenyl (BZ 80)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,3'-Dichlorobiphenyl (BZ 11)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4,4',5-Tetrachlorobiphenyl (BZ 81)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4,4'-Trichlorobiphenyl (BZ 37)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4-Dichlorobiphenyl (BZ 12)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,4'-Dichlorobiphenyl (BZ 13)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	3,6-Dimethylphenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	4,4'-Dichlorobiphenyl (BZ 15)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	4-Chlorobiphenyl (BZ 3)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Acenaphthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Acenaphthylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(a)anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(a)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(b)thiophene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(e)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Benzo(k)fluoranthene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 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 8270D MOD	GC-MS	Biphenyl
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Chrysene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	cis-Decalin
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Decachlorobiphenyl (BZ 209)
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenz(a,h)anthracene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenzofuran
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Dibenzothiophene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Fluoranthene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Fluorene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	lndeno(l,2,3-cd)pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Naphthalene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Perylene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Phenanthrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	Pyrene
Aqueous/Solid/Tissue	EPA 8270D MOD	GC-MS	trans-Decalin

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 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	EPA 3510 C	Separatory Funnel	Prep
Aqueous	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Aqueous	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Solid	EPA 3660B MOD	Sulfur Cleanup	Cleanup
Solid	NOAA NOS ORCA 71	Orbital Shaker	Prep
Tissue	EPA 3640A MOD	Gel-permeation chromatography (GPC)	Cleanup
Tissue	EPA 3660B MOD	Sulfur Cleanup	Cleanup
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

7979 Innovation Park Drive, Baton Rouge, LA 70820

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the DoD Quality Systems Manual for Environmental Laboratories Version 5.1.1 February 2018 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 27, 2018	December 27, 2020

Accreditation No.:	*Certificate No.:*
74960	L18-597

Tracy Szerszen
President/Operations Manager

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 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

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	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
Aqueous	EPA 300.0	IC	Nitrite as N

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 420.4	FIA	Total Phenolics (4AAP)
Aqueous	EPA 624	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous	EPA 624	GC-MS	1,1,1-Trichloroethane
Aqueous	EPA 624	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous	EPA 624	GC-MS	1,1,2-Trichloroethane
Aqueous	EPA 624	GC-MS	1,1-Dichloroethane
Aqueous	EPA 624	GC-MS	1,1-Dichloroethene
Aqueous	EPA 624	GC-MS	1,1-Dichloropropene
Aqueous	EPA 624	GC-MS	1,2 Dichlorobenzene
Aqueous	EPA 624	GC-MS	1,2 Dichloroethane
Aqueous	EPA 624	GC-MS	1,2,3-Trichlorobenzene
Aqueous	EPA 624	GC-MS	1,2,3-Trichloropropane
Aqueous	EPA 624	GC-MS	1,2,4-Trichlorobenzene
Aqueous	EPA 624	GC-MS	1,2,4-Trimethylbenzene
Aqueous	EPA 624	GC-MS	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous	EPA 624	GC-MS	1,2-Dibromoethane (EDB)
Aqueous	EPA 624	GC-MS	1,2-Dichloropropane
Aqueous	EPA 624	GC-MS	1,3 Dichlorobenzene
Aqueous	EPA 624	GC-MS	1,3,5-Trimethylbenzene
Aqueous	EPA 624	GC-MS	1,3-Dichloropropane
Aqueous	EPA 624	GC-MS	1,4 Dichlorobenzene
Aqueous	EPA 624	GC-MS	2,2-Dichloropropane
Aqueous	EPA 624	GC-MS	2-Butanone (MEK)
Aqueous	EPA 624	GC-MS	2-Chloroethylvinylether
Aqueous	EPA 624	GC-MS	2-Chlorotoluene
Aqueous	EPA 624	GC-MS	2-Hexanone
Aqueous	EPA 624	GC-MS	4-Chlorotoluene
Aqueous	EPA 624	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous	EPA 624	GC-MS	Acetone
Aqueous	EPA 624	GC-MS	Acetonitrile
Aqueous	EPA 624	GC-MS	Acrolein
Aqueous	EPA 624	GC-MS	Acrylonitrile
Aqueous	EPA 624	GC-MS	Benzene
Aqueous	EPA 624	GC-MS	Bromochloromethane
Aqueous	EPA 624	GC-MS	Bromodichloromethane

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 624	GC-MS	Bromoform
Aqueous	EPA 624	GC-MS	Bromomethane
Aqueous	EPA 624	GC-MS	Carbon disulfide
Aqueous	EPA 624	GC-MS	Carbon tetrachloride
Aqueous	EPA 624	GC-MS	Chlorobenzene
Aqueous	EPA 624	GC-MS	Chloroethane
Aqueous	EPA 624	GC-MS	Chloroform
Aqueous	EPA 624	GC-MS	Chloromethane
Aqueous	EPA 624	GC-MS	cis-1,2-Dichloroethene
Aqueous	EPA 624	GC-MS	cis-1,3-Dichloropropylene
Aqueous	EPA 624	GC-MS	Dibromochloromethane
Aqueous	EPA 624	GC-MS	Dibromomethane
Aqueous	EPA 624	GC-MS	Dichlorodifluoromethane
Aqueous	EPA 624	GC-MS	Ethylbenzene
Aqueous	EPA 624	GC-MS	Hexachlorobutadiene
Aqueous	EPA 624	GC-MS	Isopropylbenzene
Aqueous	EPA 624	GC-MS	m+p-Xylene
Aqueous	EPA 624	GC-MS	Methyl tert-butyl ether (MTBE)
Aqueous	EPA 624	GC-MS	Methylene Chloride
Aqueous	EPA 624	GC-MS	Naphthalene
Aqueous	EPA 624	GC-MS	n-Butylbenzene
Aqueous	EPA 624	GC-MS	n-Propylbenzene
Aqueous	EPA 624	GC-MS	o-Xylene
Aqueous	EPA 624	GC-MS	p-Isopropyltoluene
Aqueous	EPA 624	GC-MS	sec-Butylbenzene
Aqueous	EPA 624	GC-MS	Styrene
Aqueous	EPA 624	GC-MS	tert-Butylbenzene
Aqueous	EPA 624	GC-MS	Tetrachloroethene
Aqueous	EPA 624	GC-MS	Toluene
Aqueous	EPA 624	GC-MS	trans-1,2-Dichloroethene
Aqueous	EPA 624	GC-MS	trans-1,3-Dichloropropene
Aqueous	EPA 624	GC-MS	Trichloroethene
Aqueous	EPA 624	GC-MS	Trichlorofluoromethane
Aqueous	EPA 624	GC-MS	Vinyl acetate
Aqueous	EPA 624	GC-MS	Vinyl chloride
Aqueous	EPA 624	GC-MS	Xylenes, total

