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FINAL TIER I SAMPLING AND ANALYSIS PLAN FOR PER AND POLYFLUOROALKYL SUBSTANCES GROUNDWATER MONITORING FORMER NAS BRUNSWICK ME

01/01/2026

RESOLUTION CONSULTANTS

Naval Facilities Engineering Systems Command
BRAC Program Management Office Northeast
Philadelphia, Pennsylvania

Final

Tier I Sampling and Analysis Plan for Per- and Polyfluoroalkyl Substances Groundwater Monitoring

Former Naval Air Station Brunswick
Brunswick, Maine

Contract Number: N62470-22-D-0005
Delivery Order Number: N4008523F5067

January 2026

Naval Facilities Engineering Systems Command
BRAC Program Management Office Northeast
Philadelphia, Pennsylvania

Final

Tier I Sampling and Analysis Plan for Per- and Polyfluoroalkyl Substances Groundwater Monitoring

Former Naval Air Station Brunswick
Brunswick, Maine

29 January 2026

Prepared for:
Department of the Navy
BRAC Program Management Office East
4911 South Broad Street
Philadelphia, Pennsylvania 19112-1303

Prepared by:
Resolution Consultants
A Joint Venture of AECOM & EnSafe
222 Central Park Avenue, Suite 300
Virginia Beach, Virginia 23462

Contract Number: N62470-22-D-0005
Delivery Order No. N4008523F5067

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)

TIER I SAMPLING AND ANALYSIS PLAN
Per- and Polyfluoroalkyl Substances Groundwater Monitoring
Former Naval Air Station Brunswick
Brunswick, Maine

Prepared for:
Department of the Navy
BRAC PMO East
4911 South Broad Street
Philadelphia, Pennsylvania 19112-1303

Naval Facilities Engineering Systems Command
NAVFAC MID-ATLANTIC

Contract Number: N62470-22-D-0005
Contract Task Order: N4008523F5067

Prepared by:

RESOLUTION CONSULTANTS

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Acronyms and Abbreviations

AFFF	aqueous film-forming foam
ASD	Assistant Secretary of Defense
bgs	below ground surface
BRAC	Base Realignment and Closure
BTWD	Brunswick Topsham Water District
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CSM	Conceptual Site Model
CTO	Contract Task Order
DL	Detection Limit
DoD	Department of Defense
DON	Department of Navy
DQO	Data Quality Objective
DV	Data Validation
EB	Equipment Blank
EDQW	Environmental Data Quality Workgroup
ELAP	Environmental Laboratory Accreditation Program
FB	Field Blank
FD	Field Duplicate
FTL	Field Team Leader
FTMR	Field Task Modification Request
GWETS	Groundwater Extraction and Treatment System
HDPE	High-Density Polyethylene
HSM	Health and Safety Manager
LOD	Limit of Detection
LOQ	Limit of Quantitation
LTM	Long-Term Monitoring
MEDEP	Maine Department of Environmental Protection
mL	milliliters
NA	Not Applicable
NARA	Naval Archive Records Administration
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering systems Command
Navy	Department of the Navy
NEDDs	NAVFAC Electronic Data Deliverables
NIRIS	Naval Installation Restoration Information Solution
PA	Preliminary Assessments

PAL	Project Action Level
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFPrA	perfluoropropanoic acid
PM	Project Manager
PMO	Project Management Office
POC	Point of Contact
ppt	parts per trillion
PSQ	principal study questions
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	Quality Control
RB	Rinsate Blank
RI	Remedial Investigation
RPM	Remedial Project Manager
RSL	Regional Screening Levels
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SSHO	Site Safety & Health Officer
TFSI	Bis (trifluoromethylsulfonyl)amine
UCMR	Unregulated Contaminate Monitoring Rule
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency

Executive Summary

Resolution Consultants has prepared this Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) to conduct groundwater monitoring for per- and polyfluoroalkyl substances (PFAS) at former Naval Air Station (NAS) Brunswick base in support of the Navy's separate, ongoing PFAS Remedial Investigation (RI). Resolution Consultants was retained to develop this SAP by Naval Facilities Engineering Systems Command (NAVFAC) Base Realignment and Closure Act (BRAC) Program Management Office (PMO) East under Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-22-D-0005, Contract Task Order N4008523F5067.

The Navy has conducted numerous investigations at former NAS Brunswick base between 2010 and 2023 to evaluate the extent of PFAS on the former base property. These investigations have identified the presence of PFAS, specifically perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), in groundwater, surface water, sediment, and stormwater. The Navy is currently determining the path forward for the ongoing PFAS RI program; however, since groundwater data has not been collected since the 2022/2023 PFAS RI, the Navy plans to conduct additional PFAS sampling to monitor concentrations in key areas located on former NAS Brunswick. Specifically, additional data is needed to monitor concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFOS have been detected in the water supply above the Department of Defence (DoD) PFAS Interim Action Levels established in the Memorandum from the Assistant Secretary of Defense (ASD), *Prioritization of Department of Defense Cleanup Action to Implement the Federal Drinking Water Standards for Per- and Polyfluoroalkyl Substances Under the Defense Environmental Restoration Program* (ASD 2024b) .

The objective of this investigation is to collect data to evaluate whether PFAS concentrations in groundwater have decreased or increased within plume areas compared to historical PFAS sample results, monitor PFAS concentrations along the plume fringe areas and former base boundary, expand the PFAS dataset in existing bedrock monitoring wells, and identify if PFAS is present in groundwater in the vicinity of the Mere Creek Golf Course.

Analytical results from this investigation will be provided as a data deliverable in the form of a PFAS Groundwater Technical Memorandum. This data will aid the Navy in establishing the path forward for the separate, ongoing PFAS RI program and will ultimately be incorporated into the PFAS RI program.

Field work will be performed by Resolution Consultants, a Joint Venture between AECOM and EnSafe. This SAP outlines the organization, objectives, planned activities, and data review/reporting procedures associated with the data collection effort. Protocols for sample collection, handling, and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are addressed herein. This SAP was generated for, and complies with, applicable United States Department of the Navy, United State Environmental Protection Agency (USEPA), and Maine Department of Environmental Protection (MEDEP) requirements, regulations, guidance, and technical standards, as

appropriate. This SAP also meets the requirements of the Department of Defense, Department of Energy, and USEPA Interagency Data Quality Task Force regarding federal facilities, as specified in the Uniform Federal Policy Quality Assurance Project Plan (QAPP) guidance (USEPA 2005a, 2005b, 2005c). Field activities conducted under this SAP will be conducted in accordance with Resolution Consultants Standard Operating Procedures and a Site-Specific Health and Safety Plan.

SAP Worksheet #2: Sampling and Analysis Plan Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Former Naval Air Station Brunswick
Brunswick, Maine 04011

Contractor Name: Resolution Consultants
Contract Number: N62470-22-D-0005
Contract Title: Atlantic Comprehensive Long-Term Environmental Action, Navy (CLEAN), Naval Facilities Engineering Command, Mid-Atlantic (NAVFAC MIDLANT)
Work Assignment No: Contract Task Order (CTO) N4008523F5067

This sampling and analysis plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (United States Environmental Protection Agency [USEPA] 2005a, 2005b, 2005c) and USEPA *Guidance for Quality Assurance Project Plans, EPA QA/G-5* (USEPA 2002) and the following:

- Deputy Assistant Secretary of the Navy (Environment) (DASN (E)) Policy Memorandum, Perfluorinated Compounds/Perfluoroalkyl Substances (PFC/PFAS) - Identification of Potential Areas of Concern (DASN (E) 2016).
- Department of the Navy Environmental Restoration Program Manual (DON 2018).
- Memorandum from Commander, Naval Facilities Engineering Systems Command, regarding Interim Per- and Polyfluoroalkyl Substances (PFAS) Site Guidance for NAVFAC Remedial Project Managers (RPMs)/November 2020 Update (NAVFAC 2020).
- Memorandum for Assistant Secretary of the Army (Installations, Energy and Environment), Assistant Secretary of the Navy (Energy, Installations and Environment), Assistant Secretary of the Air Force (Installations, Environment and Energy), Director, National Guard Bureau (Joint Staff, J8) Director, Defense Logistics Agency (Installation Management): Taking Interim Actions to Address Per- and Polyfluoroalkyl Substances Migration from DoD Installations and National Guard Facilities (ASD 2023a).
- Memorandum for Assistant Secretary of the Army (Installations, Energy and Environment), Assistant Secretary of the Navy (Energy, Installations and Environment), Assistant Secretary of the Air Force (Installations, Environment and Energy), Director, Defense Logistics Agency (Logistics Operations): Interim

Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States (ASD 2023b).

- Memorandum for Assistant Secretary of the Army (Installations Energy and Environment), Assistant Secretary of The Navy (Energy, Installations and Environment), Assistant Secretary of the Air Force (Installations, Environment and Energy) Director, National Guard Bureau (Joint Staff, J3/4/7)) Director, Defense Logistics Agency (Installation Management): Establishing a Consistent Methodology for the Analysis of Per- and Polyfluoroalkyl Substances in Matrices Other than Drinking Water (ASD 2024a).
- Memorandum for Assistant Secretary of the Army (Installations, Energy and Environment), Assistant Secretary of The Navy (Energy, Installations and Environment), Assistant Secretary of the Air Force (Energy, Installations and Environment) Director, National Guard Bureau (Joint Staff, J3/4/7)) Director, Defense Logistics Agency (Installation Management): Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (ASD 2025).

Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as reauthorized by Superfund Amendments and Reauthorization Act.

This SAP is a project-specific SAP.

List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partners/Stakeholders	Connection
Naval Facilities Engineering Systems Command (NAVFAC), Base Realignment and Closure (BRAC) Program Management Office (PMO) East	Lead Agency
USEPA, Region 1	Federal Regulatory Oversight
Maine Department of Environmental Protection (MEDEP)	State Regulatory Oversight
Resolution Consultants	Contractor preparing SAP

If any required SAP elements and required information are not applicable (NA) to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

Not applicable, as there are no exclusions.

SAP Worksheet #3: Distribution List

(UFP-QAPP Manual Section 2.3.1)

SAP Recipients	Title	Organization	Telephone Number	Email Address or Mailing Address
Derek Pinkham	Remedial Project Manager (RPM)	NAVFAC BRAC PMO East	215-200-5182	derek.j.pinkham.civ@us.navy.mil
Chris Harding	BRAC Environmental Coordinator	NAVFAC BRAC PMO East	215-897-4904	christopher.l.harding4.civ@us.navy.mil
Marty McMahon	Department of the Navy (Navy) Caretaker and Point of Contact (POC)/Facility POC	Former NAS Brunswick	207-406-2290	martin.g.mcmahon.civ@us.navy.mil
Mike Daly	RPM	USEPA Region 1	617-918-1386	daly.mike@epamail.epa.gov
Iver McLeod	RPM	MEDEP	207-592-2981	iver.j.mcleod@maine.gov
Finn Whiting	Hydrogeologist	MEDEP	207-287-7688	finn.whiting@maine.gov
Caryn DeJesus	CTO Manager	Resolution Consultants	978-905-2100	caryn.dejesus@aecom.com
Robert Shoemaker	Quality Assurance Officer (QAO)	Resolution Consultants	978-905-2100	robert.shoemaker@aecom.com
Steve Hartmann	Project Chemist/Data Validation Manager	Resolution Consultants	978-905-2100	steve.hartmann@aecom.com
Kristin Rutherford	Data Validator	Resolution Consultants	978-905-2100	kristin.rutherford@aecom.com
Michelle McClelland	Data Manager	Resolution Consultants	206-438-2700	michelle.mcclelland@aecom.com
Keefe Askin	Field Team Leader (FTL)	Resolution Consultants	207-775-4820	keefe.askin@aecom.com
Steven Surrusco	Site Safety & Health Officer (SSHO)	Resolution Consultants	978-905-2100	steven.surrusco@aecom.com
Heather Manz	Laboratory Project Manager (PM)	Katahdin	207-303-0917	hmanz@sgs.com
Jennifer Prescott	Laboratory QAO	Katahdin	207-303-0916	jprescott@sgs.com

***Notes**:*

BRAC	=	Base Realignment and Closure
CTO	=	Contract Task Order
FTL	=	Field Team Lead
MEDEP	=	Maine Department of Environmental Protection
NAVFAC	=	Naval Facilities Engineering Systems Command
Navy	=	Department of the Navy
PM	=	Project Manager
PMO	=	Program Management Office
POC	=	Point of Contact
QAO	=	Quality Assurance Officer
RPM	=	Remedial Project Manager
SSHO	=	Site Safety & Health Officer
USEPA	=	United States Environmental Protection Agency

SAP Worksheet #4: Personnel Sign-off Sheet

(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by the following methods:

Emails will be sent to Resolution Consultants and subcontractor project personnel listed below, who will be requested to verify by email that they have read the applicable SAP sections and provide the date on which they were reviewed. Copies of the verification email will be included in the project files and identified in Worksheet #29.

SAP Recipients	Title	Organization	Telephone Number	E-mail Address
Caryn DeJesus	CTO Manager	Resolution Consultants	978-905-2100	caryn.dejesus@aecom.com
Robert Shoemaker	QAO	Resolution Consultants	978-905-2100	robert.shoemaker@aecom.com
Steve Hartmann	Project Chemist/ Data Validation Manager	Resolution Consultants	978-905-2100	steve.hartmann@aecom.com
Kristin Rutherford	Data Validator	Resolution Consultants	978-905-2100	kristin.rutherford@aecom.com
Michelle McClelland	Data Manager	Resolution Consultants	206-438-2700	michelle.mcclelland@aecom.com
Keefe Askin	FTL	Resolution Consultants	207-775-4820	keefe.askin@aecom.com
Steven Surrusco	SSHO	Resolution Consultants	978-905-2100	steven.surrusco@aecom.com
Heather Manz	Analytical Laboratory Project Manager	Katahdin	207-303-0917	hmanz@sgs.com
Jennifer Prescott	Analytical Laboratory QAO	Katahdin	207-303-0916	jprescott@sgs.com

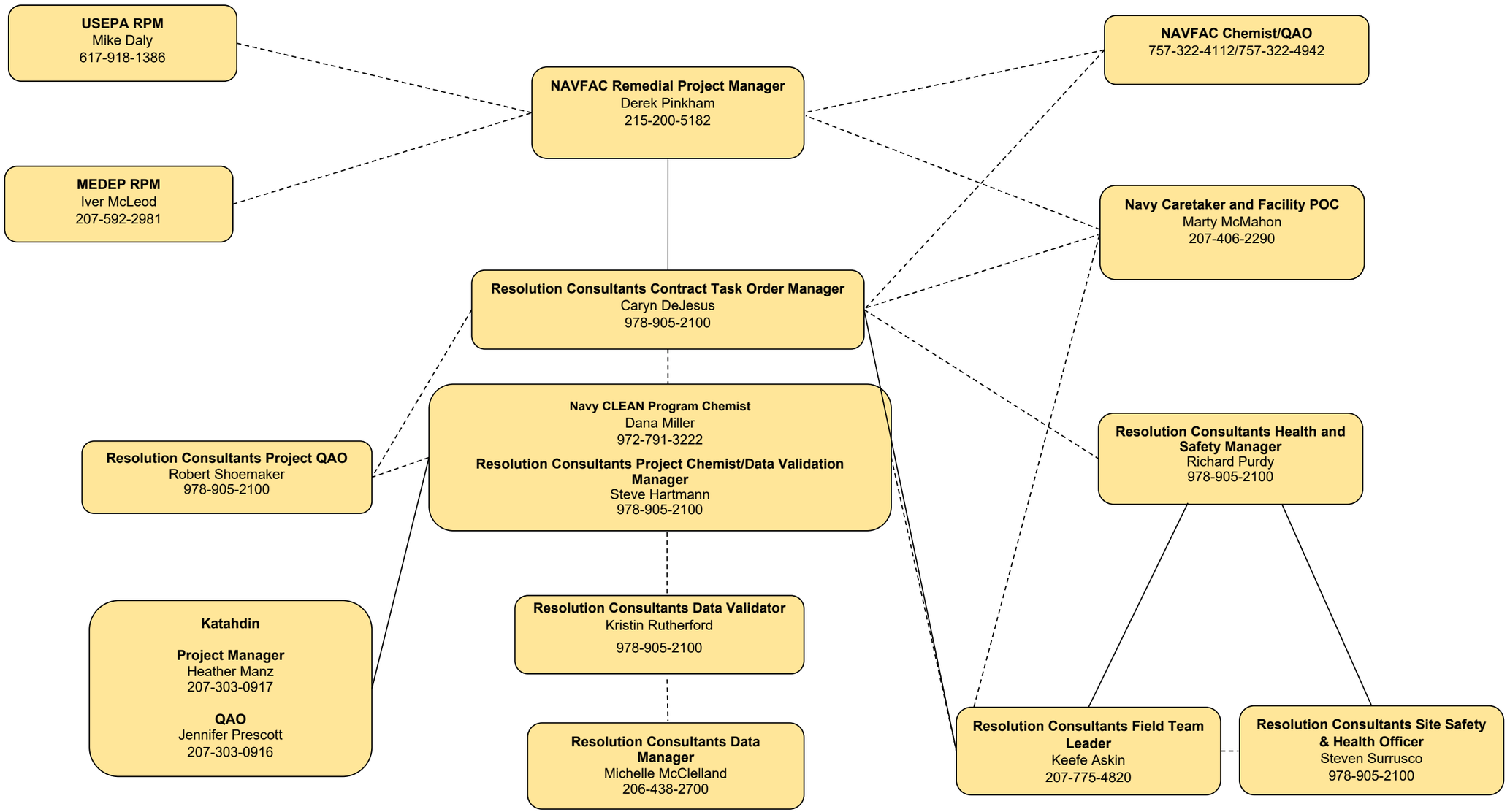
Notes:

CTO	=	Contract Task Order
FTL	=	Field Team Leader
QAO	=	Quality Assurance Officer
SAP	=	Sampling and Analysis Plan
SSHO	=	Site Safety & Health Officer

SAP Worksheet #5: Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)

Lines of Authority: ——————— **Lines of Communication:** ----------



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SAP Worksheet #6: Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	Navy RPM USEPA RPM MEDEP RPM	Derek Pinkham Mike Daly Iver McLeod	215-200-5182 617-918-1386 207-592-2981	The Navy RPM informs the regulatory agencies of work progress periodically.
Field Progress Reports	Resolution Consultants FTL Resolution Consultants CTO Manager	Keefe Askin Caryn DeJesus	207-775-4820 978-905-2100	FTL verbally informs the CTO Manager daily of field updates. CTO Manager provides a weekly update to the Navy RPM either by phone message and/or e-mail each Friday afternoon field activities are taking place.
Gaining Site Access	Resolution Consultants FTL Former NAS Brunswick POC	Keefe Askin Marty McMahon	207-775-4820 207-406-2290	The Resolution Consultants FTL, or designee, will contact the NAS Brunswick POC verbally or via e-mail at least 14 days before commencement of field work to arrange for access to the sites for all personnel, including subcontractors. The FTL will assist with access and will need at least two weeks to coordinate with the NAS Brunswick POC.
SAP Changes prior to Field/Laboratory work	Resolution Consultants FTL Resolution Consultants CTO Manager Resolution Consultants QAO Navy RPM Navy QAO USEPA RPM MEDEP RPM Resolution Consultants Project Chemist Resolution Consultants Data Validator Laboratory PM	Keefe Askin Caryn DeJesus Robert Shoemaker Derek Pinkham Navy QAO Mike Daly Iver McLeod Steve Hartman Kristin Rutherford Heather Manz	207-775-4820 978-905-2100 978-905-2100 215-200-5182 757-322-4112/ 757-322-4942 617-918-1386 207-592-2981 978-905-2100 978-905-2100 207-303-0917	The Resolution Consultants FTL will verbally inform the CTO Manager upon realizing a need for a SAP modification. The FTL or CTO Manager will document the proposed changes via a SAP modification form within 5 days and send it to the Resolution Consultants QAO. The Resolution Consultants QAO will assess whether the modification has the potential to affect the project's ability to achieve DQOs or the modification is administrative and is for documentation purposes only. SAP modifications potentially affecting DQOs will be submitted to the Navy for review and consideration. Any changes to technical content will be reviewed and discussed with the Navy QAO to determine whether subsequent Navy QAO review is required. Administrative revisions will be documented in the project file. All SAP modifications will be submitted to the Navy QAO via Naval Installation Restoration Information Solution (NIRIS). The Navy RPM will notify the agencies of any significant field changes within 5 business days. Any change of the approved SAP affecting the scope or implementation of the sampling program will be made only upon authorization of the Navy RPM. The changes will be provided to the Project Team after final approval,

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
				ensuring that the most current approved version of the SAP is available, distributed, and implemented. As appropriate, copies of distribution of the updated SAP sent via email will be included in the project files.
Field Corrective Actions	Resolution Consultants FTL Resolution Consultants CTO Manager Navy RPM	Keefe Askin Caryn DeJesus Derek Pinkham	207-775-4820 978-905-2100 215-200-5182	The Resolution Consultants FTL will inform the CTO Manager verbally within the same day of field corrective actions. The Resolution Consultants CTO Manager will then notify the Navy RPM verbally and/or by email within 1 business day. Corrective actions will be documented in progress reports. The Navy RPM will notify the agencies of any significant corrective actions taken within 5 business days.
Stop Work due to Safety Issues	Resolution Consultants CTO Manager Resolution Consultants FTL Resolution Consultants SSHO Resolution Consultants Health and Safety Manager (HSM) Navy RPM	Caryn DeJesus Keefe Askin Steven Surrusco Richard Purdy Derek Pinkham	978-905-2100 207-775-4820 978-905-2100 978-905-2100 215-200-5182	Any field team member who observes an unsafe situation has the authority to stop work. If Resolution Consultants is the responsible party for a stop-work command, the Resolution Consultants SSHO will inform onsite personnel, subcontractor(s), the NAS Brunswick POC, and the identified Project Team members within 1 hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor must verbally inform the Resolution Consultants SSHO within 15 minutes, and the Resolution Consultants SSHO will then follow the procedure listed above.
SAP Changes in the Field	Resolution Consultants CTO Manager Resolution Consultants FTL Resolution Consultants QAO Resolution Consultants Project Chemist Resolution Consultants Data Validator Navy RPM USEPA RPM MEDEP RPM Laboratory PM	Caryn DeJesus Keefe Askin Robert Shoemaker Steve Hartmann Kristin Rutherford Derek Pinkham Mike Daly Iver McLeod Heather Manz	978-905-2100 207-775-4820 978-905-2100 978-905-2100 978-905-2100 215-200-5182 617-918-1386 207-592-2981 207-303-0917	The Resolution Consultants FTL will inform the CTO Manager verbally within the same day of a change in scope of fieldwork. The CTO Manager will inform the Navy RPM by email within 24 hours. Any changes to technical content will be reviewed and discussed with the Navy QAO to determine whether subsequent Navy QAO review is required. The change will be documented on the SAP modification form within 2 business days or documented on the SAP amendment within the timeframe agreed to by Project Team, in coordination with the Resolution Consultants QAO. All SAP modifications will be submitted to the Navy QAO via NIRIS. The Navy RPM will notify the agencies of any significant SAP field changes within 5 business days. Any change of the approved SAP affecting the scope or implementation of the sampling program will be made

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
				only upon authorization of the Navy RPM. The changes will be provided to the Project Team after final approval, ensuring that the most current approved version of the SAP is available, distributed, and implemented.
Recommendations to stop work and initiate work upon corrective action	Resolution Consultants FTL Resolution Consultants SSHO Resolution Consultants CTO Manager Navy RPM USEPA RPM MEDEP RPM	Keefe Askin Steven Surrusco Caryn DeJesus Derek Pinkham Mike Daly Iver McLeod	207-775-4820 978-905-2100 978-905-2100 215-200-5182 617-918-1386 207-592-2981	The responsible party will inform the Resolution Consultants CTO Manager, FTL, SSHO, and subcontractors verbally within 1 hour of recommendation to stop work and within 24 hours of recommendation to restart work. The responsible party will follow verbal notification with an email to the Project Team within 24 hours.
Field Data Quality Issues	Resolution Consultants FTL Resolution Consultants CTO Manager Resolution Consultants QAO Navy RPM	Keefe Askin Caryn DeJesus Robert Shoemaker Derek Pinkham	207-775-4820 978-905-2100 978-905-2100 215-200-5182	The Resolution Consultants FTL will notify the Resolution Consultants CTO Manager of field data quality issues the same day they are identified. The Resolution Consultants CTO Manager will discuss the field data quality issues with the Resolution Consultants QAO to determine potential impacts to DQOs and will notify the Navy RPM within 24 hours that a field data quality issue has been identified.
Sample Receipt Variances and Laboratory Quality Variances	Katahdin PM Resolution Consultants CTO Manager Resolution Consultants FTL Resolution Consultants Project Chemist/Data Validation Manager	Heather Manz Caryn DeJesus Keefe Askin Steve Hartmann	207-303-0917 978-905-2100 207-775-4820 978-905-2100	The Laboratory PM will notify the Resolution Consultants FTL and Project Chemist verbally or by email immediately upon receipt of any chain of custody/sample receipt variances for clarification or direction from the FTL. The Resolution Consultants FTL will notify the Resolution Consultants CTO Manager verbally or by email within 1 business day if corrective action is required. The Resolution Consultants CTO Manager or Project Chemist will notify all parties verbally or by email within 1 business day of any required corrective action. The Laboratory PM will document all quality variances in the Case Narrative of the laboratory reports.