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 625	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous	EPA 625	GC-MS	1,2,4-Trichlorobenzene
Aqueous	EPA 625	GC-MS	1-Methylnaphthalene
Aqueous	EPA 625	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous	EPA 625	GC-MS	2,4,5-Trichlorophenol
Aqueous	EPA 625	GC-MS	2,4,6-Trichlorophenol
Aqueous	EPA 625	GC-MS	2,4-Dichlorophenol
Aqueous	EPA 625	GC-MS	2,4-Dimethylphenol
Aqueous	EPA 625	GC-MS	2,4-Dinitrophenol
Aqueous	EPA 625	GC-MS	2,4-Dinitrotoluene
Aqueous	EPA 625	GC-MS	2,6-Dichlorophenol
Aqueous	EPA 625	GC-MS	2,6-Dinitrotoluene
Aqueous	EPA 625	GC-MS	2-Chloronaphthalene
Aqueous	EPA 625	GC-MS	2-Chlorophenol
Aqueous	EPA 625	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous	EPA 625	GC-MS	2-Methylnaphthalene
Aqueous	EPA 625	GC-MS	2-Methylphenol
Aqueous	EPA 625	GC-MS	2-Nitroaniline
Aqueous	EPA 625	GC-MS	2-Nitrophenol
Aqueous	EPA 625	GC-MS	3,3'-Dichlorobenzidine
Aqueous	EPA 625	GC-MS	3-Nitroaniline
Aqueous	EPA 625	GC-MS	4-Bromophenyl-phenylether
Aqueous	EPA 625	GC-MS	4-Chloro-3-methylphenol
Aqueous	EPA 625	GC-MS	4-Chloroaniline
Aqueous	EPA 625	GC-MS	4-Chlorophenyl-phenylether
Aqueous	EPA 625	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous	EPA 625	GC-MS	4-Nitroaniline
Aqueous	EPA 625	GC-MS	4-Nitrophenol
Aqueous	EPA 625	GC-MS	Acenaphthene
Aqueous	EPA 625	GC-MS	Acenaphthylene
Aqueous	EPA 625	GC-MS	Aniline
Aqueous	EPA 625	GC-MS	Anthracene
Aqueous	EPA 625	GC-MS	Benzidine
Aqueous	EPA 625	GC-MS	Benzo(a)anthracene
Aqueous	EPA 625	GC-MS	Benzo(a)pyrene
Aqueous	EPA 625	GC-MS	Benzo(b)fluoranthene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous	EPA 625	GC-MS	Benzo(g,h,i)perylene
Aqueous	EPA 625	GC-MS	Benzo(k)fluoranthene
Aqueous	EPA 625	GC-MS	Benzoic acid
Aqueous	EPA 625	GC-MS	Benzyl alcohol
Aqueous	EPA 625	GC-MS	bis(2-Chloroethoxy)methane
Aqueous	EPA 625	GC-MS	bis(2-Chloroethyl)ether
Aqueous	EPA 625	GC-MS	bis(2-Chloroiospropyl) ether
Aqueous	EPA 625	GC-MS	bis(2-ethylhexyl) phthalate
Aqueous	EPA 625	GC-MS	Butyl benzyl phthalate
Aqueous	EPA 625	GC-MS	Carbazole
Aqueous	EPA 625	GC-MS	Chrysene
Aqueous	EPA 625	GC-MS	Dibenzo(a,h)anthracene
Aqueous	EPA 625	GC-MS	Dibenzofuran
Aqueous	EPA 625	GC-MS	Diethyl phthalate
Aqueous	EPA 625	GC-MS	Dimethyl phthalate
Aqueous	EPA 625	GC-MS	Di-n-butylphthalate
Aqueous	EPA 625	GC-MS	Di-n-octylphthalate
Aqueous	EPA 625	GC-MS	Fluoranthene
Aqueous	EPA 625	GC-MS	Fluorene
Aqueous	EPA 625	GC-MS	Hexachlorobenzene
Aqueous	EPA 625	GC-MS	Hexachlorocyclopentadiene
Aqueous	EPA 625	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous	EPA 625	GC-MS	Isophorone
Aqueous	EPA 625	GC-MS	Naphthalene
Aqueous	EPA 625	GC-MS	Nitrobenzene
Aqueous	EPA 625	GC-MS	N-Nitrosodiethylamine
Aqueous	EPA 625	GC-MS	N-Nitrosodimethylamine
Aqueous	EPA 625	GC-MS	N-Nitroso-di-n-propylamine
Aqueous	EPA 625	GC-MS	N-Nitrosodiphenylamine
Aqueous	EPA 625	GC-MS	o-Toluidine
Aqueous	EPA 625	GC-MS	Pentachlorobenzene
Aqueous	EPA 625	GC-MS	Pentachlorophenol
Aqueous	EPA 625	GC-MS	Phenanthrene
Aqueous	EPA 625	GC-MS	Phenol
Aqueous	EPA 625	GC-MS	Pyrene
Aqueous	EPA 625	GC-MS	Pyridine