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Data Quality Issues	Katahdin PM Resolution Consultants CTO Manager Resolution Consultants Project Chemist/Data Validation Manager Resolution Consultants QAO Navy RPM Navy QAO	Heather Manz Caryn DeJesus Steve Hartmann Robert Shoemaker Derek Pinkham Navy QAO	207-303-0917 978-905-2100 978-905-2100 978-905-2100 215-200-5182 757-322-4112/ 757-322-4942	The Laboratory PM will notify the Resolution Consultants Project Chemist verbally or by email within 1 business day if an issue related to analytical laboratory data is discovered. The Resolution Consultants Project Chemist will notify the Resolution Consultants CTO Manager within 1 business day. The Resolution Consultants Project Chemist will notify the Resolution Consultants CTO Manager verbally or by email within 48 hours of validation completion that a non-routine and significant analytical laboratory quality deficiency has been identified that could affect this project and/or other projects. The Resolution Consultants CTO Manager will verbally advise the Navy RPM within 24 hours of notification from the Resolution Consultants Project Chemist. The Navy will take corrective action appropriate for the identified deficiency. If there are significant data quality or non-useable data issues, the Navy QAO will be contacted by the Resolution Consultants Project Chemist to ensure the issues do not have the potential to impact other Navy projects.
Analytical Corrective Actions	Katahdin PM Resolution Consultant Project Chemist/Data Validation Manager Resolution Consultants CTO Manager Navy RPM	Heather Manz Steve Hartmann Caryn DeJesus Derek Pinkham	207-303-0917 978-905-2100 978-905-2100 215-200-5182	The Laboratory PM shall notify the Resolution Consultants Project Chemist verbally or by email of any analytical data anomaly within 1 business day of discovery. After the Laboratory PM receives guidance from the Resolution Consultants Project Chemist, the laboratory shall initiate any corrective action to prevent further anomalies. If the deficiency is systemic, the Resolution Consultants CTO Manager will verbally and/or via email advise the Navy RPM within 24 hours of notification from the Resolution Consultants Project Chemist. Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the direction of the CTO Manager and Navy RPM.

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Reporting Data Validation Issues/ Data Validation Corrective Actions	Resolution Consultants Project Chemist/Data Validation Manager Resolution Consultants CTO Manager Navy RPM Navy QAO	Steve Hartmann Caryn DeJesus Derek Pinkham Navy QAO	978-905-2100 978-905-2100 215-200-5182 757-322-4112/ 757-322-4942	The Resolution Consultants Project Chemist/Data Validation Manager will perform validation as specified in Worksheets #34-36 and will contact the laboratory as soon as possible if issues are found that require corrective action. If the Resolution Consultants Project Chemist/Data Validation Manager identifies data during the validation process that requires corrective action, the Resolution Consultants CTO Manager will coordinate with the Resolution Consultants Project Chemist to take corrective action appropriate for the identified deficiency to ensure that project objectives are met. Corrective action may include resampling and/or reanalyzing the affected samples, as determined by the Resolution Consultants CTO Manager. If a data validation issue cannot be resolved between the Resolution Consultants Project Chemist and the laboratory, or if any issues appear to be systemic, the Resolution Consultants Project Chemist will notify the CTO Manager who will verbally or by email notify the Navy RPM within 24 hours of notification from the Resolution Consultants Project Chemist. The Navy RPM will advise on the appropriate corrective action for the identified deficiency. This may include a consult with the Navy QAO at the RPM's discretion.

Communication Drivers	Responsible Entity/Recipients	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Data with Serious Deficiencies	Katahdin PM Resolution Consultants CTO Manager Resolution Consultants Project Chemist/Data Validation Manger Resolution Consultants QAO Resolution Consultants Data Validator Navy RPM Navy QAO USEPA RPM MEDEP RPM	Heather Manz Caryn DeJesus Steve Hartmann Robert Shoemaker Kristin Rutherford Derek Pinkham Navy QAO Mike Daly Iver McLeod	207-303-0917 978-905-2100 978-905-2100 978-905-2100 978-905-2100 215-200-5182 757-322-4112/ 757-322-4942 617-918-1386 207-592-2981	If the laboratory determines that any data they have generated have serious deficiencies, the Laboratory PM will notify (verbally or by email) the Resolution Consultants Project Chemist within 1 business day of when the issue is discovered. The Resolution Consultants Project Chemist will notify the Resolution Consultants CTO Manager (verbally or by email) within 1 business day of the need for corrective action if the data with serious deficiencies constitute a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the affected samples. If a Resolution Consultants Project Chemist or Data Validator identifies data with serious deficiencies during the data validation process, the Resolution Consultants CTO Manager will be notified verbally or via email within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in data with serious deficiencies. The Resolution Consultants CTO Manager will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The CTO Manager will notify the Navy RPM verbally or by email of any problems with the analytical laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. The Navy RPM may contact the Navy QAO for assistance in problem resolution. Such notification will be made within 1 business day of when the issue is discovered. The Navy RPM will notify the agencies when any significant corrective action is taken. The use of data with serious Quality Control (QC) deficiencies will be decided by the Project Team.

Notes:

CTO	=	Contract Task Order
DQO	=	Data Quality Objective
FTL	=	Field Team Lead
HSM	=	Health and Safety Manager
MEDEP	=	Maine Department of Environmental Protection
NAS	=	Naval Air Station
Navy	=	Department of the Navy
NIRIS	=	Naval Installation Restoration Information Solution
PM	=	Project Manager
POC	=	Point of Contact
QAO	=	Quality Assurance Officer
QC	=	Quality Control
RPM	=	Remedial Project Manager
SAP	=	Sampling and Analysis Plan
SSHO	=	Site Safety & Health Officer
USEPA	=	United States Environmental Protection Agency

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SAP Worksheet #7: Personnel Responsibilities Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Derek Pinkham	RPM/Manages project activities for the Navy	NAVFAC BRAC PMO East	Primary Point of Contact for the Navy. Oversees project implementation, including scoping, data review, and evaluation, on behalf of the Navy.
Marty McMahon	Navy Site Caretaker's Office and POC/Facility POC	Former NAS Brunswick	Point of Contact for base-specific activity. Oversees onsite project activities.
Mike Daly	RPM/Regulatory Support	USEPA Region 1	Functions as primary USEPA interface. Participates in scoping and data review/evaluation and provides review and approval of project deliverables.
Iver McLeod	RPM/Regulatory Support	MEDEP	Functions as primary MEDEP interface. Participates in scoping and data review/evaluation and provides review and approval of project deliverables.
Caryn DeJesus	Contract Task Order Manager/Manages project on a daily basis	Resolution Consultants	Primary Point of Contact for Resolution Consultants. Oversees project implementation, including financials, schedule, and technical aspects.
Keefe Askin	Field Team Leader /Manages field operations	Resolution Consultants	Supervises, coordinates, and performs field activities.
Steven Surrusco	Site Safety Officer/Oversees site activities to ensure safety requirements are met	Resolution Consultants	Responsible for onsite project specific health and safety training and monitoring site conditions.
Dana Miller	Program Chemist/Manages data quality issues	Resolution Consultants	Provides chemistry guidance at the program level and is responsible for reviewing data quality issues and corrective actions.
Steve Hartmann	Project Chemist//Data Validation Manager/ Oversees chemistry aspects of project	Resolution Consultants	Prepares laboratory scopes of work, and coordinates with the laboratory. As Data Validation Manager, performs or oversees data validation and data input in both the project database and the Navy's database.
Robert Shoemaker	QAO/Oversees quality aspects of project	Resolution Consultants	Ensures quality aspects of the project are implemented, documented, and maintained.
Richard Purdy	Health and Safety Manager/ Oversees health and safety activities	Resolution Consultants	Oversees the health and safety program.
Heather Manz	Analytical Laboratory Project Manager/ Subcontractor	Katahdin	Oversees quality and technical aspects related to subcontracted analytical services.

Notes:

BRAC	=	Base Realignment and Closure
MEDEP	=	Maine Department of Environmental Protection
NAS	=	Naval Air Station
NAVFAC	=	Naval Facilities Engineering Systems Command
Navy	=	Department of the Navy
PMO	=	Program Management Office
POC	=	Point of Contact
QAO	=	Quality Assurance Officer
USEPA	=	United States Environmental Protection Agency

SAP Worksheet #8: Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations 1910.120(e). Additionally, all field personnel have completed internal Resolution Consultants PFAS sampling training.

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SAP Worksheet #9: Project Scoping Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1)

The Navy has worked with Resolution Consultants to develop the methodology for the scope of work to be presented in this SAP in email correspondence on 2 April 2025. Participants, topics addressed, and decisions reached associated with scoping discussions are shown in the table below and summarized in the text that follows.

Former NAS Brunswick Scoping Discussion Participants

Name	Title	Affiliation	Email Address
Derek Pinkham	RPM	NAVFAC BRAC PMO East	derek.j.pinkham.civ@us.navy.mil
Caryn DeJesus	CTO Manager	Resolution Consultants	caryn.dejesus@aecom.com

Notes:

BRAC	=	Base Realignment and Closure
CTO	=	Contract Task Order
NAS	=	Naval Air Station
NAVFAC	=	Naval Facilities Engineering Systems Command
PMO	=	Program Management Office
RPM	=	Remedial Project Manager

The Navy requested additional basewide PFAS sampling in groundwater via email correspondence dated 2 April 2025. The sampling is needed to support the separate, ongoing PFAS RI to continue monitoring groundwater PFAS concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFOS has been detected in the water supply above DoD PFAS Interim Action Levels established in the Memorandum from the ASD, *Prioritization of Department of Defense Cleanup Action to Implement the Federal Drinking Water Standards for Per- and Polyfluoroalkyl Substances Under the Defense Environmental Restoration Program* (ASD 2024b).

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SAP Worksheet #10: Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

This worksheet presents a brief site description, history, and a conceptual site model (CSM) for the planned PFAS investigation areas at former NAS Brunswick. Information included in this CSM has been summarized or included in its entirety from the following documents:

- Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Per- and Polyfluoroalkyl Substances Remedial Investigation (Tetra Tech 2022b)
- Final Tier I Sampling and Analysis Plan for PFAS Drinking Water Well Sampling (Resolution Consultants 2025)

10.1 Site Location, Description, and Overview

Former NAS Brunswick (**Figure 10-1**) is located in Brunswick, Cumberland County, which is situated near the southern coastal area of Maine. Former NAS Brunswick is located approximately 20 miles northeast of Portland, (not shown on **Figure 10-1**), just south of the Androscoggin River and north of several coves (Harpswell, Buttermilk, and Woodward) that connect with Casco Bay (not shown).

Figure 10-2 presents an aerial view of the facility with the base property lines, surface water bodies and streams, and the sites at the facility and the surrounding area. The former base occupied approximately 3,094 acres of land. The operational area included the area east of the two parallel runways and consisted of numerous office buildings, barracks, recreational facilities, hangars, repair shops, and other facilities to support NAS Brunswick aircraft. One of the two existing parallel runways is still in operation. The majority of former NAS Brunswick is comprised of forested areas, grasslands, shrub land, marsh, and open waters. The remaining area of the base consists of an operations area and paved areas, primary flight ramps, and runways. The southern edge of the base borders coves and estuaries of the Gulf of Maine.

Property uses surrounding former NAS Brunswick are primarily suburban and rural residential, with some commercial and light industrial uses along Routes 1, 24, and 123. An elementary school and college are located within a 1-mile radius of the western base boundary.

10.2 Previous Investigations

The Navy has conducted Preliminary Assessments (PA) for PFAS at many installations, including former NAS Brunswick, to identify PFAS release areas and the potential for exposure to PFAS. Much of the PA information for PFAS at former NAS Brunswick is documented in the 2014 *Tier II Sampling and Analysis Plan Perfluorinated Compounds in Groundwater* (Resolution Consultants 2014). The 2014 SAP documented historical aqueous film-forming foam (AFFF) operations including AFFF storage, fire training areas, fire suppression systems, fires, and fuel spills. Based on the review of

historical information, Navy records/databases, and interviews with various Navy personnel, known or suspected PFAS release areas were identified. PFAS areas of concern at the Former NAS Brunswick are shown on **Figure 10-2**.

Since 2010, the Navy has conducted numerous PFAS investigations in various environmental media at former NAS Brunswick. The 2020 *Per- and Polyfluoroalkyl Substances (PFAS) Investigation Summary Report* (Resolution Consultants 2020) documents the following PFAS investigations between 2010 and 2019:

- October 2010 West Fire Training Area Investigation
- August 2012 Eastern Plume and Site 11 Investigation (Round 1)
- November 2012 MEDEP Groundwater Extraction and Treatment System (GWETS) Split Sampling
- November - December 2012 Building 611 & 555 Investigation
- May 2013 Eastern Plume and Site 11 Investigation (Round 2)
- November 2014 Basewide PFAS Investigation
- November 2014 MEDEP Basewide PFAS Split Sampling
- November and December 2014 Eastern Flightline Investigation (Phase I)
- February 2015 Brunswick and Topsham Water District Unregulated Contaminate Monitoring Rule (UCMR) 3 Sampling (Round 1)
- June and November 2015 Picnic Pond Investigation
- June 2015 Paradise Spring PFAS Sampling
- August 2015 Brunswick and Topsham Water District UCMR 3 Sampling (Round 2)
- November 2015 Basewide PFAS Investigation
- November 2015 MEDEP Basewide PFAS Split Sampling
- November 2015 – April 2019 GWETS PFAS Pilot Study
- December 2015 Eastern Flightline Investigation (Phase II)
- April - June 2016 Off-facility Sampling, Coombs Road
- October and November 2016 Off-facility Sampling, Northern Properties
- June 2017 Former Building 653 PFAS Investigation
- October 2017 Limited Basewide PFAS Investigation
- December 2017 Old Navy Fuel Farm PFAS Investigation

- January 2018 Brunswick Landing Venture PFAS Investigation
- January 2018 Site 4/Building 53 PFAS Investigation
- May 2018 Basewide PFAS Investigation
- May 2018 MEDEP Basewide PFAS Split Sampling
- August 2018 Cooks Corner Connector Road PFAS Investigation
- August 2018 Brunswick Landing Lot 15 PFAS Investigation (Round 1)
- November 2018 Brunswick Landing Lot 15 PFAS Investigation (Round 2)
- November 2018 Eastern Plume Extraction Well PFAS Investigation
- December 2018 Site 9 PFAS Investigation
- December 2018 Captains Way PFAS Investigation
- April 2019 Wild Oats PFAS investigation
- April 2019 Undocumented Orion Street Landfill PFAS Investigation
- April 2019 Blue Dog Day Care PFAS Investigation

In the 2020 PFAS report, due to the significant amount of PFAS investigations, the number of samples, environmental media, and the basewide nature of the investigations, smaller reporting areas for the PFAS investigations were created and are shown on **Figure 10-3**. These PFAS Reporting Areas have been used to reference historical data associated with current/ongoing PFAS investigations. A basewide PFAS Remedial Investigation was initiated in 2022 based upon the results and recommendations of the 2020 PFAS report and included sampling of soil, groundwater, surface water, sediment, stormwater, porewater, seeps, and springs. Additional supplemental investigations are ongoing.

Subsequent to the 2020 PFAS report, additional PFAS investigations have been conducted and include:

- June 2020 Storm Drain Sampling (Tetra Tech 2021)
- October 2021 – March 2022 Off-base Private Drinking Water Sampling (Tetra Tech 2023)
- April – May 2022 Jordan Avenue Wellfield Investigation (Tetra Tech 2022a)
- April 2022 – April 2023 PFAS RI
- September 2023 PFAS Shellfish Tissue Sampling
- October 2023 PFAS Finned Fish Tissue Sampling

- October 2023 PFAS RI Data Gap Investigation

The results of these investigations have been reported except for the PFAS RI, shellfish and finned fish sampling, and the PFAS RI Data Gap Investigation. Additional investigations related to the PFAS RI program are ongoing and, therefore, have not yet been reported. However, the PFAS shellfish and finned fish sampling data have been provided to the USEPA and MEDEP. Based on review of the data, MEDEP recommended that the Maine Center for Disease Control and Prevention (Maine CDC) be consulted as the data suggested potential unacceptable human health risks associated with the consumption of freshwater fish based on former NAS Brunswick PFAS RI screening levels. As a result, the Maine CDC issued a "Do Not Eat" freshwater fish advisory for the following waterbodies at former NAS Brunswick on August 23, 2024:

- Mere Brook from Coffin Ice Pond to the western side of airport runway
- Mere Brook from the eastern side of the airport runway to Liberty Crossing
- Merriconeag Stream
- Picnic Pond
- Site 8 Stream

It should be noted that on August 19, 2024, approximately 1,450 gallons of AFFF concentrate, mixed with approximately 50,000 gallons of water was released from the fire suppression system at Hangar 4 (refer to **Figure 10-3** for the location of Hangar 4). The mixture resulted in release of foam from Hangar 4 into an oil/water separator and through the sanitary sewer system and stormwater collection system. Emergency response to clean up the spill was immediately implemented and the spill has since been contained. MEDEP initiated a multi-media monitoring program which began in August 2024 which has included limited soil sampling, surface water sampling, and sampling of nearby off-facility private drinking water wells.

Most recently, MEDEP collected a sample from the Mere Creek Golf Course water supply on January 23, 2025 which included the analysis for PFAS. PFAS results indicate that PFOS was detected at a concentration of 19.9 parts per trillion (ppt), which exceeded the DoD PFAS Interim Action Level for private drinking water wells for PFOS of 12 ppt. Other detected PFAS that were below DoD PFAS Interim Action Levels (ASD 2024b) include PFOA and perfluorohexane sulfonic acid (PFHxS) detected at concentrations of 1.67 ppt and 0.763 ppt, respectively. Data have not been reported but are available on MEDEP's website (MEDEP 2025).

The Navy is currently determining the path forward for the ongoing PFAS RI program; however, since groundwater data has not been collected since the 2022/2023 PFAS RI, the Navy plans to conduct an additional round of PFAS sampling to monitor concentrations in key areas located on former NAS Brunswick. Groundwater samples collected as part of the 2022/2023 PFAS RI are shown on **Figure**

10-4. The planned investigation is to collect additional groundwater data to monitor PFAS concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFAS have been detected above DoD PFAS Interim Action Levels (ASD 2024b) in the water supply.

10.3 Site Geology and Hydrogeology

Geology

Site geology and hydrogeology data are based on data collected during various CERCLA investigations at former NAS Brunswick. The geology of the area around former NAS Brunswick is characterized by Pleistocene and Holocene unconsolidated sediments overlying Paleozoic bedrock. Thicknesses of the surficial unconsolidated sediments (and also depths to bedrock) vary from as little as a few feet over much of the southern portion of the installation and along the eastern and western installation boundaries to more than 100 feet in the northern half of the former installation and in a glacially scoured sediment-filled trough trending approximately north-northeast to south-southwest through the center of the southern half of the former installation.

Most of the northern portion of the former installation and those areas within the previously described glacially scoured trough is underlain by Pleistocene-aged regressive marine delta deposits described as interbedded sandy and silty beds. Individual beds dip gently to the east. Much of the remainder of the former installation is underlain by either Pleistocene-aged marine near-shore deposits (consisting of gravel, sand, or mud), the Presumpscot Formation (consisting of massive to laminated silty clays), or, primarily in elevated areas where bedrock is close to the ground surface, thin drift consisting of glacial till and/or thin layers of nearshore deposits. Sediments deposited in freshwater wetlands and recent alluvial material are present locally.

The predominant bedrock type at former NAS Brunswick is the Ordovician metamorphic Cape Elizabeth Formation described as a rusty weathering, thinly bedded, micaceous schist. The Cape Elizabeth Formation underlies all but the northwestern third of the former installation. The northwestern third of the former installation is underlain by the Ordovician metamorphic Cushing Formation, which is the basal unit in the Casco Bay Group. The Cushing Formation is described as a rusty weathering micaceous schist and interbedded gneiss (Tetra Tech 2022b).

Hydrogeology

Groundwater in the area occurs in both unconsolidated sediments and underlying bedrock. Groundwater is used as the municipal water supply for the Brunswick and Topsham Water District, located in the residential area north of former NAS Brunswick and also supplies those areas not connected to public water. The most productive aquifers in the area are the unconsolidated sand and gravel aquifers. Much of the northern half of the former installation is underlain by a significant sand

and gravel aquifer as indicated in Open File Report 99-18 (Neil and Locke 1999). On the former installation, the presence of this significant sand and gravel aquifer largely correlates with the presence of the regressive marine delta. These units are also present north and west of the former installation. The sand and gravel aquifers are reported to yield in excess of 10 gallons per minute (gpm) and may yield in excess of 50 gpm. The specific units are discontinuous and are obscured by development in some areas. The most common sequence encountered includes glacial outwash of variable thickness (five to 90 feet) overlying marine clays (Presumpscot Formation). The remainder of the former installation (the southern half of the former installation and the western and eastern former installation boundaries) is outside of the area described as a significant aquifer. These areas either do not contain water within unconsolidated sediments due to the lack of a significant thickness of unconsolidated material, or the units in these areas are sufficiently fine grained that wells installed in these areas yield less than 10 gpm.