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
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)
Aqueous	EPA 8081B	GC-ECD	Diallate
Aqueous	EPA 9040C	pH Meter	Corrosivity (pH)
Aqueous	HACH 8000	Spectrophotometer	COD
Aqueous	RSK175	GC-FID	Acetylene
Aqueous	RSK175	GC-FID	Butane
Aqueous	RSK175	GC-TCD	Carbon Dioxide
Aqueous	RSK175	GC-FID	Ethane
Aqueous	RSK175	GC-FID	Ethene
Aqueous	RSK175	GC-FID	Methane
Aqueous	RSK175	GC-FID	Propane
Aqueous	SM 2130B	Turbidimetric	Turbidity
Aqueous	HACH 10242	Spectrophotometer	Total Kieldahl Nitrogen
Aqueous	SM 2310B	Titration	Acidity(as CaCO3)
Aqueous	SM 2320B	Titration	Total Alkalinity(as CaCO3)
Aqueous	SM 2340 B	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-Cl E	Autotitrator	Chloride
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 9020B	TOX Analyzer	Total Organic Halides
Drinking Water	EPA 537	LC/MS/MS	NMeFOSAA
Drinking Water	EPA 537	LC/MS/MS	NEtFOSAA
Drinking Water	EPA 537	LC/MS/MS	PFBS
Drinking Water	EPA 537	LC/MS/MS	PFDA

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Drinking Water	EPA 537	LC/MS/MS	PFDoA
Drinking Water	EPA 537	LC/MS/MS	PFHpA
Drinking Water	EPA 537	LC/MS/MS	PFHxS
Drinking Water	EPA 537	LC/MS/MS	PFHxA
Drinking Water	EPA 537	LC/MS/MS	PFNA
Drinking Water	EPA 537	LC/MS/MS	PFOS
Drinking Water	EPA 537	LC/MS/MS	PFOA
Drinking Water	EPA 537	LC/MS/MS	PFTA
Drinking Water	EPA 537	LC/MS/MS	PFTrDA
Drinking Water	EPA 537	LC/MS/MS	PFUnA
Solid	EPA 1030	N/A	Ignitability
Solid	EPA 3060A	N/A	Hexavalent Chromium Preparation
Solid	EPA 7471B	CVAA	Mercury
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 6020A	ICP-MS	Aluminum
Aqueous/Solid	EPA 6020A	ICP-MS	Antimony
Aqueous/Solid	EPA 6020A	ICP-MS	Arsenic
Aqueous/Solid	EPA 6020A	ICP-MS	Barium
Aqueous/Solid	EPA 6020A	ICP-MS	Beryllium
Aqueous/Solid	EPA 6020A	ICP-MS	Cadmium
Aqueous/Solid	EPA 6020A	ICP-MS	Calcium
Aqueous/Solid	EPA 6020A	ICP-MS	Chromium
Aqueous/Solid	EPA 6020A	ICP-MS	Cobalt
Aqueous/Solid	EPA 6020A	ICP-MS	Copper
Aqueous/Solid	EPA 6020A	ICP-MS	Iron
Aqueous/Solid	EPA 6020A	ICP-MS	Lead
Aqueous/Solid	EPA 6020A	ICP-MS	Magnesium
Aqueous/Solid	EPA 6020A	ICP-MS	Manganese

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 6020A	ICP-MS	Molybdenum
Aqueous/Solid	EPA 6020A	ICP-MS	Nickel
Aqueous/Solid	EPA 6020A	ICP-MS	Potassium
Aqueous/Solid	EPA 6020A	ICP-MS	Selenium
Aqueous/Solid	EPA 6020A	ICP-MS	Silver
Aqueous/Solid	EPA 6020A	ICP-MS	Sodium
Aqueous/Solid	EPA 6020A	ICP-MS	Strontium
Aqueous/Solid	EPA 6020A	ICP-MS	Thallium
Aqueous/Solid	EPA 6020A	ICP-MS	Tin
Aqueous/Solid	EPA 6020A	ICP-MS	Titanium
Aqueous/Solid	EPA 6020A	ICP-MS	Vanadium
Aqueous/Solid	EPA 6020A	ICP-MS	Zinc
Aqueous/Solid	EPA 6020A	ICP-MS	Zirconium
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	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

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 6020B	ICP-MS	Titanium
Aqueous/Solid	EPA 6020B	ICP-MS	Vanadium
Aqueous/Solid	EPA 6020B	ICP-MS	Zinc
Aqueous/Solid	EPA 6020B	ICP-MS	Zirconium
Aqueous/Solid	EPA 7196A	Spectrophotometer	Chromium VI
Aqueous/Solid	EPA 8015C	GC-FID	Diesel
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

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
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
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	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,1,1-Trichloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,1,2-trichloro-1,2,2-trifluoroethane

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260B	GC-MS	1,1,2-Trichloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,1-Dichloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,1-Dichloroethene
Aqueous/Solid	EPA 8260B	GC-MS	1,1-Dichloropropene
Aqueous/Solid	EPA 8260B	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,2 Dichloroethane
Aqueous/Solid	EPA 8260B	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,2,3-Trichloropropane
Aqueous/Solid	EPA 8260B	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous/Solid	EPA 8260B	GC-MS	1,2-Dibromoethane (EDB)
Aqueous/Solid	EPA 8260B	GC-MS	1,2-Dichloropropane
Aqueous/Solid	EPA 8260B	GC-MS	1,3 Dichlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	1,3-Dichloropropane
Aqueous/Solid	EPA 8260B	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	1-Chlorohexane
Aqueous/Solid	EPA 8260B	GC-MS	2,2-Dichloropropane
Aqueous/Solid	EPA 8260B	GC-MS	2-Butanone (MEK)
Aqueous/Solid	EPA 8260B	GC-MS	2-Chloroethylvinylether
Aqueous/Solid	EPA 8260B	GC-MS	2-Chlorotoluene
Aqueous/Solid	EPA 8260B	GC-MS	2-Hexanone
Aqueous/Solid	EPA 8260B	GC-MS	4-Chlorotoluene
Aqueous/Solid	EPA 8260B	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solid	EPA 8260B	GC-MS	Acetone
Aqueous/Solid	EPA 8260B	GC-MS	Acetonitrile
Aqueous/Solid	EPA 8260B	GC-MS	Acrolein
Aqueous/Solid	EPA 8260B	GC-MS	Acrylonitrile
Aqueous/Solid	EPA 8260B	GC-MS	Benzene
Aqueous/Solid	EPA 8260B	GC-MS	Bromobenzene
Aqueous/Solid	EPA 8260B	GC-MS	Bromochloromethane
Aqueous/Solid	EPA 8260B	GC-MS	Bromodichloromethane
Aqueous/Solid	EPA 8260B	GC-MS	Bromoform
Aqueous/Solid	EPA 8260B	GC-MS	Bromomethane

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260B	GC-MS	Carbon disulfide
Aqueous/Solid	EPA 8260B	GC-MS	Carbon tetrachloride
Aqueous/Solid	EPA 8260B	GC-MS	Chlorobenzene
Aqueous/Solid	EPA 8260B	GC-MS	Chloroethane
Aqueous/Solid	EPA 8260B	GC-MS	Chloroform
Aqueous/Solid	EPA 8260B	GC-MS	Chloromethane
Aqueous/Solid	EPA 8260B	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B	GC-MS	cis-1,3-Dichloropropylene
Aqueous/Solid	EPA 8260B	GC-MS	Dibromochloromethane
Aqueous/Solid	EPA 8260B	GC-MS	Dibromomethane
Aqueous/Solid	EPA 8260B	GC-MS	Dichlorodifluoromethane
Aqueous/Solid	EPA 8260B	GC-MS	DIPE
Aqueous/Solid	EPA 8260B	GC-MS	ETBE
Aqueous/Solid	EPA 8260B	GC-MS	Ethylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8260B	GC-MS	Isopropylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	m+p-Xylene
Aqueous/Solid	EPA 8260B	GC-MS	Methyl tert-butyl ether (MTBE)
Aqueous/Solid	EPA 8260B	GC-MS	Methylcyclohexane
Aqueous/Solid	EPA 8260B	GC-MS	Methylene Chloride
Aqueous/Solid	EPA 8260B	GC-MS	Methyl Acetate
Aqueous/Solid	EPA 8260B	GC-MS	MTBE
Aqueous/Solid	EPA 8260B	GC-MS	Naphthalene
Aqueous/Solid	EPA 8260B	GC-MS	n-Butylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	n-Propylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	o-Xylene
Aqueous/Solid	EPA 8260B	GC-MS	p-Isopropyltoluene
Aqueous/Solid	EPA 8260B	GC-MS	sec-Butylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	Styrene
Aqueous/Solid	EPA 8260B	GC-MS	TAME
Aqueous/Solid	EPA 8260B	GC-MS	tert-Butyl alcohol
Aqueous/Solid	EPA 8260B	GC-MS	tert-Butylbenzene
Aqueous/Solid	EPA 8260B	GC-MS	Tetrachloroethene
Aqueous/Solid	EPA 8260B	GC-MS	Toluene
Aqueous/Solid	EPA 8260B	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solid	EPA 8260B	GC-MS	trans-1,3-Dichloropropene

Certificate of Accreditation: Supplement

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Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260B	GC-MS	Trichloroethene
Aqueous/Solid	EPA 8260B	GC-MS	Trichlorofluoromethane
Aqueous/Solid	EPA 8260B	GC-MS	Vinyl acetate
Aqueous/Solid	EPA 8260B	GC-MS	Vinyl chloride
Aqueous/Solid	EPA 8260B	GC-MS	Xylenes, total
Aqueous/Solid	EPA 8260B	GC-MS VOC	Cyclohexane
Aqueous/Solid	EPA 8260B	GC-MS VOC	Ethyl Acetate
Aqueous/Solid	EPA 8260B	GC-MS VOC	n-Butanol
Aqueous/Solid	EPA 8260C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1,2-trichloro-1,2,2-trifluoroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1,2-Trichloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1-Dichloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,1-Dichloroethene
Aqueous/Solid	EPA 8260C	GC-MS	1,1-Dichloropropene
Aqueous/Solid	EPA 8260C	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,2 Dichloroethane
Aqueous/Solid	EPA 8260C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solid	EPA 8260C	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,2-Dibromo-3-chloropropane (DBCP)
Aqueous/Solid	EPA 8260C	GC-MS	1,2-Dibromoethane (EDB)
Aqueous/Solid	EPA 8260C	GC-MS	1,2-Dichloropropane
Aqueous/Solid	EPA 8260C	GC-MS	1,3 Dichlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	1,3-Dichloropropane
Aqueous/Solid	EPA 8260C	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	1-Chlorohexane
Aqueous/Solid	EPA 8260C	GC-MS	2,2-Dichloropropane
Aqueous/Solid	EPA 8260C	GC-MS	2-Butanone (MEK)
Aqueous/Solid	EPA 8260C	GC-MS	2-Chloroethylvinylether
Aqueous/Solid	EPA 8260C	GC-MS	2-Chlorotoluene
Aqueous/Solid	EPA 8260C	GC-MS	2-Hexanone