Generally, groundwater flows south across most of former NAS Brunswick with an east/southeastern trend in the vicinity of Merriconeag Stream and Mere Brook. An east/west trending groundwater divide is located near the northern terminus of the runway. Groundwater north of this groundwater divide generally flows north/northwest toward the Androscoggin River. Shallow groundwater may locally flow in other directions toward local surface waterbodies. Shallow (upper sand) and deep (lower sand) groundwater overburden potentiometric surface figures from April 2023 are provided on **Figures 10-5 and 10-6**. A bedrock potentiometric surface figure from April 2023 is provided as **Figure 10-7**. Groundwater flow directions for various onbase areas are indicated by arrows on **Figures 10-5, 10-6, and 10-7**, for their respective water-bearing unit. The location of the groundwater divide separating northward and southward flowing groundwater regimes is identified on **Figure 10-6**. Depth to groundwater across the facility varies greatly and is largely dependent on land surface elevation. Groundwater depths typically range from 3 to 15 feet below ground surface (bgs) with local variations (Tetra Tech 2022b).

10.4 Potential Exposure Pathways and Receptors

Historical storage, handling, and usage (including training) practices for AFFF at former NAS Brunswick indicate that PFAS may have been released to the ground surface (surface soil, pavement, concrete, etc.). PFAS can adsorb to soil and be transported via wind erosion or overland flow or can dissolve in surface water to be transported in solution to downgradient areas via overland flow. PFAS can ultimately migrate to groundwater via leaching and be transported via groundwater flow to other locations. Groundwater discharge to surface water bodies is also possible (Tetra Tech 2022b). Potential receptors include residents who may be exposed to PFAS in groundwater used for drinking water.

10.5 Environmental Media Targeted for Planned Investigation

The planned investigation is designed to assess PFAS-impacted groundwater in the shallow overburden, deep overburden, and bedrock aquifers located beneath former NAS Brunswick.

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

(UFP-QAPP Manual Section 2.6.1)

11.1 Problem Statement

The Navy has conducted numerous investigations at the former NAS Brunswick base between 2010 and 2023 to evaluate the extent of PFAS on the former base property. These investigations have identified the presence of PFAS, specifically PFOS and PFOA, in groundwater, surface water, sediment, and stormwater. The Navy is currently determining the path forward for the ongoing PFAS RI program; however, since groundwater data has not been collected since the 2022/2023 PFAS RI, the Navy plans to conduct additional PFAS sampling to monitor concentrations in key areas located on former NAS Brunswick. Specifically, additional data is needed to monitor concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFOS has been detected above DoD PFAS Interim Action Levels (ASD 2024b) in the water supply.

Analytical results from this investigation will be provided as a data deliverable in the form of a PFAS Groundwater Technical Memorandum. This data will aid the Navy in establishing the path forward for the separate, ongoing PFAS RI program and will ultimately be incorporated into the PFAS RI program.

11.2 Goals of the Study

The objective of this investigation is to collect data to evaluate whether PFAS concentrations in groundwater have decreased or increased within plume areas compared to historical PFAS sample results, monitor PFAS concentrations along the plume fringe areas and former base boundary, expand the PFAS dataset in existing bedrock monitoring wells, and identify if PFAS is present in groundwater in the vicinity of the Mere Creek Golf Course. To achieve this goal, the following principal study questions (PSQs) have been established:

- **PSQ 1**: Are PFAS concentrations within the plume increasing or decreasing from historical concentrations in each aquifer?
- **PSQ 2:** Are PFAS concentrations along the plume fringes increasing or decreasing from historical concentrations in each aquifer? Do concentrations suggest plume movement?
- **PSQ 3**: Are PFAS concentrations in downgradient areas along the former base boundaries increasing or decreasing from historical concentrations?
- **PSQ 4:** What are PFAS concentrations in existing bedrock monitoring wells? Are PFAS concentrations increasing or decreasing in bedrock monitoring wells previously sampled?

- **PSQ 5:** Are PFAS present at concentrations above project action levels (PALs) in bedrock monitoring wells located at the Quarry Area?
- **PSQ 6**: Are PFAS present at concentration above PALs in groundwater south of the Mere Creek Golf Course?

11.3 Information Inputs to Resolve the Problem

The inputs needed to resolve the project problem statement identified in Section 11.1 include the following measurements, observations, data, and PALs described below. Details of the sampling design are presented in Worksheet #17.

Chemical Data: Groundwater at former NAS Brunswick will be sampled to supplement the existing dataset to determine concentrations of PFAS. All samples, including quality assurance/quality control (QA/QC) samples, will be analyzed for 40 PFAS analytes via USEPA Method 1633.

PALs: The groundwater PALs for this investigation are as follows:

- Human health PALs:
  - Equal to the DoD-approved USEPA RSLs for tap water (November 2024) (USEPA 2024a), based on a target cancer risk level of 1E-06 and target hazard quotient (HQ) of 0.1, for the PFAS listed in the Memorandum from the ASD, *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (ASD 2025).
  - USEPA RSLs based on toxicity values that were not peer-reviewed and therefore do not meet the minimum data quality standards provided in the DoD *Instruction 4715.18 Emerging Chemicals of Environmental Concern* (DoD 2024) will not be incorporated in the PFAS Groundwater Monitoring Technical Memorandum.

The PALs will be protective of relevant site-specific current and potential future human health receptors. Ecological receptors and PALs are not applicable to the project. Worksheet #10 identifies the potential receptors. Ultimately, the results will be included as part of the separate, ongoing RI and compared to the latest DoD-approved human health screening levels for PFAS, as applicable, at the time of data evaluation to ensure the latest science is being considered. Individual PFAS with toxicity values that were not peer-reviewed and therefore do not meet the minimum data quality standards provided in *DoD Instruction 4715.18 Emerging Chemicals of Environmental Concern* (DoD 2024) will not be discussed in the PFAS Groundwater Monitoring Technical Memorandum or used for decision making purposes. These PFAS results will be provided in an appendix to the PFAS Groundwater Monitoring Technical Memorandum for comparison to appropriate screening levels if they become available in the future.

In March 2024, DoD approved the use of RSLs for bis(trifluoromethylsulfonyl)amine (TFSI) and perfluoropropanoic acid (PFPrA). However, TFSI and PFPrA are not included for analysis in this SAP because the laboratory is not DoD-accredited for these PFAS. In accordance with ASD guidance (ASD 2025), as laboratories receive accreditation for additional PFAS, the analyte lists presented in Worksheet #15 may be updated. A Field Task Modification Request (FTMR) will be prepared to document any new PFAS and their corresponding laboratory limits, as appropriate. The uncertainties associated with the lack of analytical data for individual PFAS that have DoD-approved screening levels at the time of the PFAS Groundwater Monitoring Technical Memorandum preparation will be discussed in the technical memorandum, as applicable.

The PALs are not intended to be used as cleanup levels and concentrations above the PALs would not automatically trigger a response action but suggest further site-specific consideration is appropriate. Conservative assumptions were made when selecting PALs. Site-specific refinements may be made during application of screening levels for use in the evaluation of analytical data.

Worksheet #15 presents the lowest of the human health PALs and other applicable criteria that may be used during the planned groundwater monitoring program and/or later stages of the CERCLA process, as applicable, in comparison to the laboratory limit of quantitation (LOQ), limit of detection (LOD), and/or detection limit (DL), per media and analyte. Laboratory LOQ, LOD, and DL values are compared against the PAL to determine whether a dataset of known quality and sufficient sensitivity can be obtained to meet project data quality objectives (DQO) based on the goals of the study presented in Section 11.2.

11.4 Boundaries of the Study

The following are the temporal, horizontal and vertical boundaries for this study:

- Temporal: Data are expected to be collected within a 1-month period during the fall of 2025.
- Horizontal: The population of interest is groundwater data horizontally bound by the designated installation boundary for this field mobilization as presented on Figure 10-1.
- Vertical: Sampling will be performed in three aquifers including the shallow overburden, deep overburden, and bedrock formations.

11.5 Analytic Approach

This PFAS groundwater monitoring approach has been developed to provide basewide groundwater PFAS concentration data to monitor concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFOS has been detected above DoD PFAS Interim Action Levels (ASD 2024b) in the water supply.

Specific decision rules have not been developed as part of this SAP as the data collected as part of the planned PFAS groundwater monitoring program will be used to aid the Navy in establishing the path forward for the separate, ongoing PFAS RI and will eventually be incorporated into the PFAS RI dataset. Analytical results from this investigation will be provided as a data deliverable in the form of a PFAS Groundwater Technical Memorandum.

11.6 Performance Criteria

The performance criteria for analytical data are as follows:

- Identify potential sources of study error (i.e., field error, analytical error)
- Establish and identify the methods used to reduce potential sources of error
- Determine how decision errors will be managed during the project

Sources of Error — Sources of error may be divided into two main categories: sampling errors and measurement errors. A sampling error occurs when the sampling design, planning, and implementation do not provide a representative range of heterogeneity. A measurement error occurs because of performance variance from laboratory instrumentation, analytical methods, and operator error. The USEPA identifies the combination of all these errors as a "total study error" (USEPA 2006). One objective of the investigation is to reduce the total study error so that decision-makers can be confident that the data collected accurately represent the chemical characteristics of the site.

Managing Decision Error — The investigation will utilize decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurement of analytes. Possible decision errors will be minimized during the field investigation by using the following methods:

- Use standard field sampling methodologies (as discussed in Worksheets #14, #18 and #21).
- Use applicable analytical methods and standard operating procedures (SOPs) for sample analysis by a competent analytical laboratory accredited through the National Environmental Laboratory Accreditation Program (NELAP) and Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).
- Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and replicated samples.

Decision errors associated with judgmental sampling are based on sample design and measurement errors. Assuming the best possible professional judgment was used to develop the biased sampling plan (i.e., sampling locations), the most important decision errors will be associated with field and laboratory techniques involved in the collection and analysis of the data.

Sampling Methodologies and Procedures – Possible decision errors generated by sampling errors will be minimized during the field investigation by applying standardized field sampling methodologies

(discussed in Worksheets #14, #18, #20, #21, and #22). Sampling activities will be performed as described in Worksheet #14 and the SOPs specified in this SAP. Potential cross-contamination issues will be minimized by following the sampling procedures presented in Worksheet #14 and in SOP 3-41, *Perfluoroalkyl Substance Field Sampling Protocol*.

Shortened Holding Times for PFAS (EPA Method 1633) – In accordance with the DoD Environmental Data Quality Workgroup (EDQW) *Recommendation to Address Shorter Holding Times for Specific Per- and Polyfluoroalkyl Substances (PFAS) When Using EPA Method 1633 for PFAS Investigations* (DoD 2025) (see **Appendix A**), the laboratory will be instructed to follow the recommended shortened holding times for select PFAS. As noted in Worksheet #19, none of the PFAS subject to these shortened holding times currently have associated toxicity factors or USEPA RSLs. As a result, any uncertainty related to holding time exceedances for these compounds is not expected to impact current decision-making. If the laboratory is unable to prepare and/or analyze samples within the shortened holding time, the holding time exceedance will be addressed during data validation.

Data Validation and Usability – Analytical data will be validated in accordance with the procedures described in Worksheets #34–36. Following validation, data usability will be assessed by the project team as outlined in Worksheet #37. This assessment will incorporate all relevant qualifiers and evaluate whether the data meets the project's performance and decision-making objectives.

Laboratory Reference Limits — For certain analytes, the PALs presented in Worksheet #15 may not be analytically achievable, thus, the DL, LOQ and/or LOD may be greater than the lowest PAL. Results between the LOQ and DL will be flagged with a J-qualifier and represent estimated values. Estimated values are regarded as usable for data assessment. Non-detected values will be reported at the LOD with a U qualifier. In cases where an individual PFAS is not detected and the LOD exceeds the PAL identified in Section 11.3, that specific chemical will be considered below detection limits. The uncertainties associated with elevated LODs will be discussed in the PFAS Groundwater Monitoring Technical Memorandum, as applicable.

11.7 Sampling Design

The sampling design for this SAP was developed to optimize resources and generate data to satisfy the data quality objectives. The critical objective is to obtain a quality dataset for additional groundwater data needed to monitor concentrations in high source areas, along plume fringe areas, along the former base boundary, within the bedrock aquifer where limited groundwater sampling has been conducted, as well as in areas in the vicinity of the Mere Creek Golf Course where PFOS has been detected above DoD PFAS Interim Action Levels (ASD 2024b) in the water supply. The plan for obtaining data, along with the sampling design and rationale, are described in detail in Worksheets #14, #17, and #18.

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SAP Worksheet #12: Field Quality Control (QC) Samples

(UFP-QAPP Manual Section 2.6.2)

Table 12-1: Measurement Performance Criteria Table — Groundwater Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators	Measurement Performance Criteria
Equipment Blank (EB)	PFAS	One per day for non-dedicated sampling equipment[1]	Accuracy/Bias/Contamination	No analytes ≥½ LOQ
Field Blank	PFAS	One per sampling event	Accuracy/Bias/Contamination	No analytes ≥½ LOQ
Field Duplicate	PFAS	One per 10 field samples	Precision	If the parent and duplicate results are greater than the LOQ, the Relative Percent Difference (RPD) must be ≤30%. If either the parent or duplicate result is less than the LOQ, use professional judgement.
Sample Cooler Temperature Indicator	PFAS	One per cooler	Representativeness	Temperature must be > 0 degrees Celsius and ≤ 6 degrees Celsius

Notes:

[1] Equipment rinsate blanks will be collected if decontamination is required and will not apply if dedicated or disposable equipment is used.

> = Greater Than
≥ = Greater Than or Equal To
≤ = Less Than or Equal To
% = Percent
EB = Equipment Blank
LOQ = Limit of Quantitation
PFAS = Per- and Polyfluoroalkyl Substances
QC = Quality Control
RPD = Relative Percent Difference

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SAP Worksheet #13: Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Historical Background Information, Conceptual Site Model, Analytical Data	*Tier II Sampling and Analysis Plan Perfluorinated Compounds in Groundwater, Former Naval Air Station Brunswick, Brunswick, Maine, October 2014*	*Originating Organization*: Resolution Consultants *Data Types*: Background information, conceptual site model, analytical data *Data Collection Dates*: 2010 - 2012	Background information, conceptual site model, and historical analytical results were used in planning of the sampling effort.	None
Historical Background Information, Conceptual Site Model, Analytical Data	*Per- and Polyfluoroalkyl Substances (PFAS) Investigation Summary Report, Former Naval Air Station Brunswick, Brunswick, Maine, September 2020.*	*Originating Organization*: Resolution Consultants *Data Types*: Background information, conceptual site model, analytical data *Data Collection Dates*: 2010 - 2019	Background information, conceptual site model, and historical analytical results were used in planning of the sampling effort.	None
Historical Background Information, Conceptual Site Model	*Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) for Per- and Polyfluoroalkyl Substances Remedial Investigation, 2022*	*Originating Organization*: Tetra Tech *Data Types*: Background information, conceptual site model, analytical data *Data Collection Dates*: 2010 - 2019	Background information, conceptual site model, and historical analytical results were used in planning of the sampling effort.	None
Analytical Data	*Department of Navy analytical database*	*Originating Organization*: Department of the Navy *Data Types*: Analytical data *Data Collection Dates*: 2020-2023	Analytical data were used in planning of the sampling effort.	None

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SAP Worksheet #14: Summary of Project Tasks

(UFP-QAPP Manual Section 2.8.1)

The following project tasks are summarized below:

Field Tasks

- Mobilization/Demobilization
- Field Documentation Procedures
- Sampling of Water Supply Used for Investigation
- Monitoring Equipment Calibration
- Sample Collection and Sample Handling Tasks
- Synoptic Groundwater Level Measurements
- Groundwater Sampling
- Field Decontamination Procedures
- Investigation Derived Waste (IDW) Management

Data Analysis and Reporting Tasks

- Analytical Tasks
- Data Tracking; Data Storage, Archiving, and Retrieval; Data Security; Electronic Data
- Project Reports

14.1 Field Tasks

A short description of each field task is provided in this section.

14.1.1 Mobilization/Demobilization

Mobilization includes procurement of field equipment and supplies; a site walkover; mobilization of field staff, equipment, and supplies to the site; and site set-up. The Navy RPM and former NAS POC will be notified of mobilizations at least 14 days before commencement of field work to arrange for access to the site for all personnel.

A field team orientation meeting will be conducted before starting the fieldwork to familiarize the team personnel with the site-specific health and safety requirements, the objectives and scope of the field

activities, and chain-of-command. The meeting will be attended by the field staff and conducted by the FTL.

Demobilization includes removing field equipment and supplies from the site, returning rented equipment, managing IDW, performing general site cleanup, organizing and finalizing field paperwork, and entering field records/data into the database.

14.1.2 Field Documentation Procedures

Field documentation will be performed in accordance with Resolution Consultants SOP 3-02 *Logbooks* and SOP 3-03 *Recordkeeping, Sample Labeling, and Chain of Custody*. Sample collection information will be recorded in bound field logbooks or specific field forms. A summary of field activities will be properly recorded in indelible ink in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use. All entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction; and the person making the correction will initial and date the change. Boring logs, sampling forms, calibration forms, and other field forms will also be used to document field activities.

14.1.3 Sampling of Water Supply Used for Investigation Activities

Available PFAS data will be reviewed for the facility's potable water source to determine if it is acceptable to be used as source water (i.e., decontamination water). Analytical data collected in accordance with the Assistant Secretary of Defense *Memorandum for Sampling of Per- and Polyfluoroalkyl Substances in DoD-Owned Drinking Water Systems* (ASD 2023b) or the subsequent *Memorandum: Policy for Per- and Polyfluoroalkyl Substances Monitoring and Treatment in DoD-Owned Drinking Water Systems in the United States* (ASD 2024c) will be used to evaluate Navy facilities. Data from the Fifth Unregulated Contaminant Monitoring Rule (UCMR) will be used to evaluate off base potable water supply systems.

Potable water at former NAS Brunswick is provided by the Brunswick Topsham Water District (BTWD). The Fifth UCMR data for the BTWD were compared to the USEPA Maximum Contaminant Levels (MCLs) (USEPA 2024) and some select non-regulatory health-based reference concentrations. The review indicated all PFAS concentrations were detected below the method reporting limits, and where screening values were available, the PFAS method reporting limits were below the USEPA MCL. Based on a comparison of the Fifth UCMR results to the USEPA MCLs, the water from former NAS Brunswick is suitable for use as site decontamination water.

14.1.4 Monitoring Equipment Calibration

Field equipment will consist of a photoionization detector (PID) and water quality meter and will be calibrated by the FTL or designee in accordance with Resolution Consultants SOP 3-20 *Operation and Calibration of a Photoionization Detector,* SOP-23 *Operation and Calibration of YSI Multi-*

Parameter Water Quality Monitor, and SOP 03-24 *Water Quality Parameter Testing*. Documentation of the field equipment calibration will be conducted in accordance with Resolution Consultants SOP 3-02 *Logbooks* and SOP 3-24 *Water Quality Parameter Testing*. Field equipment should be calibrated at the beginning of each day and a continuing calibration verification (CCV) conducted at the end of each day, unless otherwise stated by the equipment manufacturer.

14.1.5 Sample Collection and Sample Handling Tasks

The groundwater program is outlined in Worksheets #17 and #18. Sample collection and handling will be in accordance with the SOPs listed in Worksheet #21. Sample labeling will be in accordance with Resolution Consultants SOP 3-03 *Recordkeeping, Sample Labeling, and Chain of Custody* and Worksheet #27. Field QC samples will be as shown in Worksheet #12. Methods for sample handling will be in accordance with Resolution Consultants SOP 3-04 *Sample Handling, Storage, and Shipping*. Sample containers will be provided in "certified-clean" condition from the analytical laboratory. Sample containers, sample preservation, packaging, and shipping will be in accordance with Resolution Consultants SOP 3-04 *Sample Handling, Storage, and Shipping* and Worksheet #19. PFAS samples will be collected in accordance with Resolution Consultants SOP 3-41 *Per- and Polyfluoroalkyl Substance Field Sampling Protocol*. Field QC samples will be collected as specified in Worksheet #12. Worksheet #20 presents the field QC sample summary.

14.1.6 Synoptic Groundwater Level Measurements

Before sampling, the depth to the static water level will be measured in wells shown in Table 17-1 using an electronic water level meter in accordance with Resolution Consultants SOP 3-14 *Monitoring Well Sampling*. The depth to groundwater will be measured in units of feet (to the nearest 0.01 foot) with respect to the measuring point identified on the well riser to determine the depth-to-water below the ground surface. Water levels will be recorded on a water level measurement form. The water level meter will be decontaminated before use and between each monitoring well.

14.1.7 Groundwater Sampling

Groundwater sampling will be performed in accordance with *SOP 3-14: Monitoring Well Sampling* and SOP 3-24 *Water Quality Parameter Testing*, and USEPA Region 1 Low-Flow Sampling Guidance (USEPA, 2017). The specific monitoring wells selected for groundwater sample collection are specified in Worksheets #17 & #18 and shown on **Figures 17-1, 17-2, and 17-3**. The monitoring wells will be purged before sampling using low-flow sampling techniques in accordance with Resolution Consultants SOP 3-14 *Monitor Well Sampling* and SOP 3-24 *Water Quality Parameter Testing.*

Groundwater samples will be collected after stabilization is achieved. Readings of field parameters will be recorded at a minimum of every three to five minutes; stabilization will be achieved when the last three consecutive measurements are at or below the following listed thresholds:

- Temperature: 3% of reading
- pH: ± 0.1 Standard Units
- Specific Conductance: ± 3.0% of reading
- Dissolved Oxygen: < 0.5 milligrams per liter (mg/L) or 10% for values ≥ 0.5 mg/L
- Oxidation-reduction potential: ± 10 millivolts
- Turbidity: ≤5 NTU, or within ± 10% if above 5 NTU

If stabilization criteria are unable to be reached, then five well screen volumes will be purged from the well (unless the well purges dry), after which the well will be sampled. If a monitoring well purges dry, then it will be allowed to recover before sample collection.

Samples will be collected using a peristaltic pump for the shallow wells (<25 feet) and a bladder pump or similarly equipped PFAS-free submersible pump for the deep wells (>25 feet). PFAS-free disposable tubing (i.e., high-density polyethylene [HDPE]) will be used for both pumps and HDPE bladders will be used for the bladder pumps. The bladder and tubing will be replaced with unused materials at each well location. Worksheets #17 and #18 specify the sample locations and analyses for this investigation, and Worksheet #23 specifies the analytical methods to be used. After collection, the samples will be placed in a cooler, chilled with ice, and shipped under chain-of-custody protocol to the appropriate laboratories for analysis.