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260C	GC-MS	4-Chlorotoluene
Aqueous/Solid	EPA 8260C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solid	EPA 8260C	GC-MS	Acetone
Aqueous/Solid	EPA 8260C	GC-MS	Acetonitrile
Aqueous/Solid	EPA 8260C	GC-MS	Acrolein
Aqueous/Solid	EPA 8260C	GC-MS	Acrylonitrile
Aqueous/Solid	EPA 8260C	GC-MS	Benzene
Aqueous/Solid	EPA 8260C	GC-MS	Bromobenzene
Aqueous/Solid	EPA 8260C	GC-MS	Bromochloromethane
Aqueous/Solid	EPA 8260C	GC-MS	Bromodichloromethane
Aqueous/Solid	EPA 8260C	GC-MS	Bromoform
Aqueous/Solid	EPA 8260C	GC-MS	Bromomethane
Aqueous/Solid	EPA 8260C	GC-MS	Carbon disulfide
Aqueous/Solid	EPA 8260C	GC-MS	Carbon tetrachloride
Aqueous/Solid	EPA 8260C	GC-MS	Chlorobenzene
Aqueous/Solid	EPA 8260C	GC-MS	Chloroethane
Aqueous/Solid	EPA 8260C	GC-MS	Chloroform
Aqueous/Solid	EPA 8260C	GC-MS	Chloromethane
Aqueous/Solid	EPA 8260C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solid	EPA 8260C	GC-MS	cis-1,3-Dichloropropylene
Aqueous/Solid	EPA 8260C	GC-MS	Dibromochloromethane
Aqueous/Solid	EPA 8260C	GC-MS	Dibromomethane
Aqueous/Solid	EPA 8260C	GC-MS	Dichlorodifluoromethane
Aqueous/Solid	EPA 8260C	GC-MS	DIPE
Aqueous/Solid	EPA 8260C	GC-MS	ETBE
Aqueous/Solid	EPA 8260C	GC-MS	Ethylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8260C	GC-MS	Isopropylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	m+p-Xylene
Aqueous/Solid	EPA 8260C	GC-MS	Methyl tert-butyl ether (MTBE)
Aqueous/Solid	EPA 8260C	GC-MS	Methylcyclohexane
Aqueous/Solid	EPA 8260C	GC-MS	Methylene Chloride
Aqueous/Solid	EPA 8260C	GC-MS	Methyl Acetate
Aqueous/Solid	EPA 8260C	GC-MS	MTBE
Aqueous/Solid	EPA 8260C	GC-MS	Naphthalene
Aqueous/Solid	EPA 8260C	GC-MS	n-Butylbenzene

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8260C	GC-MS	n-Propylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	o-Xylene
Aqueous/Solid	EPA 8260C	GC-MS	p-Isopropyltoluene
Aqueous/Solid	EPA 8260C	GC-MS	sec-Butylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	Styrene
Aqueous/Solid	EPA 8260C	GC-MS	TAME
Aqueous/Solid	EPA 8260C	GC-MS	tert-Butyl alcohol
Aqueous/Solid	EPA 8260C	GC-MS	tert-Butylbenzene
Aqueous/Solid	EPA 8260C	GC-MS	Tetrachloroethene
Aqueous/Solid	EPA 8260C	GC-MS	Toluene
Aqueous/Solid	EPA 8260C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solid	EPA 8260C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solid	EPA 8260C	GC-MS	Trichloroethene
Aqueous/Solid	EPA 8260C	GC-MS	Trichlorofluoromethane
Aqueous/Solid	EPA 8260C	GC-MS	Vinyl acetate
Aqueous/Solid	EPA 8260C	GC-MS	Vinyl chloride
Aqueous/Solid	EPA 8260C	GC-MS	Xylenes, total
Aqueous/Solid	EPA 8260C	GC-MS VOC	Cyclohexane
Aqueous/Solid	EPA 8260C	GC-MS VOC	Ethyl Acetate
Aqueous/Solid	EPA 8260C	GC-MS VOC	n-Butanol
Aqueous/Solid	EPA 8270C	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solid	EPA 8270C	GC-MS	1,3 Dichlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270C	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4-Dichlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4-Dimethylphenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4-Dinitrophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8270C	GC-MS	2,6-Dichlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2,6-Dinitrotoluene

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C	GC-MS	2-Chloronaphthalene
Aqueous/Solid	EPA 8270C	GC-MS	2-Chlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous/Solid	EPA 8270C	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C	GC-MS	2-Methylphenol
Aqueous/Solid	EPA 8270C	GC-MS	2-Nitroaniline
Aqueous/Solid	EPA 8270C	GC-MS	2-Nitrophenol
Aqueous/Solid	EPA 8270C	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solid	EPA 8270C	GC-MS	3-Nitroaniline
Aqueous/Solid	EPA 8270C	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solid	EPA 8270C	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solid	EPA 8270C	GC-MS	4-Chloroaniline
Aqueous/Solid	EPA 8270C	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solid	EPA 8270C	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous/Solid	EPA 8270C	GC-MS	4-Nitroaniline
Aqueous/Solid	EPA 8270C	GC-MS	4-Nitrophenol
Aqueous/Solid	EPA 8270C	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C	GC-MS	Acetophenone
Aqueous/Solid	EPA 8270C	GC-MS	Aniline
Aqueous/Solid	EPA 8270C	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C	GC-MS	Atrazine
Aqueous/Solid	EPA 8270C	GC-MS	Benzaldehyde
Aqueous/Solid	EPA 8270C	GC-MS	Benzidine
Aqueous/Solid	EPA 8270C	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270C	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C	GC-MS	Benzoic acid
Aqueous/Solid	EPA 8270C	GC-MS	Benzyl alcohol
Aqueous/Solid	EPA 8270C	GC-MS	Biphenyl
Aqueous/Solid	EPA 8270C	GC-MS	bis(2-Chloroethoxy)methane
Aqueous/Solid	EPA 8270C	GC-MS	bis(2-Chloroethyl)ether
Aqueous/Solid	EPA 8270C	GC-MS	bis(2-Chloroiospropyl) ether
Aqueous/Solid	EPA 8270C	GC-MS	bis(2-ethylhexyl) phthalate

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C	GC-MS	bis(2-ethylhexyl) phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Caprolactom
Aqueous/Solid	EPA 8270C	GC-MS	Carbazole
Aqueous/Solid	EPA 8270C	GC-MS	Carbazole
Aqueous/Solid	EPA 8270C	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270C	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270C	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270C	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270C	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Dimethyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Dimethyl phthalate
Aqueous/Solid	EPA 8270C	GC-MS	Di-n-butylphthalate
Aqueous/Solid	EPA 8270C	GC-MS	Di-n-butylphthalate
Aqueous/Solid	EPA 8270C	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270C	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270C	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solid	EPA 8270C	GC-MS	Hexachloroethane
Aqueous/Solid	EPA 8270C	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270C	GC-MS	Isophorone
Aqueous/Solid	EPA 8270C	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C	GC-MS	Nitrobenzene
Aqueous/Solid	EPA 8270C	GC-MS	N-Nitrosodiethylamine
Aqueous/Solid	EPA 8270C	GC-MS	N-Nitrosodimethylamine