14.1.8 Field Decontamination Procedures

Non-disposable equipment that contacts the sample medium will be decontaminated to prevent cross-contamination between sampling locations. Decontamination of sampling equipment will not be necessary for dedicated or disposable samplers. Decontamination of reusable sampling equipment will be conducted before sampling and between samples at each location. Decontamination water will be sourced from a spigot within the Eastern Plume groundwater extraction treatment system (GWETS) at Building 50. The source water will be evaluated according to Section 14.1.3 prior to use. The decontamination procedures in Resolution Consultants SOP 3-06: *Equipment Decontamination* will be followed.

14.1.9 Investigation Derived Waste Management

IDW includes excess environmental media, decontamination fluid, used personal protective equipment (PPE), used disposable sampling equipment, etc. IDW generated during the sampling activities will be managed in an environmentally responsible manner consistent with the PFAS IDW disposal guidance provided in the Navy Interim PFAS Site Guidance (DON 2020), July 2023 Interim Guidance on Destruction or Disposal of Materials Containing Per- and Polyfluoroalkyl Substances in the United States (ASD 2023b), former NAS Brunswick requirements (e.g., designation of staging areas), and Resolution Consultants SOP 3-05 *Investigation Derived Waste Management*. All disposal

facilities will be listed on the Defense Logistics Agency Qualified Facilities List. The objectives of the IDW management are:

- Managing IDW in a manner that prevents contamination of uncontaminated areas (by IDW) and that is protective of human health and the environment
- Minimizing IDW, thereby reducing costs and the potential for human or ecological exposure to contaminated materials
- Managing, characterizing, and disposing IDW in compliance with all federal, state, and local laws, as well as with any additional requirements identified by the waste disposal facility

IDW generated during the field program is expected to consist only of well purge water and water generated during decontamination. This aqueous IDW will be disposed of at the Eastern Plume groundwater extraction treatment system (GWETS) located on Purinton Road Building 50. Disposable PPE and disposable sampling equipment/materials will be disposed of as general refuse at an approved disposal location.

14.2 Analytical Tasks

Chemical analysis will be performed by Katahdin, a DoD ELAP accredited laboratory. Copies of the laboratory accreditation are included in **Appendix B**. Analyses will be performed in accordance with the analytical methods specified in Worksheets #19 and #30, and the *Department of Defense Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories*, 6.0, December 2023. The laboratory will strive to meet the values specified in Worksheet #15 and chemical analyses will be in compliance with the DoD Quality Systems Manual (QSM) while following the laboratory-specific SOPs identified in Worksheet #23. If the laboratory is accredited for a newer version of the QSM, the Navy Quality Assurance Officer must be consulted prior to use, and a Field Task Modification Request Form (FTMR) will be initiated to reflect the change in accreditation. Laboratory SOPs are available upon request.

The laboratory will provide results in a Stage 4 analytical data package for all data which includes all laboratory QC forms and raw data.

14.3 Data Management and Review

The principal data generated for this project will be laboratory analytical data. The field forms, chain of custody forms, and logbooks will be placed in the project files after the completion of the field program. The field logbooks for this project will be used only for this site and will be categorized and maintained in the project files after the completion of the field program. All project records will be maintained in a secure location.

14.3.1 Data Tracking

The CTO Manager, or designee, is responsible for the overall tracking and control of data generated for the project. Data are tracked from generation to archiving in the project-specific files. The Project Chemist, or designee, is responsible for tracking the samples collected and shipped to the subcontracted laboratory. Upon receipt of the data packages from the analytical laboratory, the Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by the analytical laboratory.

Resolution Consultants shall submit all Administrative Record Files, Site Files, and Post Decision Files in accordance with the specifications defined in the NAVFAC Environmental Restoration Recordkeeping Manual (NAVFAC 2017) and subsequent changes. Additionally, Resolution Consultants will update and manage the project-related documents, data, and maps in NIRIS. Project-related spatial data including maps, models, and associated collected or created data will also be uploaded into NIRIS. All documentation submittals for NIRIS will be coordinated with the Navy RPM.

14.3.2 Data Review and Validation

Data verification and validation are described in Worksheets #34-#36, while the data usability assessment is described in Worksheet #37.

14.3.3 Data Storage, Archiving, and Retrieval

After the data are validated, the data packages are entered into the Resolution Consultants file system and archived in secure files. The field records including field logbooks, sample logs, and chain-of-custody records will be submitted by the Resolution Consultants FTL to be entered into the file system before archiving in secure project files. Project files are audited for accuracy and completeness. Project files will be kept in a secured, limited-access area.

14.3.4 Data Security

Access to Resolution Consultants project files is restricted to designated personnel only. The Resolution Consultants data manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

14.3.5 Electronic Data

Laboratory data, provided in electronic format, will be verified for accuracy before use and during the data validation process. After data are validated, the electronic data results will be uploaded into the Resolution Consultants database for use in data evaluation and subsequent report preparation. The project database will be on a password-protected secure network and access to changing data files will be restricted to qualified personnel. The CTO Manager (or designee) is responsible for the overall tracking and control of data generated for the project. Electronic analytical results will also be verified, entered, and maintained in a database on a password-protected Structured Query Language server.

Data qualifiers will be added to the database during data validation. After validation, the validated data files will be transferred to the NIRIS database via NAVFAC Electronic Data Deliverables (NEDDs) for final repository as soon as the data has been validated, and no later than three months following the collection of the samples.

Per the August 2023 ASD Memorandum *Managing Controlled Unclassified Information in Department of Defense Environmental Cleanup Data and* Reports (ASD 2023c), electronic data, including analytical and spatial information (latitude and longitude) will be shared with MEDEP. Data will be provided to MEDEP in an environmental and geographic analysis database (EGAD) compliant electronic data deliverable (EDD) format.

14.4 Project Reports

Project documents and records obtained during project activities (e.g., calibration logs, boring logs, validation reports, etc.) are identified on Worksheet #29.

Analytical results from this investigation will be provided as a data deliverable in the form of a PFAS Groundwater Technical Memorandum. This data will aid the Navy in establishing the path forward for the separate, ongoing PFAS RI program and will ultimately be incorporated into the PFAS RI program. The PFAS Groundwater Monitoring Technical Memorandum will be submitted to BRAC PMO East for initial review. BRAC PMO East comments will be addressed, and the Final technical memorandum will be submitted to USEPA and MEDEP for their records.

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SAP Worksheet #15: Reference Limits and Evaluation Tables

(UFP-QAPP Manual Section 2.8.1)

Worksheet #15 Table 15-1 identifies the project action limits (PALs). The table also identifies the laboratory reference limits and project quantitation limit goals as defined below:

- Detection Limit (DL) – The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type I error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.

- Limits of Detection (LOD) – The smallest concentration of a substance that must be present in a sample in order to be detected at the detection limit (DL) with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.

- Limit of Quantitation (LOQ) – The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias.

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SAP Worksheet #16: Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)

Project Schedule

Task	Start Date	End Date
SAP Preparation	June 2025	October 2025
Field Investigation	November 2025	November 2025
Laboratory Analysis & Data Validation	December 2025	February 2026
Results provided to Navy for inclusion into PFAS RI	March 2026	March 2026
Investigation Summary Technical Memorandum	April 2026	April 2026

Notes:
PFAS = Per- and Polyfluoroalkyl Substances
RI = Remedial Investigation
SAP = Sampling and Analysis Plan

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SAP Worksheet #17: Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

17.1 General Sampling Design and Rationale

The sampling design and rationale proposed for former NAS Brunswick will satisfy the objectives identified in Worksheets #10 and #11.

Samples will be collected as described in Worksheet #14 and using the SOPs identified in Worksheet #21. Katahdin will be subcontracted to provide the necessary analytical services. Laboratory accreditation certificates for Katahdin may be found in **Appendix B**. The number of samples to be analyzed for each matrix and analytical group or target analyte are identified in Worksheet #18. Worksheet #19 presents a summary of the sample analyses, container types and volumes, preservation requirements, and holding times for the samples to be collected. Field QC samples will be collected as described in Worksheet #12 and summarized in Worksheet #20.

Figures 17-1, 17-2 and 17-3 graphically depict the sample locations proposed in the sampling design.

17.2 Groundwater Sampling

Groundwater samples will be collected from 60 existing monitoring wells as shown on **Figures 17-1, 17-2 and 17-3.** The rationale for location and screened intervals for monitoring well sampling are provided on **Table 17-1**. Sample locations are based on review of historical and current PFAS concentrations in each of the aquifer units (i.e., shallow overburden, deep overburden, and bedrock). In general, locations are based on continued monitoring of PFAS within a plume, along the plume boundary, or along the former base boundary to monitor PFAS concentrations and plume movement. A few monitoring wells have also been included in areas outside of previously known PFAS source areas to determine if PFAS is present. Proposed sample locations in the shallow overburden, deep overburden, and bedrock aquifers are presented on **Figures 17-1, 17-2, and 17-3**, respectively.

Synoptic water level gauging, with measurements collected within a single eight-hour period, will be performed at all monitoring wells that will be sampled in accordance with the details provided Worksheet #14.

Analytical results from this investigation will be provided as a data deliverable in the form of a PFAS Groundwater Technical Memorandum. This data will aid the Navy in establishing the path forward for the PFAS RI program and will ultimately be incorporated into the separate, ongoing PFAS RI dataset.

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SAP Worksheet #18: Location-Specific Sampling Methods/SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Sample Location	Sample ID[1]	Monitored Interval (feet bgs)	Number of Samples[2]	Analytical Group	Sampling SOP Reference[3]
Upper Sand/Shallow Groundwater					
MW-JA03S	NASB-MW-JA03S-MMDDYY	35 - 45	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
TW-04	TW-04-MMDDYY	8 – 18	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
TW-05	TW-05-MMDDYY	0 – 5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
TW-06	TW-06-MMDDYY	10 - 20	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-BG-MW-06	NASB-BG-MW-06-MMDDYY	13 - 18	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NW-NASB-093	NW-NASB-093-MMDDYY	6 - 16	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-ONFF-002R	MW-ONFF-002R-MMDDYY	34- 44	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-ONFF-004	MW-ONFF-004-MMDDYY	20 - 30	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-529	MW-529-MMDDYY	10 -20	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-BG-MW-18	NASB-GB-MW-18-MMDDYY	3 – 8	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-502	MW-502-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-NBA-MW-531	NASB-NBA-MW-531-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-808	MW-808-MMDDYY	10 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-H123-MW07	NASB-H123-MW07-MMDDYY	7 - 12	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-08	PFC-MW-08-MMDDYY	3 - 13	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-526	MW-526-MMDDYY	10 -20	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-508	MW-508-MMDDYY	10 -20	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-10	PFC-MW-10-MMDDYY	4 - 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-11	PFC-MW-11-MMDDYY	4 - 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-NASB-010	MW-NASB-010-MMDDYY	4 - 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-B250-15	MW-B250-15-MMDDYY	5 – 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-09-22	MW-09-22-MMDDYY	5 – 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-NASB-071	MW-NASB-071-MMDDYY	7 – 17	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-B250-09	MW-B250-09-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4

Sample Location	Sample ID[1]	Monitored Interval (feet bgs)	Number of Samples[2]	Analytical Group	Sampling SOP Reference[3]
ASA-MW-08	ASA-MW-08-MMDDYY	9 – 19	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-15	PFC-MW-15-MMDDYY	4 – 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-09-001S	MW-09-001S-MMDDYY	4.5 – 14.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-12	PFC-MW-12-MMDDYY	4 - 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PFC-MW-13	PFC-MW-13-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-522	MW-522-MMDDYY	30 - 40	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-307	MW-307-MMDDYY	12 - 22	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-1104	MW-1104-MMDDYY	24 - 34	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-B35-MW03	NASB-B35-MW03-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-513	MW-513-MMDDYY	8 – 18	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-BG-MW-21	NASB-BG-MW-21-MMDDYY	1 - 6	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-BG-MW-25	NASB-BG-MW-25-MMDDYY	5 - 15	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-340S	MW-EP-340S-MMDDYY	48 - 58	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
PZ-MB-B6B	PZ-MB-B6B-MMDDYY	9 - 14	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-318	MW-318-MMDDYY	12 - 22	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-02-307	MW-02-307-MMDDYY	5.7 – 15.7	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-2101R	MW-2101R	18.5 – 28.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
Lower Sand/Deep Groundwater					
MW-JA03D	MW-JA03D-MMDDYY	55 - 65	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-813	MW-813-MMDDYY	32.5 - 42.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-EFA-07D	NASB-EFA-07D-MMDDYY	40 - 45	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-508D	MW-508D-MMDDYY	52 - 62	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-EFA-MW09	NASB-EFA-MW09-MMDDYY	24 - 34	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-509D	MW-509D-MMDDYY	34 - 44	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-B250-08	MW-B250-08-MMDDYY	32.5 - 42.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-NASB-227	MW-NASB-227-MMDDYY	27 – 27	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-09-001	MW-09-001-MMDDYY	30 - 40	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-510D	MW-510D-MMDDYY	26.2 - 36.2	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4

Sample Location	Sample ID[1]	Monitored Interval (feet bgs)	Number of Samples[2]	Analytical Group	Sampling SOP Reference[3]
MW-NASB-077	MW-NASB-077-MMDDYY	25 – 35	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-518D	MW-518D-MMDDYY	20.5 - 30.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
B611-MW01D	B611-MW01D-MMDDYY	48 - 58	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-B04-MW06	NASB-B04-MW06-MMDDYY	35 - 45	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-NASB-212R	MW-NASB-212R-MMDDYY	40 - 50	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-343	MW-EP-343-MMDDYY	68 - 78	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-331	MW-331-MMDDYY	44 - 54	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-208	MW-208-MMDDYY	91 - 101	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-MB05C	MW-MB05C-MMDDYY	44.5 - 54.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-351	MW-EP-351-MMDDYY	23 - 33	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-354	MW-EP-354-MMDDYY	29 - 34	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-334	MW-334-MMDDYY	35 - 45	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-315A	MW-315A-MMDDYY	64.5 - 74.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
NASB-BG-MW-36	NASB-BG-MW-36-MMDDYY	54 – 64	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-310	MW-310-MMDDYY	61 – 71	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-335	MW-335	76 – 86	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
Bedrock Groundwater					
MW-316A	MW-316A-MMDDYY	89.5 - 99.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-316B	MW-316B-MMDDYY	45 – 55	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-317A	MW-317A-MMDDYY	108 - 118	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-317B	MW-317B-MMDDYY	84.5 – 95.5	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-QRY-02	MW-QRY-02-MMDDYY	12 - 22	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-QRY-13D	MW-QRY-13D-MMDDYY	31.8 - 41.8	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-NASB-047	MW-NASB-047-MMDDYY	23 - 28	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-503BR	MW-503BR-MMDDYY	40 - 50	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-323	MW-323-MMDDYY	29 - 39	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-341-B1	MW-EP-341-B1-MMDDYY	73 - 78	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-EP-341-B2	MW-EP-341-B2-MMDDYY	88 - 93	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4

Sample Location	Sample ID(1)	Monitored Interval (feet bgs)	Number of Samples(2)	Analytical Group	Sampling SOP Reference(3)
MW-EP-342-B1	MW-EP-342-B1-MMDDYY	63.2 - 68.2	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
MW-309A	MW-309A-MMDDYY	59 - 69	1	PFAS	SOP 3-14, SOP 3-24, SOP 3-41, EQASO-GW4
QC Samples					
Field Duplicates (FD)	NASB-FDXX-MMDDYY	NA	8	PFAS	NA
Field Blank (FB)	NASB-FBXX-MMDDYY	NA	1	PFAS	NA
Equipment Blank (EB)	NASB-EBXX-MMDDYY	NA	14	PFAS	NA

Notes:

bgs = below ground surface
NA = not applicable
PFAS = Per- and Polyfluoroalkyl Substances
QC = Quality Control
SOP = Standard Operating Procedure

(1) Sample IDs as listed and the “MMDDYY” will be replaced with the year, month, and day the sample was collected. For example, a sample collected from monitoring well MW-JA03S on June 19, 2025, the sample ID will be NASB-MW-JA03S-061925. For QC sample IDs, samples will be numbered with an ascending sequential number (“XX”) to differentiate samples. For example, the first field duplicate sampled collected on June 19, 2025, the sample ID will be NASB-FD01-061925.
(2) The number of additional QC samples will be based on the type of QC collected and as described in Worksheet #20.
(3) SOP that describes the sample collection procedures.

SAP Worksheet #19: Field Sampling Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers (number, size, and type)(1)	Minimum Sample volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time(2,3) (preparation/analysis)
Aqueous	PFAS	USEPA Method 1633 with QSM 6.0 Table B-24/CA-409/CA-556	Two 500 mL high-density polyethylene (HDPE) bottles with no Teflon liners	500 mL	Cool to 0 - 6 °C, no preservative	Collection to prep: 90 days when stored at ≤–20 °C and protected from light; or 28 days when stored at 0–6 °C and protected from light. Extraction to analysis: Up to 90 days when stored at ≤–20 °C or 0–6 °C and protected from light.

Notes:

°C = Degrees Celsius
HDPE = High-Density Polyethylene
mL = milliliter
PFAS = Per- and Polyfluoroalkyl Substances
QSM = Quality Systems Manual
SOP = Standard Operating Procedure
USEPA = United States Environmental Protection Agency

1. PFAS sample containers will be lot-certified by the laboratory to be PFAS-free.
2. Maximum holding time is calculated from the time the sample is collected to the time the sample is extracted, digested, or analyzed.
3. In accordance with the recommendations from the DoD Environmental Data Quality Workgroup, if holding times are exceeded—specifically, the 7-day limit for NMeFOSE, NEtFOSE, NMeFOSAA, and NEtFOSAA in aqueous matrices (not stored at -20°C) or the 28-day limit for 9Cl-PF3OUdS and 11Cl-PF3ONS following extraction—data will be qualified as estimated J for detects and UJ for non-detects. While it is acknowledged that exceeding these holding times introduces additional uncertainty, these results can still be used for decision-making purposes. Source: DoD Environmental Data Quality Workgroup, Memorandum dated 27 March 2025 (DoD 2025) (see **Appendix A**).

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SAP Worksheet #20: Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sample Locations	No. of FDs	No. of FB	No. of EBs	Total No. of Samples to Laboratory
Groundwater	PFAS	80	8	1	14	103

Notes:
Locations where samples are collected for field QC samples may be altered at the discretion of the Resolution FTL as long as the reallocations support the attainment of project objectives.

QA/QC Sample Collection:
Field Duplicate (FD) = one per 10 field samples
Field Blank (FB) = one per sampling event
Equipment Blank (EB) = one per day for non-disposable sampling equipment; additional EBs may be collected at the discretion of the FTL

Water used for equipment blanks will be provided by the laboratory.
Equipment blanks will be collected if any sample equipment decontamination is performed in the field.

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SAP Worksheet #21: Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

The SOPs most relevant to the sample collection activities described in this SAP are presented in the following table. The field standard operating procedures presented below are in **Appendix C.**

SOP Reference #	Title, Revision, Date	Originating Organization	SOP Option or Equipment Type	Modified for Project? Y/N	Comments
SOP 3-02	Logbooks, Revision 3	Resolution Consultants	None	N	None
SOP 3-03	Recordkeeping, Sample Labeling, and Chain of Custody, Revision 3	Resolution Consultants	None	N	None
SOP 3-04	Sample Handling, Storage, and Shipping, Revision 4	Resolution Consultants	None	N	None
SOP 3-05	Investigation Derived Waste Management, Revision 6	Resolution Consultants	None	N	None
SOP 3-06	Equipment Decontamination, Revision 3	Resolution Consultants	Buckets, brushes	N	None
SOP 3-14	Monitor Well Sampling, Revision 3	Resolution Consultants	Pump, tubing, meters, water level probe, sample kits	N	Use in conjunction with SOP EQASOP-GW4
SOP 3-20	Operation and Calibration of a Photoionization Detector, Revision 3	Resolution Consultants	PID, Calibration Gas, Regulator, Tedlar Bag	N	None
SOP 3-23	Operation and Calibration of Yellow Spring Instrument (YSI) Multi-Parameter Water Quality Monitor, Revision 1	Resolution Consultants	YSI Sonde	N	None
SOP 3-24	Water Quality Parameter Testing, Revision 3	Resolution Consultants	Water quality meters	N	None
SOP 3-41	Per- and Polyfluoroalkyl Substance Field Sampling Protocol, Revision 8	Resolution Consultants	None	N	None

SOP Reference #	Title, Revision, Date	Originating Organization	SOP Option or Equipment Type	Modified for Project? Y/N	Comments
EQASOP-GW4	Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision 4	USEPA	Pump, tubing, meters, water level probe, sample kits	N	Used in conjunction with SOP 3-14

Notes:

PID = Photoionization Detector
SOP = Standard Operating Procedures
USEPA = United States Environmental Protection Agency
YSI = Yellow Spring Instrument

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

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Inspection/ Calibration Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference	Spare Parts (Keep on hand)
Photoionization Detector	Visual Inspection; Calibration/Verification	Daily before use, every 20 readings, or anytime unstable readings occur	Isobutylene reads 100 parts per million (ppm) +/- 2 percent	Operator correction or replacement	FTL or designee	SOP 3-20	Tedlar bag, regulator
Peristaltic Pump GeoTech Series II (or similar)	Visual Inspection; Field checks as per manufacturer	Daily/Beginning of each day	Pump is variable speed and therefore, acceptance is based on pumps ability to pump at rate necessary to achieve stable flow from various wells.	Operator correction or replacement	FTL or designee	Manufacturer's Manual	Batteries
Bladder Pump (QED Sample Pro (or similar)	Visual Inspection; Field checks as per manufacturer	Daily/Beginning of each day	Pump is pneumatic driven, acceptance is based on pumps ability to pump at rate necessary to achieve stable flow from various wells without leaking air.	Operator correction or replacement	FTL or designee	Manufacturer's Manual	New bladders for each well, O-rings, check valves, grab plates
Water Quality Parameter Instrument: YSI Pro Series YSI 556/650 In-Situ Aqua TROLL Horiba U Series Or similar instrument	- Visual Inspection - IC - CV - CCV	- Visual inspection - daily - IC – Daily before use - Calibration Verification (CV) – Immediately following completion of Initial Calibration (IC) and anytime erroneous readings are encountered - CCV – End of each day used	To pass acceptance criteria, the deviation of each parameter must be within the variances listed below: - pH: ± 0.2 Standard Units of pH buffer true value - Specific Conductance: ± 5.0% of standard true value - Dissolved Oxygen: ±0.3 mg/L of theoretical value at that temperature - ORP: ± 10 millivolt (mV) of standard true value at that temperature	Operator correction or replacement	FTL or designee	SOP 3-24, manufacturer's guidance manual	Batteries, calibration solutions, gaskets, membranes
Turbidity Meter: Hach 2100Q Geotech Hanna HI98703 LaMotte 2020we/2020wi Or similar instrument	- Visual Inspection - IC - CV - CCV	- IC – Beginning of each day used - CV – Immediately following completion of IC and anytime erroneous readings are encountered - CCV – End of each day used	To pass acceptance criteria, the deviation of each parameter must be within variances listed below: - 0.1-10 NTU: within 10% of the standard - 11-40 NTU: within 8% of the standard - 41-100 NTU: within 6.5% of the standard	Operator correction or replacement	FTL or designee	SOP 3-24, manufacturer's guidance manual	Batteries, sample vials
Electronic Water Level Indicator: Solinst Model 101 Geotech ET/ETL Heron Dipper/Skinny Dipper Or similar instrument	- Visual Inspection - Field checks as per manufacturer	- Upon receiving from vendor - Daily	0.01-foot accuracy	Ensure the sensor is clean, tighten screw terminals on site of unit, operator correction, or replacement	FTL or designee	SOP 3-14, manufacturer's guidance manual	Batteries

Notes:

%	=	Percent
CCV	=	Continuing Calibration Verification
CV	=	Calibration Verification
FTL	=	Field Team Leader
IC	=	Initial Calibration
mg/L	=	milligrams per Liter
mV	=	Millivolt
NTU	=	Nephelometric Turbidity Unit
ORP	=	Oxidation-Reduction Potential
pH	=	Potential of Hydrogen
ppm	=	parts – per - million
SOP	=	Standard Operating Procedure
YSI	=	Yellow Spring Instrument

SAP Worksheet #23: Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

Laboratory Name and Address: Katahdin, 600 Technology Way, Scarborough, Maine 04074
Laboratory Point of Contact: Heather Manz, 207-303-0917, Heather.Manz@sgs.commailto:

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to Quality Systems Manual	Modified for Project Work? (Yes/No)
CA-409	Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solids, and Biosolids by LC-MS/MS, 5/29/24, Revision 4[1] (Reviewed 7/3/25)	Definitive	Groundwater/PFAS	Liquid Chromatography Tandem Mass Spectrometer (LC/MS/MS)	No	No

Notes:
[1]Katahdin DoD ELAP accreditation is ANSI National Accreditation Board (ANAB) Certificate No L2223 (exp. 2/1/2027) for QSM 6.0 and USEPA 1633 Final Version.

DoD	=	Department of Defense
DoD ELAP	=	DoD Environmental Laboratory Accreditation Program
LC/MS/MS	=	Liquid Chromatography Tandem Mass Spectrometer
NA	=	Not Applicable
PFAS	=	Per- and Polyfluoroalkyl Substances
SOP	=	Standard Operating Procedure
USEPA	=	Environmental Protection Agency

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SAP Worksheet #24: Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
LC/MS/MS	Ion transitions (Precursor --> Product)	Every field sample, standard, blank and QC samples	If a qualitative or quantitative standard containing an isomeric mixture (branched and linear isomers) of an analyte is commercially available for an analyte, the quantification ion used must be the quantification ion identified in Table 10 of Final EPA 1633 unless interferences render the product ion unusable as the quantification ion. If these transitions are not used, the reason must be technically justified and documented in the Case Narrative (e.g., alternate transition was used due to observed interferences). documented in the Case Narrative (e.g., alternate transition was used due to observed interferences)	Not Applicable.	Analyst/Supervisor	CA-409
LC/MS/MS	Mass calibration (USEPA Method 1633)	Initially, annually, and after performing major maintenance to maintain instrument sensitivity and stability. Instrument must have a valid mass calibration before any sample analysis.	Calibration of the mass scale of the MS must be performed using the calibration compounds and procedures per manufacturer specifications. Mass calibration must be performed in Multiple Reaction Monitoring mode.	No samples may be analyzed under a failing mass calibration. If the mass calibration fails, consult manufacturer instructions on corrective maintenance. Flagging is not appropriate.	Analyst/Supervisor	CA-409

Instrument	CalibrationProcedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
LC/MS/MS	Mass calibration verification (USEPA Method 1633)	Mass calibration must be verified after each mass calibration and before the ICAL.	Mass calibration verification must be performed using the procedures per manufacturer specifications. Manufacturer's QC acceptance criteria must be met.	Check the mass calibration by measuring the amount of peak drift from the expected masses. If the peak apex has shifted more than approximately 0.2 atomic mass units, then the instrument will need to be recalibrated to the max axis following the manufacturer's instructions Flagging is not appropriate.	Analyst/Supervisor	CA-409
LC/MS/MS	Ion Ratio	All analytes detected in a sample	The ion ratio must fall within 50-150% of the observed ratio in the mid-point calibration standard.	Apply a flag to the result associated with the failure and document exceedance in the case narrative.	Analyst/Supervisor	CA-409
LC/MS/MS	Retention Time Window (USEPA Method 1633)	Every field sample, standard, blank, and QC sample for each analyte and EIS.	Retention time of each analyte and EIS analyte must fall within 0.4 minutes of the predicted retention times from the midpoint standard of the IC on days when the IC is performed, or from the initial daily CCV. All branched isomer peaks identified in either the calibration standard or the qualitative (technical grade) standard must fall within the retention time window for that analyte.	Not applicable	Analyst/Supervisor	CA-409
LC/MS/MS	Relative Retention Time Window (EIS RRT) (USEPA Method 1633)	Each analyte that has a labeled EIS analog.	Analytes must elute within 0.1 minutes of the associated EIS. This criterion applies only to analyte and labeled analog pairs.	Correct problem and reanalyze samples.	Analyst/Supervisor	CA-409

Instrument	CalibrationProcedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
LC/MS/MS	ICAL (USEPA Method 1633)	At instrument set-up, whenever laboratory takes action that changes the chromatographic conditions, if either the CV, ICV, or ISC acceptance criteria have not been met.	Performed with a minimum of six calibration points, including native PFAS, EIS, and Non-Extracted Internal Standards (NIS) compounds (an additional calibration point is required for second order calibration model). At least five of the six calibration standards being used should be within the quantification range, and the lowest standard at or below the LOQ. If a second-order calibration model is used, then one additional concentration is required, with at least six of the seven calibration standards within the quantitation range. Peak Signal to Noise (S/N) ratio ≥ 3:1 for quantitation and confirmation ions, or S/N ≥ 10:1 for analytes that do not have a suitable confirmatory ion. The RSD of the response factors or the Relative Standard Error (RSE) for each native PFAS and EIS compound must be ≤ 20%.	Correct problem, then repeat ICAL. Flagging is not appropriate.	Analyst/Supervisor	CA-409

Instrument	CalibrationProcedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
LC/MS/MS	Instrument Blanks (DoD QSM Table B-24)	At the beginning of the analytical sequence and after the analysis of high concentration samples and standards (e.g., customer samples, highest calibration standard, calibration verification standard).	No analytes detected > ½ LOQ.	If acceptance criteria are not met after the highest calibration standard, calibration shall be performed using a lower concentration for the highest standard until acceptance criteria is met. If field sample analyte concentrations exceed the highest calibration standard and the same analytes in the following field sample or in consecutive following field samples also exceed the IB acceptance criteria (i.e., > 1/2 LOQ), the affected samples shall be reanalyzed using a fresh aliquot of the sample extract. If the extract cannot be reanalyzed and re-extraction is not possible, apply qualifier to affected results and explain in the case narrative.	Analyst/Supervisor	CA-409
LC/MS/MS	Instrument Sensitivity Check (ISC) (USEPA Method 1633)	At the beginning of the analytical sequence prior to the opening CV/CCV.	ISC standard concentration must be equal to the laboratory's LOQ. Peak S/N ratio ≥ 3:1 for quantitation and confirmation ions and ion ratios must meet QC acceptance limits, or S/N ≥ 10:1 for analytes that do not have a suitable confirmation ion. The concentration of each target analyte must be within + 30% of the true concentration.	No samples may be analyzed under a failing ISC. Perform maintenance and re-analyze ISC. If problem persists, recalibrate.	Analyst/Supervisor	CA-409

Instrument	CalibrationProcedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
LC/MS/MS	Calibration Verification (CV or CCV) (USEPA Method 1633)	Analysis of mid-level calibration solution. After a passing ISC, at the beginning of each analytical sequence, after every 10 field samples, and at the end of the analytical sequence.	Target analyte concentrations must be within ±30% of their true value.	Reanalyze any extracts that were analyzed between the last passing CCV and the one that failed. However, if an analyte in the CCV failed because of high recovery, but the analyte was not detected in a sample extract associated with that failure, then the sample extract does not need to be reanalyzed.	Analyst/Supervisor	CA-409
LC/MS/MS	Bile Salts Interference Check	Analyzed after the IC and prior to samples.	The retention time (RT) of Taurodeoxycholic Acid (TDCA) should differ from the RT for PFOS by at least one minute.	If the QC acceptance criteria are not met, the chromatographic conditions must be adjusted to meet the QC acceptance criteria. Repeat the ICAL.	Analyst/Supervisor	CA-409
LC/MS/MS	Qualitative Identification Standards (USEPA Method 1633)	Analyzed daily prior to sample analysis.	The laboratory should incorporate all qualitative standards containing branched and linear isomeric mixtures that are available at the time of sample analysis. The qualitative identification standard is used to determine the retention of the branched isomers.	Not applicable.	Analyst/Supervisor	CA-409

Notes:

Calibration procedures must be consistent with the *Department of Defense Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories*, Version 6.0, December 2023.

≥	=	Greater Than or Equal To
≤	=	Less Than or Equal To
%	=	Percent
%RE	=	Percent Relative Error
%RSD	=	Percent Relative Standard Deviation
±	=	Plus Or Minus
CCB	=	Continuing Calibration Blank
CCV	=	Continuing Calibration Verification
CV	=	Calibration Verification
DoD QSM	=	Department of Defense Quality Systems Manual
EIS	=	Extracted Internal Standards
IB	=	Instrument Blank
IC	=	Initial Calibration
ISC	=	Instrument Sensitivity Check
LC/MS/MS	=	Liquid Chromatograph/Tandem Mass Spectrometer
LOQ	=	Limit of Quantitation
NIS	=	Non-Extracted Internal Standards
PFAS	=	Per- and Polyfluoroalkyl Substances
PFOS	=	Perfluorooctane Sulfonic Acid
QC	=	Quality Control
RRT	=	Relative Retention Time
RSD	=	Relative Standard Deviation
RSE	=	Relative Standard Error
RT	=	Retention Time
S/N	=	Signal to Noise
SOP	=	Standard Operating Procedure
TDCA	=	Taurodeoxycholic Acid
USEPA	=	United States Environmental Protection Agency

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

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
LC/MS/MS	Clean curtain plate	PFAS	Visual inspection for residue.	Weekly	No visible residue present.	Remove and clean curtain.	Analyst	CA-409
LC/MS/MS	Preventative Maintenance	PFAS	Degradation of instrument performance.	Every six months or as needed	ICAL within acceptance criteria.	Refer to manufacturers operating manual.	Analyst	CA-409
LC/MS/MS	Replace analytical column	PFAS	Review peak shape, retention times and peak separation for IC and CCVs.	As needed	IC and CCVs pass criteria.	Replace analytical column and reanalyze samples under new IC.	Analyst	CA-409

Notes:

CCV = Continuing Calibration Verification
IC = Initial Calibration
LC/MS/MS = Liquid Chromatograph Tandem Mass Spectrometer
PFAS = Per- and Polyfluoroalkyl Substances
SOP = Standard Operating Procedure

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SAP Worksheet #26: Sample Handling System

(UFP-QAPP Manual Appendix A)

Sample Collection, Packaging, and Shipment	
Sample Collection (Personnel/Organization):	Field Samplers: Resolution Consultants
Sample Packaging (Personnel/Organization):	Field Samplers: Resolution Consultants
Coordination of Shipment (Personnel/Organization):	Field Samplers: Resolution Consultants
Type of Shipment/Carrier:	Sample Coolers/Commercial Overnight Courier or Laboratory Courier
Sample Receipt and Analysis	
Sample Receipt (Personnel/Organization):	Sample Receiving Group: Katahdin
Sample Custody and Storage (Personnel/Organization):	Sample Receiving Group: Katahdin
Sample Preparation (Personnel/Organization):	Extractions, Preparation (Inorganic and Organic) Supervisor: Katahdin
Sample Determinative Analysis (Personnel/Organization):	Laboratory Manager/ Supervisor: Katahdin
Sample Archiving	
Field Sample Storage (Number of Days from Sample Collection):	60 Days from Receipt of Samples
Sample Disposal	
Personnel/Organization:	Waste Compliance Manager: Katahdin
Number of Days from Analysis:	60 Days from Release of Final Report

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SAP Worksheet #27: Sample Custody Requirements

(UFP-QAPP Manual Section 3.3.3)

27.1 Sample Nomenclature, Sample Collection Documentation, Handling, and Tracking Procedures

The following sections outline the procedures that will be used to document project activities and sample collection, handling, tracking, and custody procedures during the investigation. All forms must be filled in as completely as possible.

27.1.1 Sample Nomenclature

Worksheet #18 presents the sample nomenclature that will be used for the sampling and lists QA/QC samples to be collected. Nomenclature for groundwater samples will consist of the monitoring location identification with "-MMDDYY" added to the end, where MM is the two-digit month of sample collection, DD is the two-digit day of sample collection, and YY is the two-digit year of sample collection.

Field duplicates will be labeled so they will be "blind" to the laboratory; they will be identified such that the well ID is replaced with "NASB-FD" followed by a sequential numeric value (the duplicate sample collected during that sampling event) and the date ("-MMDDYY"). For example, a duplicate of MW07-MMDDYY would be indicated using NASB-FD01-MMDDYY. Equipment and field blanks will be labeled with the blank identifier (i.e., TB, EB, or FB), sequential numerical designator (if necessary) followed by a dash and the six-digit date (i.e., NASB-EB##-MMDDYY). The specific samples the field duplicates and blanks apply to will be recorded in the field notes.

27.1.2 Sample Collection Documentation

Documentation of field observations will be recorded in a field logbook(s) and/or field log sheets including sample collection logs, boring logs, and monitoring well construction logs. Since water-resistant logbooks are not allowed for PFAS sampling, non-recycled unbleached loose paper or notebooks will be used as described in SOP 3-41 *Per- and Polyfluoroalkyl Substance Field Sampling Protocol*. Observations will be recorded with indelible ink using a pen (i.e., no sharpies or markers). Instrument calibration logs will be used to record the daily instrument calibration and calibration checks.

For sampling and field activities, the following types of information will be recorded in the field logbook as appropriate:

- Site name and location
- Date and time of logbook entries
- Subcontractor activity summary
- Site observations including site entry and exit times

- Personnel and their affiliations
- Weather conditions
- Activities involved with the sampling
- Site sketches made onsite
- Visitor names, affiliations, arrival and departure times
- Health and safety issues, including personal protective equipment

27.1.3 Sample Handling and Tracking System

Sample handling is described in Worksheet #26. Following collection, all samples will be immediately placed on ice in a cooler. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local commercial courier location for priority overnight delivery to the selected laboratory or picked up by laboratory courier. Samples will be preserved as appropriate based on the analytical method. The laboratories will provide sample containers for sample collection as indicated in Worksheet #19. Samples will be maintained at 0 to 6 °C until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx or laboratory courier). For all samples collected, chain-of-custody forms will document the date and time of sample collection, the sampler's name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. Further details on chain-of-custody procedures are provided in Resolution Consultants *SOP 3-03: Recordkeeping, Sample Labelling, and Chain-of-Custody*.

The following subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample-collection procedures. All forms must be filled in as completely as possible.

Resolution Consultants personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Samples will be sealed in appropriate containers, packaged by Resolution Consultants personnel and placed into sealed coolers under chain-of-custody in accordance with *Resolution Consultants SOP 3-04 Sample Handling, Storage, and Shipping*. All coolers will contain a temperature blank. Samples will be transferred under chain-of-custody to a commercial or laboratory courier as described below. Once received by the laboratory, receipt will be documented on the chain-of-custody form and the samples will be logged in. The samples will remain under chain-of-custody throughout the analysis period to ensure their integrity is preserved. Details are provided below.

27.2 Field Sample Custody Procedures

Chain-of-custody protocols will be maintained throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for the laboratory will be packaged and shipped in accordance with Resolution Consultants *SOP 3-04: Sample Handling, Storage, and Shipping*.

A sample is under custody if:

- The sample is in the physical possession of an authorized person
- The sample is in view of an authorized person after being in his/her possession
- The sample is placed in a secure area by an authorized person after being in his/her possession
- The sample is in a secure area, restricted to authorized personnel only

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

Integrity of the samples collected will be the responsibility of identified people from the time the samples are collected until the samples, or their derived data, are incorporated into the final report.

The FTL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a laboratory or commercial courier. When transferring samples to a laboratory courier, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (i.e., laboratory or commercial courier). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs.

27.3 Laboratory Chain-of-Custody

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be performed in accordance with laboratory SOPs. Coolers are received and checked for proper temperature. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample containers for accuracy. Samples will be logged into the laboratory information management system and given a unique log number which can be tracked throughout sample analysis. The laboratory project manager will notify the FTL verbally or

via e-mail immediately if any problems are identified. Discrepancies and resolutions will be documented on the sample receiving checklist.

SAP Worksheet #28: PFAS Laboratory QC Samples Table

Matrix:		Groundwater by LC-MS/MS				
Analytical Group:		Per- and Polyfluoroalkyl Substances				
Analytical Method/Lab SOP Reference:		LC-MS/MS Compliant with USEPA Method 1633 and DoD QSM, Version 6.0, Table B-24 (1)/ CA-409				
QC Sample	**Frequency & Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicators**	**Measurement Performance Criteria**
Extracted Internal Standards (EIS)	Every field sample, QC sample, and standard.	Recoveries must be within limits listed in method Table 6. Isotopically labeled analogs of analytes shall be used when they are commercially available.	Follow the requirements listed in USEPA Method 1633, Section 15.3.2 for all sample matrices. If EIS recoveries still fall outside of the acceptance range, the customer shall be contacted for additional measures to be taken. Apply qualifier to affected analyte results and explain in the case narrative.	Analyst, Supervisor	Accuracy	Same as Method /SOP QC Acceptance Limits
NIS (USEPA Method 1633)	Every field sample, standard, blank, and quality control sample.	The NIS area in the field and QC samples are compared to the mean area of the corresponding NIS of the initial calibration. QC acceptance criteria: 50-200 percent (%)	If peak areas are unacceptable, analyze a second aliquot. If second analysis meets criteria, report it. Insufficient volume – qualify and document. Document and discuss the failure in the Case Narrative. Apply flag to the result associated with the failure.	Analyst, Supervisor	Accuracy	Same as Method /SOP QC Acceptance Limits
Method Blank	One per preparatory batch.	QSM 6.0: No analytes detected > ½ LOQ	Correct problem. If required, reprepare and analyze MB and all QC samples and affected field samples processed with the contaminated blank if sufficient sample material is available. If the samples cannot be reprepared and analyzed, apply qualifier to affected analyte results of all samples in the associated preparatory batch and explain in the case narrative.	Analyst, Supervisor	Accuracy Contamination bias	Same as Method /SOP QC Acceptance Limits

Matrix:		Groundwater by LC-MS/MS				
Analytical Group:		**Per- and Polyfluoroalkyl Substances**				
Analytical Method/Lab SOP Reference:		**LC-MS/MS Compliant with USEPA Method 1633 and DoD QSM, Version 6.0, Table B-24 (1)/ CA-409**				
QC Sample	**Frequency & Number**	**Method/SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicators**	**Measurement Performance Criteria**
Laboratory Control Sample (LCS) and Low-Level Laboratory Control Sample (LLLCS)	One per preparatory batch. Shall contain all EIS, NIS, and all analytes to be reported.	Target compound and EIS recoveries must be within limits in method Tables 5 and 6.	Correct problem. If required, reprepare and analyze the LCS and/or LLLCS and all affected QC samples and field samples in the associated preparatory batch for failed analytes if sufficient sample material is available. If the samples cannot be reprepared and analyzed, apply qualifier to affected analyte results of all samples in the associated preparatory batch and explain in the case narrative.	Analyst, Supervisor	Accuracy Bias	Same as Method /SOP QC Acceptance Limits

Notes:

(1) Quality Control procedures must be consistent with the Department of Defense Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories, Version 6.0, December 2023.

< = Less Than
≥ = Greater Than or Equal To
≤ = Less Than or Equal To
> = Greater Than
% = Percent
DoD QSM = Department of Defense Quality Systems Manual
EIS = Extracted Internal Standards
LC-MS/MS = Liquid Chromatography-Mass Spectrometer/Mass Spectrometer
LCS = Laboratory Control Sample
LOQ = Limit of Quantitation
LLLCS = Low-Level Laboratory Control Sample
NIS = Non-Extracted Internal Standards
OPR = Ongoing Precision and Recovery
PFAS = Per- and Polyfluoroalkyl Substances
RPD = Relative Percent Difference
QC = Quality Control
SOP = Standard Operating Procedures
USEPA = United States Environmental Protection Agency

SAP Worksheet #29: Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	Where maintained
Sample Collection Documents and Records Project personnel sign-off record Field logbook (and sampling notes) Field sample forms (sample log sheets, drilling logs, etc.) Chain-of-custody records Sample shipment air bills Equipment calibration logs Photographs SAP including field sampling SOPs SAP regulatory and personnel review acknowledgements Safe work permit forms	Sample collection documents and records (may include printed copy as well as electronic information) will be maintained at Resolution Consultants office at 250 Apollo Drive, Chelmsford, Massachusetts 01824.
Analytical Results Documents and Records Sample receipt/log-in forms Sample preparation logs Equipment calibration logs Sample analysis run logs Reported field sample results Reported results for standards, QC checks Reported results for standards, QC samples Data completeness checklists Data validation memoranda	Electronic analytical results will also be verified, entered, and maintained in a database on a password-protected Structured Query Language server. Data qualifiers will be added to the database during data validation. After validation, the validated data files will be transferred to NIRIS database via NEDDs for final repository as soon as the data has been validated, and no later than 3 months following the collection of the samples.

Document	Where maintained
Other Documents Personnel training records Health and safety certifications Accident Prevention Plan Field Sampling Audit Checklist Letter reports, technical memos, etc. Analytical Audit Checklist	Personnel training records and health and safety certificates will be physically stored in personnel records and electronically stored in the Resolution Consultants office at 250 Apollo Drive, Chelmsford, Massachusetts 01824. They will be stored electronically on the Resolution Consultants server library. Plans and reports will be stored in print and electronically in the Administrative Record file. Field Audit Checklists are not considered part of the Administrative Record file and will be stored in the Resolution Consultants project file at 250 Apollo Drive, Chelmsford, Massachusetts 01824, and electronically in the server library. Analytical Audit Checklists will be retained by the respective accreditation authorities.
Final Document/Records Repository Administrative Record files Site files Post decision files Analytical data Spatial data Maps	All Final Documents/Records Repositories will be stored in accordance with the NAVFAC Environmental Restoration Recordkeeping Manual. Electronic copies will be maintained, verified, and stored on the Navy's NIRIS database.

Notes:

CTO	=	Contract Task Order
NAS	=	Naval Air Station
NAVFAC	=	Naval Facilities Engineering Systems Command
Navy	=	Department of the Navy
NEDDs	=	NAVFAC Electronic Data Deliverables
NIRIS	=	Naval Installation Restoration Information Solution
QC	=	Quality Control
SAP	=	Sampling and Analysis Plan
SOPs	=	Standard Operating Procedure

SAP Worksheet #30: Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix/Sample Purpose	Analytical Group	Sample Location Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/Organization[a] (name and address, contact person and telephone number)	Backup Laboratory/ Organization
Groundwater / PFAS Monitoring	PFAS (see Worksheet #15)	See Worksheet #18	CA-409	21 Days	Katahdin, 600 Technology Way, Scarborough, ME 04074 Heather Manz, Heather.Manz@sgs.com, 207-303-0917	None

Notes:
[a] Laboratory accreditation status can be found in Worksheet #23.