Gulf Coast Analytical Laboratories, LLC
7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270C	GC-MS	N-Nitroso-di-n-propylamine
Aqueous/Solid	EPA 8270C	GC-MS	N-Nitrosodiphenylamine
Aqueous/Solid	EPA 8270C	GC-MS	o-Toluidine
Aqueous/Solid	EPA 8270C	GC-MS	p-Dioxane
Aqueous/Solid	EPA 8270C	GC-MS	Pentachlorobenzene
Aqueous/Solid	EPA 8270C	GC-MS	Pentachlorophenol
Aqueous/Solid	EPA 8270C	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C	GC-MS	Phenol
Aqueous/Solid	EPA 8270C	GC-MS	Pyrene
Aqueous/Solid	EPA 8270C	GC-MS	Pyridine
Aqueous/Solid	EPA 8270C SIM	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270C SIM	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Anthracene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Chrysene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Dibenz(a,h) anthracene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Fluorene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Indeno(1,2,3-cd) pyrene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270C SIM	GC-MS	Pyrene
Aqueous/Solid	EPA 8270D	GC-MS	1,2 Dichlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solid	EPA 8270D	GC-MS	1,3 Dichlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	1,4 Dichlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270D	GC-MS	2,3,4,6-Tetrachlorophenol

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	2,4-Dichlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	2,4-Dimethylphenol
Aqueous/Solid	EPA 8270D	GC-MS	2,4-Dinitrophenol
Aqueous/Solid	EPA 8270D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8270D	GC-MS	2,6-Dichlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8270D	GC-MS	2-Chloronaphthalene
Aqueous/Solid	EPA 8270D	GC-MS	2-Chlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	2-Methyl-4,6-Dinitrophenol
Aqueous/Solid	EPA 8270D	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270D	GC-MS	2-Methylphenol
Aqueous/Solid	EPA 8270D	GC-MS	2-Nitroaniline
Aqueous/Solid	EPA 8270D	GC-MS	2-Nitrophenol
Aqueous/Solid	EPA 8270D	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solid	EPA 8270D	GC-MS	3-Nitroaniline
Aqueous/Solid	EPA 8270D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solid	EPA 8270D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solid	EPA 8270D	GC-MS	4-Chloroaniline
Aqueous/Solid	EPA 8270D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solid	EPA 8270D	GC-MS	4-Methylphenol (and/or 3-Methylphenol)
Aqueous/Solid	EPA 8270D	GC-MS	4-Nitroaniline
Aqueous/Solid	EPA 8270D	GC-MS	4-Nitrophenol
Aqueous/Solid	EPA 8270D	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270D	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270D	GC-MS	Aniline
Aqueous/Solid	EPA 8270D	GC-MS	Anthracene
Aqueous/Solid	EPA 8270D	GC-MS	Atrazine
Aqueous/Solid	EPA 8270D	GC-MS	Benzidine
Aqueous/Solid	EPA 8270D	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270D	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270D	GC-MS	Benzoic acid

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270D	GC-MS	Benzyl alcohol
Aqueous/Solid	EPA 8270D	GC-MS	bis(2-Chloroethoxy)methane
Aqueous/Solid	EPA 8270D	GC-MS	bis(2-Chloroethyl)ether
Aqueous/Solid	EPA 8270D	GC-MS	bis(2-Chloroiospropyl) ether
Aqueous/Solid	EPA 8270D	GC-MS	bis(2-ethylhexyl) phthalate
Aqueous/Solid	EPA 8270D	GC-MS	Butyl benzyl phthalate
Aqueous/Solid	EPA 8270D	GC-MS	Caprolactom
Aqueous/Solid	EPA 8270D	GC-MS	Carbazole
Aqueous/Solid	EPA 8270D	GC-MS	Chrysene
Aqueous/Solid	EPA 8270D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solid	EPA 8270D	GC-MS	Dibenzofuran
Aqueous/Solid	EPA 8270D	GC-MS	Diethyl phthalate
Aqueous/Solid	EPA 8270D	GC-MS	Dimethyl phthalate
Aqueous/Solid	EPA 8270D	GC-MS	Di-n-butylphthalate
Aqueous/Solid	EPA 8270D	GC-MS	Di-n-octylphthalate
Aqueous/Solid	EPA 8270D	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270D	GC-MS	Fluorene
Aqueous/Solid	EPA 8270D	GC-MS	Hexachlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	Hexachlorobutadiene
Aqueous/Solid	EPA 8270D	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solid	EPA 8270D	GC-MS	Hexachloroethane
Aqueous/Solid	EPA 8270D	GC-MS	Indeno(1,2,3, cd)pyrene
Aqueous/Solid	EPA 8270D	GC-MS	Isophorone
Aqueous/Solid	EPA 8270D	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270D	GC-MS	Nitrobenzene
Aqueous/Solid	EPA 8270D	GC-MS	N-Nitrosodiethylamine
Aqueous/Solid	EPA 8270D	GC-MS	N-Nitrosodimethylamine
Aqueous/Solid	EPA 8270D	GC-MS	N-Nitroso-di-n-propylamine
Aqueous/Solid	EPA 8270D	GC-MS	N-Nitrosodiphenylamine
Aqueous/Solid	EPA 8270D	GC-MS	o-Toluidine
Aqueous/Solid	EPA 8270D	GC-MS	Pentachlorobenzene
Aqueous/Solid	EPA 8270D	GC-MS	Pentachlorophenol
Aqueous/Solid	EPA 8270D	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270D	GC-MS	Phenol
Aqueous/Solid	EPA 8270D	GC-MS	Pyrene
Aqueous/Solid	EPA 8270D	GC-MS	Pyridine