ME = Maine
PFAS = Per- and Polyfluoroalkyl Substances
SOP = Standard Operating Procedure

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SAP Worksheet #31: Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Action	Person(s) Responsible for Monitoring Effectiveness of Corrective Action
Onsite Laboratory Systems Audit	Every 18 months	External	DoD ELAP	DoD ELAP Auditor	QAO for: Katahdin	QAO for: Katahdin	QAO for: Katahdin
Work Product Peer Review	Draft, Draft Final, and Final Documents	Internal	Resolution Consultants	Technical Experts and Technical Editors	Report Authors	CTO Manager for: Resolution Consultants	CTO Manager for: Resolution Consultants

Notes:
CTO = Contract Task Order
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
QAO = Quality Assurance Officer

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SAP Worksheet #32: Assessment Findings and Corrective Action Responses Table

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Laboratory Systems Audit	Verbal debriefing, Written audit report (1)	Jennifer Prescott QAO Katahdin	Not specified by DoD-ELAP	Corrective action plan, letter	DoD-ELAP Accrediting Authorities	Specified by DoD-ELAP Accrediting Authorities
Field Supervision	Site logbook and sample collection logs	Caryn DeJesus, CTO Manager, Resolution Consultants; Keefe Askin, FTL, Resolution Consultants	Immediately, when discovered	Entry in Site logbook, potential retraining	Caryn DeJesus, CTO Manager, Resolution Consultants; Keefe Askin, FTL, Resolution Consultants	Within 24 hours

Notes:

1 - Assessment findings will be communicated with appropriate staff during verbal audit debriefings and in the written audit report and will be documented on audit checklists and audit reports.

CTO = Contract Task Order
DoD = Department of Defense
ELAP = Environmental Laboratory Accreditation Program
FTL = Field Team Lead
QAO = Quality Assurance Officer

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SAP Worksheet #33: Quality Assurance Management Reports Table

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Validation	Report per data package	Within 4 weeks of receipt of laboratory data	Project Chemist/Data Validation Manager or designee	CTO Manager, project file
Major Analysis Problem Identification (Internal Resolution Consultants Memorandum)	When Resolution Consultants detects persistent analysis problems that may impact data usability	Immediately upon detection of problem (same day)	Project QAO or Project Chemist	CTO Manager, Program Manager, contracts department, project file
Laboratory Quality Assurance (QA) Report	When significant plan deviations result from unanticipated circumstances	Within 1 business day of when the issue is discovered	Laboratory Project Manager: Katahdin	CTO Manager, Project Chemist, project file

Notes:

CTO = Contract Task Order
QA = Quality Assurance
QAO = Quality Assurance Officer

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SAP Worksheets #34-36: Data Verification and Validation (Steps I and IIA/IIB) Process Table

(UFP-QAPP Manual Section 5.2.1), (UFP-QAPP Manual Section 5.2.2), (Figure 37 UFP-QAPP Manual), (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIA/ IIB [1]	Internal/ External [2]
Verification Chain-of-custody forms Sample Login/Receipt	Review the sample shipment for completeness and integrity; sign to accept the shipment. All sample labels will be checked against the chain-of-custody form, and any discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and workstation required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms. Verification of sample login/receipt and chain-of-custody forms will be documented on the laboratory sample receipt form.	Laboratory sample custodians and analysts, Katahdin	I	Internal
Verification Chain-of-custody forms	Check that the chain-of-custody form was signed/dated by the sampler relinquishing the samples and by the laboratory sample custodian receiving the samples for analyses. Verification of chain-of-custody forms will be documented in the validation worksheets and/or workbook.	Project Chemist and/or Data Validator, Resolution Consultants	I	External
Verification SAP sample tables	Verify that all proposed samples listed in the SAP tables have been collected. Sample completeness will be documented in the validation worksheets and/or workbook and validation report.	Project Chemist and/or Data Validator, Resolution Consultants	I	External
Verification Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete. Sample log sheet verification will be documented by dated signature on the last page or page immediately following the review material.	Field personnel, Resolution Consultants	I	External
Verification Field QC samples	Check that field QC samples, described in Worksheet #12, and listed in Worksheet #20, were collected as required. QC sample completeness will be documented in the validation worksheets and/or workbook and validation report.	Field personnel and Data Validator, Resolution Consultants	I	External
Verification Analytical data package	Verify that all analytical data packages are complete. The laboratory PM (or designee) will sign the case narrative for each data package.	Laboratory PM or designee, Katahdin	I	Internal
Verification Analytical data package	Verify the data package for completeness. Missing information will be requested from the laboratory and validation (if performed) will be suspended until missing data are received. Data package completeness will be documented in the validation worksheets and/or workbook.	Project Chemist and/or Data Validator, Resolution Consultants	I	External
Verification Electronic data deliverables	Verify the electronic data against the chain-of-custody and hard copy data package for accuracy and completeness. Electronic data deliverable verification will be documented in the validation worksheets and/or workbook.	Data Manager and/or Data Validator, Resolution Consultants	I	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIA/ IIB [1]	Internal/ External [2]
Validation Chain-of-custody	Examine the traceability of the data from the time of sample collection until reporting of data. Ensure that the custody and integrity of the samples were maintained from collection to analysis and the custody records are complete and any deviations are recorded. Chain-of-custody verification will be documented in the validation worksheets and/or workbook.	Project Chemist and/or Data Validator, Resolution Consultants	IIA	External
Validation Holding times	Review that the samples were shipped and stored at the required temperature and sample pH for chemically preserved samples meet the requirements listed in Worksheet #19. Ensure that the analyses were performed within the holding times. If holding times were not met, confirm that deviations were documented. Holding time examination will be documented in the validation worksheets and/or workbook and in the validation report. As outlined in the March 27, 2025, DoD Environmental Data Quality Workgroup Memorandum (see Appendix A), several PFAS compounds are subject to shorter holding times. Data will be qualified as estimated J for detects and UJ for non-detects. While it is acknowledged that exceeding these holding times introduces additional uncertainty, these results will still be used for decision-making purposes.	Project Chemist and/or Data Validator, Resolution Consultants	IIA	External
Validation Sample results for representativeness	Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis. Sample receipt and preservation will be documented in the validation worksheets and/or workbook and in the validation report.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed and that the Measurement Performance Criteria (MPC), listed in Worksheets #24 and #28, were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed, as listed in Worksheet #12, and that the analytical QC criteria were met. Accuracy will be documented in the validation worksheets and/or workbook and in the validation report.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Field and laboratory duplicate analyses for precision	Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD values from laboratory duplicate analyses as applicable. Ensure compliance with the precision goals listed in Worksheet #12 and/or #28. Precision will be documented in the validation worksheets and/or workbook and in the validation report. As professional judgement, results for a given compound in a field duplicate pair that are both < LOQ will not be qualified by the data validator	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Project action limits	Assess and document the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant; assess and document the impact on the other target compounds reported as undetected. Project action limit achievement will be documented in the validation worksheets and/or workbook and in the validation report.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIA/ IIB (1)	Internal/ External (2)
Validation SAP QC sample documentation	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within acceptance limits. QC sample completeness and assessment will be documented in the validation workbook and validation report.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Analytical data deviations	Determine the impact of any deviation from sampling or analytical methods and laboratory SOP requirements and matrix interferences effect on the analytical results. Data deviations will be documented in the validation worksheets and/or workbook and validation report. The NAVFAC chemist will be consulted if any analytical method deviations are observed during data validation that may warrant contacting the accreditation body.	Project Chemist and/or Data Validator, Resolution Consultants	IIB	External
Validation Project quantitation limits for sensitivity	Ensure that the project detection limits were achieved. Project quantitation limit achievement will be documented in the validation worksheets and/or workbook and in the validation report.	Project Chemist and/or Data Validator, Resolution Consultants	IIB	External
Validation	Assess data against MPC identified in Worksheets #12, #15, #19, #24, and #28. DoD QSM Version 6.0 (DoD, December 2023), The *DoD General Validation Guidelines* (DoD, November 2019), *Data Validation Guidelines Module 6: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-24* (DoD, October 2022), DoD Data Validation Guidelines Modules 1, 2, 3, 4, and 6 Revised Table for Sample Qualification in the Presence of Blank Contamination (DoD, 2023), and *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2020) will be used as a guidance on applying qualifiers when MPCs are not met. PFAS results generated using Final EPA 1633 will undergo 90% Stage 2B electronic and manual validation and 10% Stage 4 electronic and manual validation. The required activities for the stage of validation will be in accordance with the DoD General Validation Guidelines (DoD, November 2019). If errors are discovered, more extensive recalculation will be triggered, and laboratory corrective action may be sought.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation in Initial calibration	The response factor, relative standard deviation, relative standard error, correlation coefficient or coefficient of determination (as applicable) will be re-calculated for one compound.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation in Initial calibration verification, calibration verification or instrument sensitivity check	The response factor and percent difference or percent drift (as applicable) will be re-calculated for one compound.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIA/ IIB (1)	Internal/ External (2)
Validation Re-calculation for Ion ratio	The ion ratio for one compound will be re-calculated when the area response of the quantitation ion and confirmation ion is provided in the laboratory report.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation in Extracted internal standard	The concentration found and percent recovery will be re-calculated for one compound.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation in LCS/LLLCS	The concentration found and percent recovery will be re-calculated for one compound. If a laboratory duplicate analysis is performed, the relative percent difference will be re-calculated for one compound.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation of NIS	The percent recovery of one NIS will be re-calculated in one sample to ensure that the QC criteria were met. If the QC limits are expressed as area responses rather than percent recovery, a transcription check will be performed to confirm that the sample area response is within the QC acceptance limits.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Re-calculation of sample results	The concentration found and limit of quantitation (LOQ) will be re-calculated for one compound. The compound selected will vary so that detected compounds with PALs are checked at least once for each matrix in an event.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External
Validation Data qualifiers	Qualifiers that will be applied during the data validation process are summarized below. Use of data with serious quality deficiencies will be decided by the Project Team.	Project Chemist and/or Data Validator, Resolution Consultants	IIA/IIB	External

<table>
<tr><th>Data Review Input</th><th>Description</th><th>Responsible for Verification (name, organization)</th><th>Step I/IIA/ IIB (1)</th><th>Internal/ External (2)</th></tr>
<tr><td>Validation
Data qualifiers</td><td>Qualifiers that will be applied during the data validation process are summarized below. Use of data with serious quality deficiencies will be decided by the Project Team.
<table><tr><th>Data Qualifier</th><th>Qualifier Definition</th></tr><tr><td>U</td><td>The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample.</td></tr><tr><td>J</td><td>The reported result was an estimated value with an unknown bias.</td></tr><tr><td>J+</td><td>The result was an estimated quantity, but the result may be biased high.</td></tr><tr><td>J-</td><td>The result was an estimated quantity, but the result may be biased low.</td></tr><tr><td>N</td><td>The analysis indicates the presence of an analyte for which there was presumptive evidence to make a "tentative identification."</td></tr><tr><td>NJ</td><td>The analyte has been “tentatively identified” or “presumptively” as present and the associated numerical value was the estimated concentration in the sample.</td></tr><tr><td>UJ</td><td>The analyte was not detected and was reported as less than the LOD or as defined by the customer. However, the associated numerical value is approximate.</td></tr><tr><td>X (3)</td><td>The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The presence or absence of the analyte cannot be substantiated by the data provided. Acceptance or rejection of the data should be decided by the project team (which should include a project chemist), but exclusion of the data is recommended.</td></tr></table></td><td>Project Chemist and/or Data Validator, Resolution Consultants</td><td>IIA/IIB</td><td>External</td></tr>
</table>

Notes:

(1) IIA Compliance with methods, procedures, and contracts (see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.)
IIB Comparison with MPC in the SAP (see Table 11, page 118, UFP-QAPP manual, V.1, March 2005).

(2) Internal or external in relation to the data generator.

(3) Final disposition of the data with serious deficiencies will be decided upon by the project team who may choose to accept or reject the data.

DoD	=	Department of Defense
LCS	=	Laboratory Control Sample
LLLCS	=	Low Level Laboratory Control sample
MPC	=	Measurement Performance Criteria
NAVFAC	=	Naval Facilities Engineering Systems Command
PFAS	=	Per- and Polyfluoroalkyl Substances
PM	=	Program Manager
QC	=	Quality Control
QSM	=	Quality Systems Manual
RPD	=	Relative Percent Difference
SAP	=	Sampling and Analysis Plan
SOP	=	Standard Operating Procedure
UFP-QAPP	=	Uniform Federal Policy for Quality Assurance Project Plan
USEPA	=	United States Environmental Protection Agency

SAP Worksheet #37: Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Review

The usability of the data directly affects whether project objectives can be achieved, and at a minimum, the characteristics listed below evaluated. The results of these evaluations will be included in the project report. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound assessments of these data characteristics:

Precision

Precision is the degree of agreement among repeated measurements of the same property under consistent conditions. To assess field precision, duplicate samples will be collected and analyzed alongside their corresponding primary field samples. Laboratory precision will be evaluated, when applicable, by calculating the relative percent difference (RPD) between results for laboratory duplicates, and laboratory control sample/laboratory control sample duplicates (LCS/LCSD). Measurement performance criteria are specified in Worksheets #12 and #28.

The RPD will be calculated for each pair of duplicate analysis samples using the following equation:

$$\text{RPD} = \frac{(S-D)}{(S+D)/2} \times 100$$

Where:

RPD = relative percent difference

S = sample result

D = duplicate result

The Project Chemist, acting on behalf of the Resolution Consultants CTO Manager, will determine whether precision goals for field duplicates and laboratory duplicates, where applicable, have been met. This will be accomplished by comparing duplicate results to the precision goals identified in Worksheet #12 and #28. The determination will include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report.

Accuracy

Accuracy is the degree to which a given result agrees with the true value. The accuracy of an entire measurement system is an indication of any bias that exists. Spiked sample results provide information needed to assess the accuracy of analyses. Specifically, EIS, LCS/LCSD, and LLLCS

percent recoveries, as applicable, are used to assess accuracy. If the calculated percent recoveries for the known spike concentrations are within defined control limits set by each method, the reported sample concentrations are considered accurate. The accuracy measurement performance criteria are specified in Worksheets #12, #24, and #28.

Accuracy is calculated using the following equation for EIS compounds and LCSs:

$$\%R = \frac{SSR}{SA} x100$$

Where:

%R = percent recovery

SSR = spike sample recovery

SA = concentration of spike added

The Project Chemist, acting on behalf of the Resolution Consultants CTO Manager, determines whether the accuracy/bias goals have been met for the project data. Additionally, this assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and spike recoveries against the goals identified in Worksheets #24 and #28. If the criteria are not met, bias of the qualified results, descriptions of the impact of identified noncompliance on a specific data package or on the overall project data, and limitations on the use of the data will be described in the project report.

Representativeness

A Project Scientist identified by Resolution Consultants CTO Manager will determine whether the data are adequately representative of the intended populations. This will be accomplished by verifying that samples were collected and analyzed in accordance with this SAP, by reviewing spatial and temporal data variations (as applicable), and by comparing these characteristics to expectations, including adherence to factors that affect sample integrity such as holding times, preservation, and storage conditions. The usability report will describe the representativeness of the data for each matrix and analytical fraction, which will not require quantitative comparisons unless the Project Scientist's professional judgment indicates that a quantitative analysis is required. If data gaps exist, they will be identified and, if appropriate, the Project Team will take them into consideration if additional work is required to meet project objectives.

Comparability

The Project Chemist, acting on behalf of the Resolution Consultants CTO Manager, will determine whether the data generated under this project are sufficiently comparable by evaluating overall precision and bias among data sets for each matrix and analytical fraction, which does not require

quantitative comparisons unless the Project Chemist indicates that such quantitative analysis is required.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. It is expected that 100% of the planned sampling points will be collected under normal conditions. The completeness goal for field measurements will be greater than 90%. Laboratory analysis for this project will have a completeness goal greater than 95%. Completeness can be calculated using the following equations.

$$\% \text{ Field Completeness} = \frac{\text{Number of Results Obtained}}{\text{Total Number of Results Planned}} \times 100$$

$$\% \text{ Analytical Completeness} = \frac{\text{Number of Valid Tests}}{\text{Total Tests Taken}} \times 100$$

The Resolution Consultants CTO Manager will determine whether deviations from the scheduled sample collection or analyses occurred. If they have occurred and the Resolution Consultants CTO Manager determines that the deviations compromise the ability to meet project objectives, the Navy RPM and other project team members will be consulted, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

Sensitivity

Sensitivity refers to the ability of an analytical method or instrument to distinguish between measurement responses corresponding to different concentrations. Sensitivity requirements are established during the planning phase to ensure they meet project-specific objectives. It is essential that the method can reliably detect target analytes at the required levels. These requirements typically include calibration criteria, instrument limits of detection (LODs), and limits of quantitation (LOQs).

The Project Chemist, on behalf of the Resolution Consultants CTO Manager, will evaluate whether the sensitivity goals outlined in Worksheet #15 have been met. Sensitivity and quantitation limits for each matrix and analysis will be compared to the project action levels (PALs). If sensitivity goals are not met, any resulting data limitations will be documented in the project report.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After completion of the data validation, the data will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In accordance with the DoD Environmental Data Quality Workgroup memorandum dated March 27, 2025 (see Appendix A), the project team will accept results associated with shortened holding times and apply J or UJ qualifiers, making the data available for use. X-qualifications not resulting from gross exceedance of shortened holding times will be reviewed by the Project Chemist in consultation with the Project Team to determine the appropriate

final qualifier and assess data usability. Following the review, the "X" qualifier will then be removed, and data will either be accepted or rejected. For accepted data, the "X" qualifier will be replaced with a "J" qualifier for detected results and a "UJ" qualifier for non-detect results. For rejected data, the "X" qualifier will be replaced with an "R" qualifier. Data usability and final qualifier decisions will be documented in the Data Usability Assessment.

The Project Team, as directed by the Resolution Consultants CTO Manager will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing data or data with serious quality deficiencies have compromised the ability to make decisions or to make the decisions with the desired level of confidence. Compromised data will be evaluated to determine whether they can be compensated by other data. Although data with serious quality deficiencies generally will not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement acceptable data. The use of serious quality deficiencies will be decided upon by the Project Team.

Identify the personnel responsible for performing the usability assessment:

The Resolution Consultants CTO Manager, Project Chemist, and select team members will be responsible for conducting the listed data usability assessments. The data usability assessment will include the elements provided in **Table 37-1.**

Table 37-1: Data Usability Process

Step 1	**Review the project's objectives and sampling design:** The sampling design, data quality objectives, and measurement performance criteria provided in this Sampling and Analysis Plan will be reviewed to assess that they are still applicable.
Step 2	**Review the data verification and validation outputs:** Review available quality assurance reports, such as data validation reports, and incorporate results of data verification; summarize findings in tabular format. Review deviations from planned activities (number and locations of samples, holding time exceedances, damaged samples, procedural deviations, etc.) and assess their impact on data usability. Evaluate implications of unacceptable quality control sample results.
Step 3	**Verify the assumptions of the selected statistical method:** Simple summary statistics for target analytes may be completed consistent with SAP or risk assessment data evaluation requirements. These may include maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, number of samples exceeding PALs, and the proportion of samples with detected and non-detected results; no assumptions are required.
Step 4	**Implement the statistical method – data analysis will include:** Summarize the data by comparing it against screening levels identified on Worksheet #15. Data will be evaluated to assess whether the underlying assumptions hold or whether departures are acceptable, given the actual data and other information.

Step 5	**Document data usability and draw conclusions – data usability will be documented in the report and will include the following:** Assessment that determines whether data can be used as intended, considering implications of deviations and corrective actions. Discussion of data quality indicators (DQI) and identification of data use limitations.

The data usability assessment will be reviewed to determine if deficiencies affecting the attainment of project objectives have occurred. If so, a meeting with the Project Team will be held to determine the next steps. If no significant deficiencies are identified, the assessment will simply be documented in the project report and reviewed during the normal document review cycle.

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 which includes any qualifiers applied during validation will be presented in tabular format. The project report will identify and explain any limitations on data usability. A copy of the data validation report will be included as an appendix. If necessary, the report will also recommend resampling or other corrective actions.

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Tables

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Table 15-1: Reference Limits and Evaluation Table - Groundwater
Analysis: PFAS (definitive)

Analytical Method / Analyte	Acronym	CAS	Units	Value (a)	Source	Laboratory Reference Limits		
						LOQs	LODs	DLs
Perfluoroalkyl Carboxylic Acids by Final EPA Method 1633								
Perfluorobutanoic acid	PFBA	375-22-4	ng/L	1800	U.S. EPA RSL [1]	8	6	2.5
Perfluoropentanoic acid	PFPeA	2706-90-3	ng/L	--	--	4	3	1.4
Perfluorohexanoic acid	PFHxA	307-24-4	ng/L	990	U.S. EPA RSL [1]	2	1.5	0.73
Perfluoroheptanoic acid	PFHpA	375-85-9	ng/L	--	--	2	1.5	0.56
Perfluorooctanoic acid	PFOA	335-67-1	ng/L	0.0027	U.S. EPA RSL [1]	2	1.5	0.91
Perfluorononanoic acid	PFNA	375-95-1	ng/L	5.9	U.S. EPA RSL [1]	2	1.5	0.72
Perfluorodecanoic acid	PFDA	335-76-2	ng/L	0.004	U.S. EPA RSL [1]	2	1.5	0.64
Perfluoroundecanoic acid	PFUnA	2058-94-8	ng/L	--	--	2	1.5	1.1
Perfluorododecanoic acid	PFDoA	307-55-1	ng/L	--	--	2	1.5	1.1
Perfluorotridecanoic acid	PFTrDA	72629-94-8	ng/L	--	--	2	1.5	0.77
Perfluorotetradecanoic acid	PFTeDA	376-06-7	ng/L	--	--	2	1.5	0.5
Perfluoroalkyl Sulfonic Acids by Final EPA Method 1633								
Perfluorobutanesulfonic acid	PFBS	375-73-5	ng/L	600	U.S. EPA RSL [1]	2	1.5	0.51
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	ng/L	--	--	2	1.5	0.7
Perfluorohexanesulfonic acid	PFHxS	355-46-4	ng/L	39	U.S. EPA RSL [1]	2	1.5	0.72
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	ng/L	--	--	2	1.5	0.85
Perfluorooctanesulfonic acid	PFOS	1763-23-1	ng/L	0.20	U.S. EPA RSL [1]	2	1.5	0.78
Perfluorononanesulfonic acid	PFNS	68259-12-1	ng/L	--	--	2	1.5	0.46
Perfluorodecanesulfonic acid	PFDS	335-77-3	ng/L	--	--	2	1.5	0.41
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	ng/L	--	--	2	1.5	0.4
Fluorotelomer Sulfonic Acids by Final EPA Method 1633								
1*H*,1*H*, 2*H*, 2*H*-Perfluorohexane sulfonic acid	4:2FTS	757124-72-4	ng/L	--	--	8	6	2.6
1*H*,1*H*, 2*H*, 2*H*-Perfluorooctane sulfonic acid	6:2FTS	27619-97-2	ng/L	--	--	8	6	2.8
1*H*,1*H*, 2*H*, 2*H*-Perfluorodecane sulfonic acid	8:2FTS	39108-34-4	ng/L	--	--	8	6	2.7
Perfluorooctane Sulfonamides by Final EPA Method 1633								
Perfluorooctanesulfonamide	PFOSA	754-91-6	ng/L	--	--	2	1.5	0.94
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8	ng/L	--	--	2	1.5	0.8
N-ethyl perfluorooctanesulfonamide	NEtFOSA	4151-50-2	ng/L	--	--	2	1.5	0.82
Perfluorooctane Sulfonamidoacetic Acids by Final EPA Method 1633								
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9	ng/L	--	--	2	1.5	0.75
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6	ng/L	--	--	2	1.5	0.87
Perfluorooctane Sulfonamide Ethanols by Final EPA Method 1633								
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7	ng/L	--	--	20	15	11
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2	ng/L	--	--	20	15	7.6

Table 15-1: Reference Limits and Evaluation Table - Groundwater
Analysis: PFAS (definitive)

Analytical Method / Analyte	Acronym	CAS	Units	Value (a)	Source	Laboratory Reference Limits		
						LOQs	LODs	DLs
Per- and Polyfluoroether Carboxylic Acids by Final EPA Method 1633								
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6	ng/L	1.5	U.S. EPA RSL [1]	8	6	3.3
4,8-Dioxa-3*H*-perfluorononanoic acid	ADONA	919005-14-4	ng/L	--	--	8	6	2.7
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	ng/L	--	--	4	3	1.3
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	ng/L	--	--	4	3	1.6
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	ng/L	--	--	4	3	1.7
Ether Sulfonic Acids by Final EPA Method 1633								
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	ng/L	--	--	8	6	1.3
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9	ng/L	--	--	8	6	0.6
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	ng/L	--	--	4	3	1.2
Fluorotelomer carboxylic acids by Final EPA Method 1633								
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5	ng/L	--	--	10	7.5	1.4
2*H*,2*H*,3*H*,3*H*-Perfluorooctanoic acid	5:3FTCA	914637-49-3	ng/L	--	--	50	37.5	20
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4	ng/L	--	--	50	37.5	21

Notes:
Non-detected results will be reported to the LOD.
Holding time criteria applicable to the analytical group presented in this table are defined in Worksheet #19.
Gray shading indicates that the laboratory LOQ, LOD, and/or DL exceeds the PALs identified in Section 11.3 and summarized below. See Section 11.6 for further discussion.

CAS - Chemical Abstracts Service number
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
DL - Detection Limit
DoD - Department of Defense
LOD - Limit of Detection
LOQ - Limit of Quantitation
ng/L - Nanograms per liter
PAL - Project Action Level
PFAS - Per- and polyfluoroalkyl substances
RI - Remedial Investigation
U.S. EPA RSL - United States Environmental Protection Agency Regional Screening Level

(a) This value is the lowest of the relevant Human Health PALs and other applicable criteria that may be used in the RI and/or later stages of the CERCLA process (defined below). Ultimately, the RI results will be compared to the latest DoD-approved human health screening levels for PFAS, as applicable, at the time of data evaluation to ensure the latest science is being considered.

Human health PALs:

[1] Screening levels are the DoD-approved U.S. EPA RSLs for tap water (November 2024) based on a target risk level of 1E-06 and a target hazard quotient of 0.1 for the PFAS listed in the Memorandum from the Office of the Assistant Secretary of Defense, "Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program" (January 2025). U.S. EPA RSLs based on toxicity values that were not peer-reviewed and therefore do not meet the minimum data quality standards provided in DoD Instruction 4715.18 (DoD 2024) will not be incorporated in the RI.

Table 17-1
Proposed PFAS Groundwater Sampling Program
Former Naval Air Station Brunswick
Brunswick, Maine

PFAS Reporting Area	Well ID	Monitored Interval (feet bgs)	Gauging	PFAS Analysis	Anticipated Concentration	Rationale
Upper Sand/Shallow Groundwater						
Area 1 - Jordan Avenue/Northwest Base Area	MW-JA03S	35 - 45	X	X	Moderate	Monitor PFAS at northern edge of former base property and downgradient of Hangar 6. This location has the highest concentrations along the base boundary in this area.
Area 4 - Western Base Area	TW-04	8 - 18	X	X	Low	Monitor PFAS at western edge of plume to confirm PFAS continues to be low in this area.
	TW-05	0 - 5	X	X	Low	Monitor PFAS at western edge of plume to confirm PFAS continues to be non-detect in this area.
	TW-06	4 - 14	X	X	Low	Monitor PFAS at western edge of plume to confirm PFAS continues to be non-detect in this area.
Area 5 - Southwest Base Area	NASB-BG-MW-06	13 - 18	X	X	Low	Sample to determine absense/presence of PFAS in the vicinity of the Mere Creek Golf Course water supply. Well is located south of the clubhouse and is a background well.
Area 6 - Eastern Base Area	NW-NASB-093	6 - 16	X	X	Low	Historically sampled in 2017 with non-detect results. Resample to confirm PFAS is still non-detect along the southern boundary of the groundwater divide.
	MW-ONFF-002R	6 - 11	X	X	Low/Moderate	Monitor PFAS immediately south of the groundwater divide and north of the ONFF. This is a replacement well for historically sampled MW-ONFF-002.
	MW-ONFF-004	5 -15	X	X	Moderate	Monitor PFAS at southern end of the ONFF.
	MW-529	4 - 14	X	X	Low/Moderate	Monitor PFAS in this well installed in residential area as part of RI program. PFAS concentrations from 2022 are not consistent with PFAS concentrations from nearby wells sampled historically.
	NASB-BG-MW-18	3 - 8	X	X	Low	Monitor PFAS in shallow groundwater near the eastern installation boundary, immediately west of Merriconeag Stream. Confirm PFAS concentrations are non-detect.
Area 7 - Former Building 653 Area	MW-502	5 - 10	X	X	Moderate	Monitor PFAS in groundwater adjacent to eastern former AFFF discharge area along Allagash Drive.
	NASB-NBA-MW-531	5 - 15	X	X	Moderate	Monitor PFAS downgradient of well MW-502 in the northeastern corner of former base boundary.
	MW-808	10 - 15	X	X	Low/Moderate	Monitor PFAS at northern edge of former base property and downgradient of former Building 653. PFAS concentrations have increased over time.
Area 8 - Industrialized Area	NASB-H123-MW07	7 - 12	X	X	Moderate	Monitor PFAS in vicinity of Hangar 6. This well is located upgradient of Hangar 6 and has the highest concentrations in this area and may be contributing to PFAS beneath Hangar 6.
	PFC-MW-08	3 - 13	X	X	High	Monitor PFAS in former AFFF discharge area downgradient of former Fire Department building.
	MW-526	9 - 19	X	X	Low	Monitor PFAS in western plume boundary in cental portion of former base to confirm plume is not moving farther west.
	MW-508	9.9 - 19.9	X	X	Moderate	Monitor PFAS downgradient of former AFFF dicharge area near PFC-MW-08. Monitor concentrations with well pair MW-508D in deep groundwater.
	PFC-MW-10	4 - 14	X	X	Low	Monitor PFAS in western plume boundary in cental portion of former base to confirm plume is not moving farther west.
	PFC-MW-11	4 - 14	X	X	Low/Moderate	Monitor PFAS in western plume boundary in cental portion of former base to confirm plume is not moving farther west.
	MW-NASB-010	4 - 14	X	X	Very High	Monitor PFAS on eastern side of central plume area. Historical PFAS concentrations are decreasing.
	MW-B250-15	5 - 15	X	X	Low	Monitor PFAS on northern side of Hangar 4 where PFAS concentrations are lower.
	MW-09-022	5 - 15	X	X	Low	Monitor PFAS in shallow groundwater downgradient of Hangar 4.
	MW-NASB-071	7 - 17	X	X	Low	Monitor PFAS in shallow groundwater downgradient of Hangar 4 and north of Pond A.
	MW-B250-09	5 - 15	X	X	Very High	Monitor PFAS as this well has highest PFAS in shallow wells around Hangar 4. Well is located on southern side of Hangar 4 and near stormwater infrastructure.
	ASA-MW-08	9 - 19	X	X	Moderate	Monitor PFAS downgradient of MW-B250-09 where PFAS is highest in shallow groundwater around Hangar 4.
	PFC-MW-15	4 - 14	X	X	Moderate	Monitor PFAS in farther downgradient of Hangar 4 and east of Hangar 5.
	MW-09-001S	4.5 - 14.5	X	X	Moderate	Monitor lower PFAS concentrations along the plume edge downgradient of PFC-MW-15 and upgradient of Pond A.

Table 17-1
Proposed PFAS Groundwater Sampling Program
Former Naval Air Station Brunswick
Brunswick, Maine

PFAS Reporting Area	Well ID	Monitored Interval (feet bgs)	Gauging	PFAS Analysis	Anticipated Concentration	Rationale
Upper Sand/Shallow Groundwater						
Area 9 - Eastern Plume/Southern Base Area	PFC-MW-12	4 - 14	X	X	Moderate	Monitor PFAS in former AFFF discharge area west of Hangar 5 to confirm plume is not moving farther west.
	PFC-MW-13	5 - 15	X	X	High	Monitor PFAS in former AFFF discharge area at southern end of the airport runway.
	MW-522	2 - 12	X	X	Low	Monitor PFAS at southwestern edge of plume to confirm PFAS continues to be non-detect in this area.
	MW-307	10 - 20	X	X	Moderate	Monitor PFAS upgradient of the central portion of the Eastern Plume.
	MW-1104	24 - 34	X	X	Low	Monitor PFAS in shallow groundwater downgradient of infiltration gallery. PFAS concentrations are decreasing in this well.
	NASB-B35-MW03	5 - 15	X	X	Moderate	Monitor PFAS upgradient and north of the Eastern Plume. Source of PFAS in this area is unknown.
	MW-513	8 - 18	X	X	Moderate	Monitor PFAS in shallow groundwater between Building 35 and Picnic Pond.
	NASB-BG-MW-21	1 - 6	X	X	Low	Monitor PFAS in shallow groundwater near the eastern installation boundary, immediately west of Merriconeag Stream.
	NASB-BG-MW-25	5 - 15	X	X	Low	Monitor PFAS west of Picnic Pond/Merriconeag Stream along the eastern former base boundary. PFAS RI results were non-detect. Confirm PFAS has not migrated towards the east.
	MW-EP-340S	48 - 58	X	X	Moderate	Monitor PFAS in north central portion of Eastern Plume. Historical results indicate PFAS concentrations are decreasing.
	PZ-MB-B6B	9 - 14	X	X	Moderate	Monitor PFAS in shallow groundwater near confluence of Mere Brook and Merriconeag Stream in southern end of Eastern Plume.
	MW-318	12 - 22	X	X	Low	Monitor PFAS in shallow groundwater south of the Eastern Plume. Shallow groundwater in this area has not been monitored since 2014.
	MW-02-307	5.7 - 15.7	X	X	Moderate	Monitor PFAS in shallow groundwater northwest of Site 2 and southwest of Sites 1 and 3. PFAS concentrations may be isolated to this well and immediate vicnity.
	MW-2101R	18.5 - 28.5	X	X	Low	Monitor PFAS in shallow groundwater southeast of AFFF discharge area at southern end of airport apron. PFAS concentrations have historically been low in this area.
Lower Sand/Deep Groundwater						
Area 1 - Jordan Avenue/Northwest Base Area	MW-JA03D	55 - 65	X	X	Low/Moderate	Monitor PFAS at northern edge of former base property and downgradient of Hangar 6. This location has the highest concentrations downgradient of Hangar 6.
Area 7 - Former Building 653 Area	MW-813	32.5 - 42.5	X	X	Low/Moderate	Monitor PFAS in the only deep well in northern groundwater divide area and along northern former base boundary.
Area 8 - Industrialized Area	NASB-EFA-07D	40 - 45	X	X	Low	Monitor PFAS in deep well closest to former Fire Department building. This well to be sampled since wells NASB-EFA-08S/D were destroyed during construction of Hangar 7.
	MW-508D	52 - 62	X	X	Moderate	Monitor PFAS downgradient of former AFFF dicharge area near PFC-MW-08. Monitor concentrations with well pair MW-508 in shallow groundwater.
	NASB-EFA-MW09	24 - 34	X	X	Low	Deep well on eastern side of central plume area and north of Hangar 4. Results were non-detect during PFAS RI. Sample to confirm non-detect.
	MW-509D	34 - 44	X	X	Moderate	Monitor PFAS west of Hangar 4 and along downgradient groundwater plume flow.
	MW-B250-08	32.5 - 42.5	X	X	Very High	Monitor PFAS as this well has highest PFAS in deep wells around Hangar 4. Well is located south of Hangar 4 and near stormwater infrastructure.
	MW-NASB-227	27 - 37	X	X	High	Monitor PFAS in deep groundwater downgradient of Hangar 4 well MW-B250-08.
	MW-09-001	30 - 40	X	X	Very High	Monitor PFAS as this well has historically had highest PFAS concentrations basewide. Located adjacent to recently installed EW-11.
	MW-510D	26.2 - 36.2	X	X	Low	Deep well south of highest PFAS concentrations basewide near western end of Pond A. Results were non-detect during PFAS Remedial Investigation. Sample to confirm non-detect.
	MW-NASB-077	25 - 35	X	X	Moderate	Monitor PFAS in deep groundwater south of Pond A, and southeast of MW-09-001.

Table 17-1
Proposed PFAS Groundwater Sampling Program
Former Naval Air Station Brunswick
Brunswick, Maine

PFAS Reporting Area	Well ID	Monitored Interval (feet bgs)	Gauging	PFAS Analysis	Anticipated Concentration	Rationale
Lower Sand/Deep Groundwater						
Area 9 - Eastern Plume/Southern Base Area	MW-518D	20.5 - 30.5	X	X	Low	Monitor PFAS at southwestern edge of plume to confirm PFAS continues to be non-detect in this area.
	B611-MW01D	48 - 58	X	X	Moderate	Monitor PFAS in deep groundwater in vicinity of Building 611 and upgradient of the north central portion of the Eastern Plume. This well has the highest PFAS concentrations in deep groundwater in the Building 611 area.
	NASB-B04-MW06	35 - 45	X	X	Moderate	Monitor PFAS upgradient of Site 11 and Eastern Plume GWETS infiltration gallery. This well has highest PFAS concentrations in this area.
	MW-NASB-212R	40 - 50	X	X	Moderate	Monitor PFAS in northern portion of Eastern Plume. Based on historical concentrations, PFAS are decreasing.
	MW-EP-343	68 - 78	X	X	High/Very High	Monitor PFAS in northern portion of Eastern Plume. This well has highest concentration of PFAS in the Eastern Plume. Concentrations have decreased.
	MW-331	44 - 54	X	X	Moderate	Monitor PFAS near new EW-10 and in the direction of deep groundwater flow toward Mere Brook. Concentrations have decreased.
	MW-208	91 - 101	X	X	Moderate	Monitor PFAS in central portion of the Eastern Plume along the western boundary.
	MW-MB05C	44.5 - 54.5	X	X	Moderate	Monitor PFAS in central portion of the Eastern Plume along the eastern boundary and north of confluence of Mere Brook and Merriconeag Stream. Concentrations have decreased.
	MW-EP-351	23 - 33	X	X	Moderate	Monitor PFAS in southern portion of the Eastern Plume south of the confluence of Mere Brook and Merriconeag Stream. Concentrations have decreased.
	MW-EP-354	29 - 34	X	X	Low	Confirm presence/absense of PFAS in deep groundwater monitoring well closest to Mere Brook in the southeastern portion of the of the Eastern Plume and west of Merriconeag Streem and the former base boundary. Well has not historically been sampled for PFAS.
	MW-334	35 - 45	X	X	Moderate	Monitor PFAS in southernmost portion of the Eastern Plume. Concentrations have decreased.
	MW-315A	64.5 - 74.5	X	X	Low	Monitor PFAS deep groundwater south of the Eastern Plume. This well has the highest PFAS concentrations south of the plume.
	NASB-BG-MW-36	54 - 64	X	X	Moderate	Monitor PFAS in deep groundwater between Building 35 and Picnic Pond. This well is located in a low PFAS area between Building 35 and Picnic Pond.
	MW-310	61 - 71	X	X	Moderate	Monitor PFAS in deep groundwater along southern end of the western boundary of Eastern Plume and east of Sites 1 and 3.
	MW-335	76 - 86	X	X	Low	Monitor PFAS in deep groundwater along southern boundary of Eastern Plume. This well was sampled in 2022, with only low concentration of PFOA detected.

Table 17-1
Proposed PFAS Groundwater Sampling Program
Former Naval Air Station Brunswick
Brunswick, Maine

PFAS Reporting Area	Well ID	Monitored Interval (feet bgs)	Gauging	PFAS Analysis	Anticipated Concentration	Rationale
Bedrock						
Area 3 Offbase Coombs Road	MW-316A	89.5 - 99.5	X	X	Low	Monitor PFAS in deeper bedrock well of the MW-316A/B well pair in the offbase area near Coombs Road. MW-317A had low detectable concentrations of PFAS in 2022.
	MW-316B	45 - 55	X	X	Low	Monitor PFAS in shallower bedrock well MW-316A/B well pair in the offbase area near Coombs Road. This well was non-detect in 2022.
	MW-317A	108 - 118	X	X	Low	Monitor PFAS in deeper bedrock well of MW-317A/B well pair in offbase area near Coombs Road. This well was non-detect in 2022.
	MW-317B	84.5 - 95.5	X	X	Low	Monitor PFAS in shallower bedrock well of MW-317A/B well pair in offbase area near Coombs Road. This well was non-detect in 2022.
Area 4 - Western Base Area	MW-QRY-02	12 - 22	X	X	Low	Well historically sampled in 2014 and was non-detect. Resample to confirm results.
	MW-QRY-13D	31.8 - 41.8	X	X	Low	Sample additional monitoring well to confirm presence/absense of PFAS at the Quarry Area. This is the deepest bedrock well in the Quarry Area.
Area 6 - Eastern Base Area	MW-NASB-047	23 - 28	X	X	Low/Moderate	Confirm presence/absense of PFAS in the only bedrock monitoring well in the cental portion of the former base. This well is located immediately south of the ONFF.
Area 7 - Former Building 653 Area	MW-503BR	32.5 - 42.5	X	X	Low	Monitor PFAS in the only bedrock well in northern groundwater divide area and along northern former base boundary.
Area 9 - Eastern Plume/Southern Base Area	MW-323	29 - 39	X	X	High	Continue to monitor PFAS in bedrock well adjacent to Eastern Plume GWETS infiltration gallery (Site 11). This well historically has the highest PFAS in bedrock groundwater.
	MW-EP-341-B1	73 - 78	X	X	Low/Moderate	Confirm concentrations of PFAS in this upper bedrock well to refine western boundary of area of high PFAS in easterly well MW-EP-342-B1. This well is located in the vicinity of a bedrock high.
	MW-EP-341-B2	88 - 93	X	X	Low/Moderate	Confirm presence/absense of PFAS in lower bedrock. Only upper bedrock wells have been historically sampled within the Eastern Plume. This well is the deepest bedrock well within the Eastern Plume.
	MW-EP-342-B1	63.2 - 68.2	X	X	Moderate	Continue to monitor PFAS in upper bedrock well located in the north central portion of the Eastern Plume. This well historically has the highest PFAS in bedrock groundwater within the Eastern Plume.
	MW-309A	59 - 69	X	X	Low	Continue to monitor PFAS in bedrock in eastern edge of the north centration portion of the Eastern Plume and former base boundary. PFAS concentrations are two orders of magnitude lower than upgradient bedrock well MW-EP-342-B1. Monitor to confirm PFAS is not migrating offbase.

Notes:
AFFF - Aqueous Film-Forming Foam
bgs - below ground surface
GWETS - Groundwater Extraction Treatment System
ONFF - Old Navy Fuel Farm
PFAS - Per- and Polyfluoroalkyl Substances

Figures

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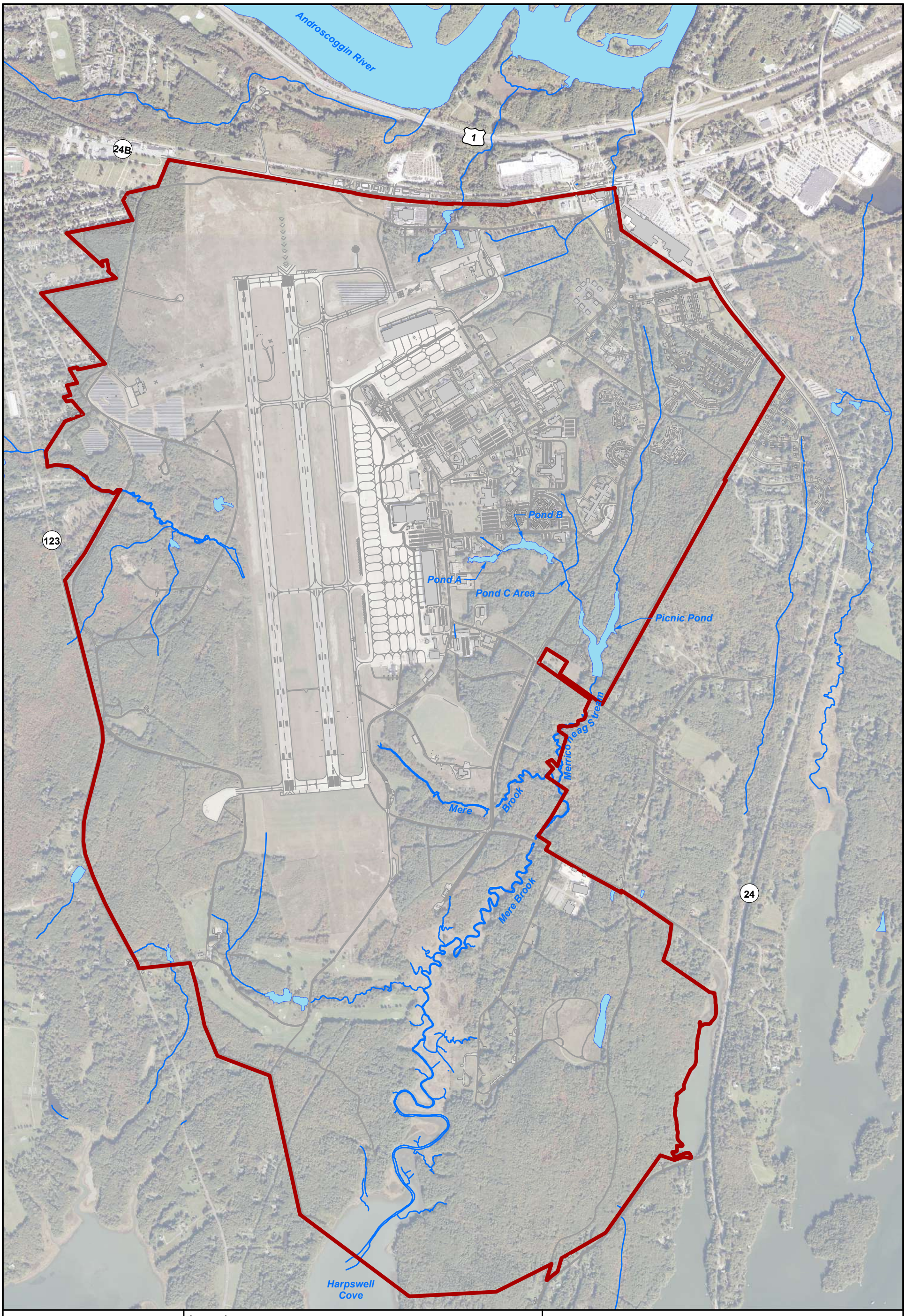

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Project #:	60708191	

Legend

- Building
- Installation Area
- Waterbody
- Stream
- Road

N

0 700 1,400

Scale in Feet

Source Orthoimagery from NOAA, 2021.