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8270D SIM	GC-MS	1-Methylnaphthalene
Aqueous/Solid	EPA 8270D SIM	GC-MS	2-Methylnaphthalene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Acenaphthene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Acenaphthylene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Anthracene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Benzo(a)anthracene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Benzo(a)pyrene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Benzo(b)fluoranthene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Benzo(k)fluoranthene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Chrysene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Dibenz(a,h) anthracene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Fluoranthene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Fluorene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Indeno(1,2,3-cd) pyrene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Naphthalene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Phenanthrene
Aqueous/Solid	EPA 8270D SIM	GC-MS	Pyrene
Aqueous/Solid	EPA 8330A	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solid	EPA 8330A	HPLC	1,3-Dinitrobenzene
Aqueous/Solid	EPA 8330A	HPLC	2,4,6-Trinitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	2-Amino-4,6-dinitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	2-Nitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	3,5-Dinitroaniline
Aqueous/Solid	EPA 8330A	HPLC	3-Nitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	4-Amino-2,6-dinitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	4-Nitrotoluene
Aqueous/Solid	EPA 8330A	HPLC	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Aqueous/Solid	EPA 8330A	HPLC	Nitrobenzene
Aqueous/Solid	EPA 8330A	HPLC	Nitroglycerin
Aqueous/Solid	EPA 8330A	HPLC	Pentaerythritoltetranitrate
Aqueous/Solid	EPA 8330A	HPLC	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	EPA 8330A	HPLC	Tetryl (Methyl-2,4,6-trinitrophenylnitramine)
Aqueous/Solid	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	2,4,6-Trinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2-amino-4,6-dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solid	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-amino-2,6-dinitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solid	EPA 8330B	HPLC	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
Aqueous/Solid	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solid	EPA 8330B	HPLC	Nitroglycerin
Aqueous/Solid	EPA 8330B	HPLC	Pentaerythritoltetranitrate
Aqueous/Solid	EPA 8330B	HPLC	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
Aqueous/Solid	EPA 8330B	HPLC	Tetryl (Methyl-2,4,6-trinitrophenylnitramine)
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
Aqueous/Solid	EPA 9056A	IC	Fluoride
Aqueous/Solid	EPA 9056A	IC	Nitrate and Nitrite as N
Aqueous/Solid	EPA 9056A	IC	Nitrate as N
Aqueous/Solid	EPA 9056A	IC	Nitrite as N
Aqueous/Solid	EPA 9056A	IC	Sulfate
Aqueous/Solid	EPA 9060A	TOC Analyzer	TOC
Aqueous/Solid	EPA 9066	FIA	Total Phenolics (4AAP)
Aqueous/Solid	EPA 9251	FIA	Chloride
Aqueous/Solid	FL-PRO	GC-FID	Petroleum Hydrocarbons
Aqueous/Solid	GCAL SOP WL-070	IC	Acetic Acid
Aqueous/Solid	GCAL SOP WL-070	IC	Butyric Acid
Aqueous/Solid	GCAL SOP WL-070	IC	Formic Acid

Certificate of Accreditation: Supplement
ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC
7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington Phone: 225-769-4900

Accreditation is granted to the facility to perform the following testing:

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solid	GCAL SOP WL-070	IC	Lactic Acid
Aqueous/Solid	GCAL SOP WL-070	IC	Propionic 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	SM4500-NH3 B & D	ISE	Ammonia as N
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
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-ethylperfluorooctanesulfonamidoacetic acid (NEtFOSAA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Fluorotelomer sulfonate 8:2 (8:2 FTS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Fluorotelomer sulfonate 4:2 (4:2 FTS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Fluorotelomer sulfonate 6:2 (6:2 FTS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	N-methylperfluorooctanesulfonamidoacetic acid (NMeFOSAA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington   Phone: 225-769-4900

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 5.1 Table B-15	LC/MS/MS	Perfluorobutanesulfonate (PFBS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorobutanoic acid (PFBA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorodecanesulfonate (PFDS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorodecanoic acid (PFDA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorododecanoic acid (PFDoA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoroheptanesulfonate (PFHpS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoroheptanoic acid (PFHpA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorohexanesulfonate (PFHxS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorohexanoic acid (PFHxA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorononanesulfonate (PFNS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorononanoic acid (PFNA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorooctane sulfonamide (FOSA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorooctanesulfonate (PFOS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorooctanoic acid (PFOA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoropentanoic acid (PFPeA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoropentansulfonate (PFPeS)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorotetradecanoic acid (PFTeDA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluorotridecanoic acid (PFTrDA)
AFFF/Aqueous/Solid	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	LC/MS/MS	Perfluoroundecanoic acid (PFUdA)

Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

Gulf Coast Analytical Laboratories, LLC

7979 Innovation Park Drive, Baton Rouge, LA 70820
Contact Name: Randy Whittington Phone: 225-769-4900

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	SPLC	Prep Method
Solid	EPA 1311	TCLP	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

Appendix C
July 2018 Scoping Session Presentation

ESI Scoping

Objectives

- Further define the lateral and vertical extent of PFAS contamination.
- Refine understanding of the hydraulic characteristics of the site.
- Determine if PFAS contamination is present in soil, surface water, and/or sediment .
- Conduct Ecological and Human Health Risk Screenings.

Ecological Screening Values - Soil

Chemical	ESV (ug/kg)	Type/ Receptor	Reference	Comments
PFOS	4,600	Plant	Beach et al. 2006	Ryegrass, 21-day NOEC (shoot height); converted to dry weight based on a reported value of 85% solids
	10,000	Invertebrate	NPCA 2008	Earthworm NOEC (note: UF of 100 was applied to this NOEC by NPCA to derive a PNEC value of 100 µg/kg but this was considered very conservative even for use as a screening value and the UF was not applied to derive the ESV)
PFOA	16,000	Invertebrate	NPCA 2008	Earthworm NOEC (note: UF of 100 was applied to this NOEC by NPCA to derive a PNEC value of 160 µg/kg but this was considered very conservative even for use as a screening value and the UF was not applied to derive the ESV)

Beach, S.A., J.L. Newsted, K. Coady, and J.P. Giesy. 2006. Ecotoxicological Evaluation of Perfluorooctanesulfonate (PFOS). Reviews of Environmental Contamination and Toxicology. 186:133-174.

Norwegian Pollution Control Authority (NPCA). 2008. Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway. TA-2444/2008. December.

Ecological Screening Values – Fresh Surface Water

Chemical	ESV (ug/L)	Type	Comments
PFOS	5.10	Final chronic value	Acute-to-chronic ratio applied to Final Acute Value (protective of 95% of test species)
PFOA	2,900	Secondary chronic value	
PFBS	24,000	Secondary chronic value	

Giesy J.P., J.E. Naile, J.S. Khim, P.D. Jones, and J.L. Newsted. 2010. Aquatic toxicology of perfluorinated chemicals. Reviews of Environmental Contamination and Toxicology. 202:1–52.

Ecological Screening Values – Fresh Sediment

Chemical	ESV (ug/kg)	Type	Comments
PFOS	220	Chronic NOEC	Threshold for chronic toxic effects

Norwegian Pollution Control Authority (NPCA). 2008. Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway. TA-2444/2008. December.

Project Action Limits

- Groundwater – USEPA L-HA for PFOS/PFOA, Tapwater RSL for PFBS, PFOA, and PFOS
- Surface Water – ESVs, Tapwater RSL X 10 for Surface Water for PFBS, PFOA, and PFOS
- Sediment – ESVs, Residential and Industrial Soil RSLs X 10 for Sediment for PFBS, PFOA, and PFOS
- Soil – ESVs, Residential and Industrial Soil RSLs for PFBS, PFOA, and PFOS, SSLs for PFBS, PFOA, and PFOS

*RSLs will be based on an HQ of 0.1. RSLs for PFOA and PFOS will be derived using EPA's RSL calculator. SSLs will not be used as clean up goals, but will be used to determine if more detailed leaching evaluation is warranted.

Updated Sampling Approach

- Install 12 shallow and 10 deep monitoring wells, including one at Site 11 to the bottom of the Yorktown aquifer
- Complete a groundwater level survey of all new and existing monitoring wells
- Complete slug testing at 3 monitoring wells in the Yorktown aquifer
- Collect approximately 73 groundwater samples:
  - 35 shallow and 5 deep monitoring wells from the PFAS SI
  - 12 shallow and 10 deep newly installed monitoring wells
  - 12 existing shallow wells (3 at North Station Landfill, 4 at Fifth Green Landfill, 5 at SWMU 2B)
- Collect approximately 8 co-located surface (0 to 6” bgs) and subsurface (6 to 24” bgs) soil samples for 14 PFAS (5 at Site 11, 1 near the hangars, 1 near the Fuel Tanks, and 1 near the Hush House).
- Collect approximately 23 co-located sediment and surface water samples for 14 PFAS.
- Existing POL monitoring wells may be sampled in place of new wells at the NEX Gas Station and FITWING POL sites.
- Additional sampling locations may be added based on the results of the Source Area Assessment.

Appendix D
Ecological Screening Values

Soil Ecological Screening Values (ESVs)
Per- and Polyfluoroalkyl Substances (PFAS)

Chemical	ESV	Units	Type/Receptor	Reference	Comments
Perfluorooctane sulfonic acid (PFOS)	4,600	µg/kg	Plant	Beach et al. 2006	Ryegrass, 21-day NOEC (shoot height); converted to dry weight based on a reported value of 85% solids
	10,000	µg/kg	Invertebrate	NPCA 2008	Earthworm NOEC (note: UF of 100 was applied to this NOEC by NPCA to derive a PNEC value of 100 µg/kg but this was considered very conservative even for use as a screening value and the UF was not applied to derive the ESV)
Perfluorooctanoic acid (PFOA)	16,000	µg/kg	Invertebrate	NPCA 2008	Earthworm NOEC (note: UF of 100 was applied to this NOEC by NPCA to derive a PNEC value of 160 µg/kg but this was considered very conservative even for use as a screening value and the UF was not applied to derive the ESV)

Beach, S.A., J.L. Newsted, K. Coady, and J.P. Giesy. 2006. Ecotoxicological Evaluation of Perfluorooctanesulfonate (PFOS). *Reviews of Environmental Contamination and Toxicology* . 186:133-174.

Norwegian Pollution Control Authority (NPCA). 2008. Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway. TA-2444/2008. December.

Fresh Surface Water Ecological Screening Values (ESVs)
Per- and Polyfluoroalkyl Substances (PFAS)

Chemical	ESV	Units	Type	Reference	Comments
Perfluorooctane sulfonic acid (PFOS)	5.10	µg/L	Final chronic value	Geisy et al. 2010	Acute-to-chronic ratio applied to Final Acute Value (protective of 95% of test species)
Perfluorooctanoic acid (PFOA)	2,900	µg/L	Secondary chronic value	Geisy et al. 2010	
Perfluorobutanesulfonic acid (PFBS)	24,000	µg/L	Secondary chronic value	Geisy et al. 2010	

Giesy J.P., J.E. Naile, J.S. Khim, P.D. Jones, and J.L. Newsted. 2010. Aquatic toxicology of perfluorinated chemicals. *Reviews of Environmental Contamination and Toxicology* . 202:1–52.

Freshwater Sediment Ecological Screening Values (ESVs)
Per- and Polyfluoroalkyl Substances (PFAS)

Chemical	ESV	Units	Type	Reference	Comments
Perfluorooctane sulfonic acid (PFOS)	220	µg/kg	Chronic NOEC	NPCA 2008	Threshold for chronic toxic effects

Norwegian Pollution Control Authority (NPCA). 2008. Screening of Polyfluorinated Organic Compounds at Four Fire Training Facilities in Norway. TA-2444/2008.