FIGURE 10-1
SITE LOCATION MAP

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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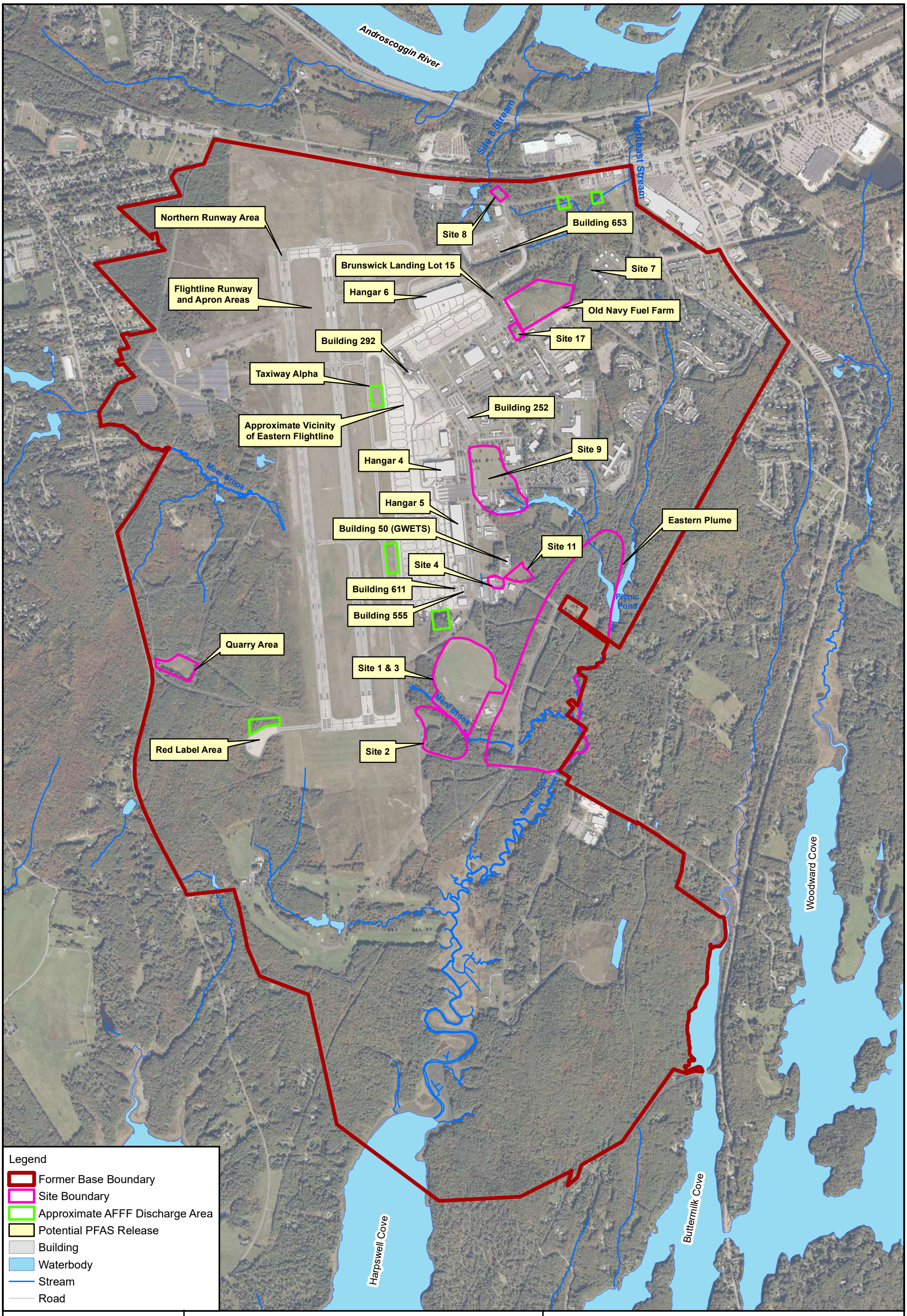

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Project #:	60708191	

N

0 900 1,800

Scale in Feet

Source
Orthoimagery from NOAA, 2021.

FIGURE 10-2
SITE MAP WITH PFAS AREAS OF CONCERN

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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Androscoggin River
Jordan Avenue Pump Station
Area 1 Jordan Avenue/Northwest Base Area
Area 2 Offbase Northern Properties
Northern Stream
Site 8 Stream
Pond 3
Site 8
Pond 2
Pond 1
Area 7 Former Building 653 Area
Northern Runway Area
Building 653
Brunswick Landing Lot 15
Site 7
Brunswick Landing Venture Development
Flightline Runway and Apron Areas
Hangar 6
Old Navy Fuel Farm
Building 586
Site 17
Building 292
Area 6 Eastern Base Area
Taxiway Alpha
Area 8 Industrialized Area
Building 225
Building 252
Building 87
Merriconeag Stream
Approximate Vicinity of Eastern Flightline
Hangar 4
Site 9
Building 35
Pond B
Hangar 5
Pond A
Pond C Area
Area 4 Western Base Area
Building 50 (GWETS)
Site 11
Site 4
Building 611
Picnic Pond
Building 555
Area 9 Eastern Plume/Southern Base Area
Quarry Area
Eastern Plume
Site 1 & 3
Mere Brook
Area 3 Offbase Coombs Road
Red Label Area
Site 2
Area 5 Southwest Base Area
Mere Brook
Woodward Cove

Legend
- Former Base Boundary
- Site Boundary
- Approximate AFFF Discharge Area
- Building
- Waterbody
- Aquifer Protection Overlay 3 District
- Surface Water Drainage Divide (Inferred Groundwater Divide)
- Ditch
- Bedrock High
- Stream
- Road

Note:
Areas 1 and 2 overlap due to the investigation area of Area 2 coinciding with the portion of the Aquifer Protection Overlay 3 District that defines the eastern boundary of Area 1.

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N
0 675 1,350
Scale in Feet

FIGURE 10-3
PFAS REPORTING AREAS

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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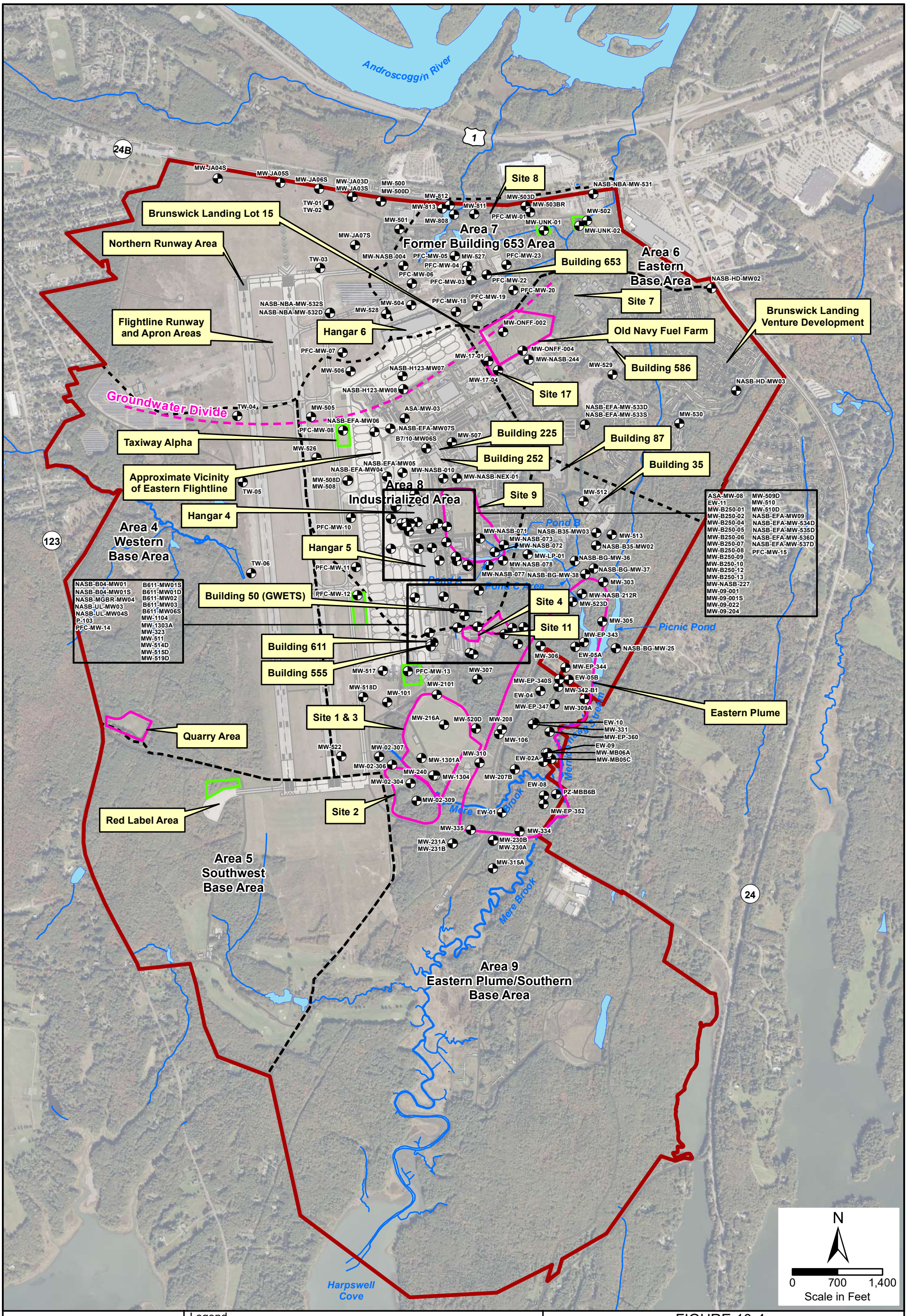

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Project #:	60708191	

Legend

- Groundwater Sample Location
- Building
- Waterbody
- Stream
- Road
- Installation Area
- Site Boundary
- PFAS Reporting Area
- Approximate AFFF Discharge Area

Source
Orthoimagery from NOAA, 2021.

FIGURE 10-4
2022/2023 PFAS REMEDIAL INVESTIGATION
GROUNDWATER SAMPLE LOCATIONS

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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Androscoggin River

Androscoggin River

unnamed tributary to Androscoggin River

Nordheast Stream

Site 6 Stream

Pond 1

Pond 2

Pond 3

Pond A

Pond B

Pond C

Former Building 653

Site 7

Site 17

Old Navy Fuel Farm (inactive)

Hangar 6

East SAA

West SAA

Hangar 5

South SAA

Site 9

Sites 1 & 3

Site 2

Eastern Plume

Picnic Pond

Mere Brook

Merriconeag Stream

SG-3 / 25.65

SG-2 / 31.32

SG-1 / 36.19

MP-4 / 44.65

SG-1&3/2-02 / 17.55

SG-4 / 40.53

Legend

- Shallow Monitoring Well
- Staff Gauge Location
- Bedrock High
- Groundwater Flow Direction
- Potentiometric Contour (dashed where inferred) (feet, above mean sea level)
- 21.11 Groundwater Elevation (feet, above mean sea level)
- Slurry Wall
- Petroleum, Oil, and Lubricant Site
- Approximate AFFF Discharge Area
- IR Program Site - Active
- Former Installation Boundary
- Building
- Former Building
- Groundwater Divide
- Surface Water
- Stream

N

0 350 700

Scale in Feet

NAVFAC Naval Facilities Engineering Systems Command

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Project #:	60708191	

FIGURE 10-5
BASEWIDE SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE MAP
UPPER SAND UNIT - APRIL 2023

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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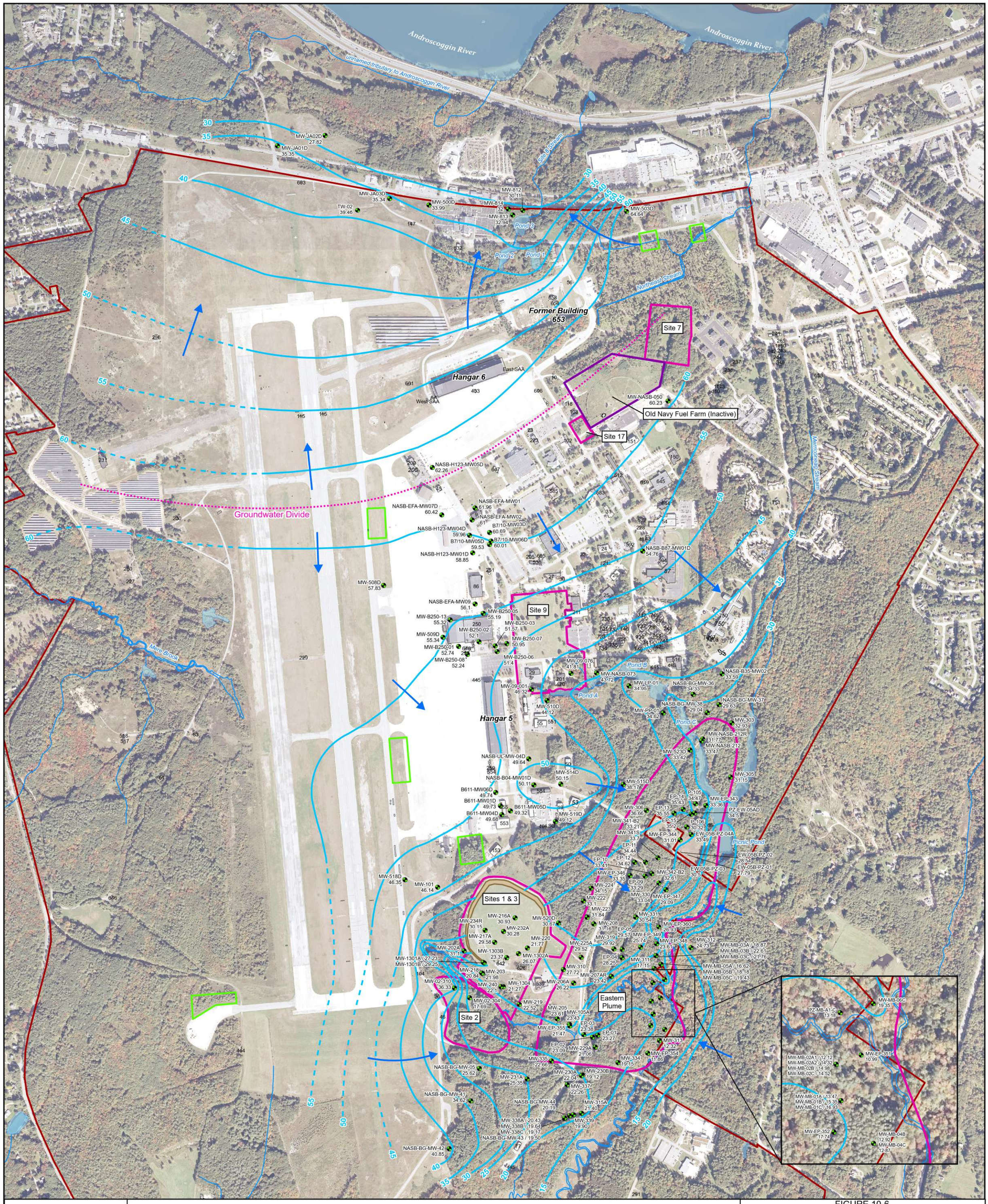

Legend

- Deep Monitoring Well
- Groundwater Flow Direction
- Potentiometric Contour (dashed where inferred) (feet, above mean sea level)
- 25.62 Groundwater Elevation (feet, above mean sea level)
- Slurry Wall
- Petroleum, Oil, and Lubricant Site
- Approximate AFFF Discharge Area
- IR Program Site - Active
- Installation Boundary
- Building
- Former Building
- Groundwater Divide
- Surface Water
- Stream

N

0 350 700

Scale in Feet

NAVFAC Naval Facilities Engineering Systems Command

Drawn:	JB	01/29/2026
Approved:	CD	01/29/2026
Project #:	60708191	

FIGURE 10-6
BASEWIDE DEEP GROUNDWATER POTENTIOMETRIC SURFACE MAP
LOWER SAND UNIT - APRIL 2023

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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Androscoggin River
Northeast Stream
Site 8 Stream
MW-503BR
64.33
SC-3 / 25.65
Pond 3
Pond 2
Pond 1
Site 7
MW-NASB-063
67.43
East SAA
Hangar 6
West SAA
MW-NASB-047
62.73
Site 17
Groundwater Divide
Site 9
Hangar 4
Hangar 5
Pond B
Pond A
Pond C
Picnic Pond
MerriConeag Stream
Mere Brook
MW-323
21.61
MW-340-B1
32.62
MW-341-B1
33.47
MW-340-B2
32.61
MW-341-B2
33.21
MW-342-B1
32.49
MW-308
33.36
MW-342-B2
32.61
MW-309A
NM
MW-211A
42.44
Sites 1 & 3
MW-210R
28.5
MW-210A
NM
Eastern Plume
Site 2
MW-317A
58.17
MW-317B
58.12
MW-316A
32.05
MW-316B
40.1
MW-QRY-13D
91.21
MW-QRY-15
91.37
MW-QRY-16
91.45
MW-QRY-05
92.45
MW-QRY-17
82.85
MW-QRY-12
90.92
MW-QRY-04
92.57
MW-QRY-07
90.25
MW-QRY-02
90.66
MW-QRY-08
94.31
MW-QRY-06
91.99
MW-QRY-01A
95.49
MW-QRY-01B
95.49

Legend

- Bedrock Monitoring Well
- Road
- Potentiometric Contour (dashed where inferred)
- 25.62 Groundwater Elevation
- Groundwater Flow Direction
- Slurry Wall
- IR Program Site
- Approximate AFFF Discharge Area
- Former Installation Boundary
- Building
- Historical Building
- Water

N

0 350 700

Scale in Feet

NAVFAC Naval Facilities Engineering Systems Command

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Project #:	60708191	

FIGURE 10-7
BASEWIDE BEDROCK GROUNDWATER POTENTIOMETRIC SURFACE MAP
APRIL 2023

TIER I SAMPLING AND ANALYSIS PLAN
FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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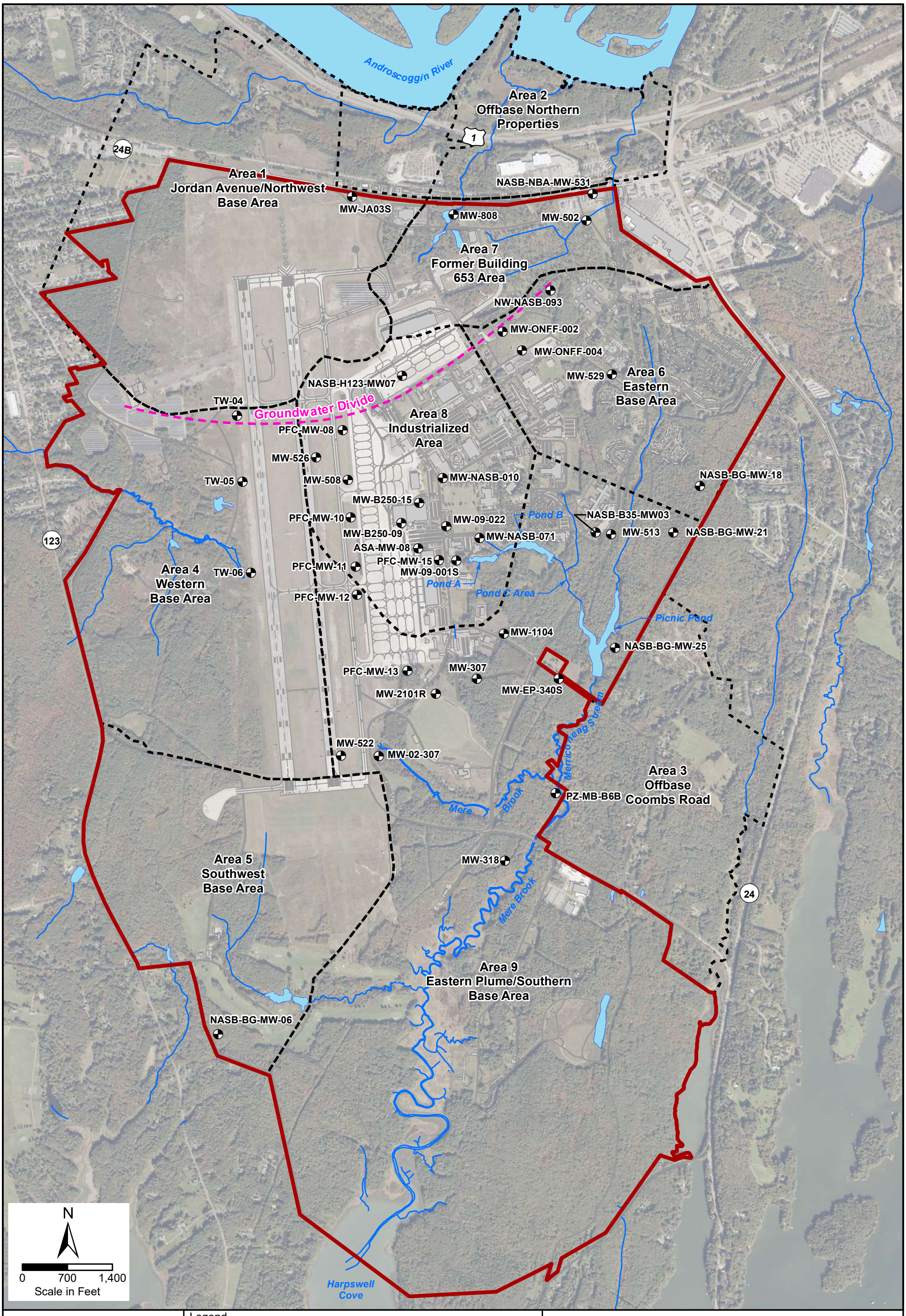

Legend

- Proposed Groundwater Sampling and Gauging Location
- Building
- Waterbody
- Stream
- Road
- Installation Area
- PFAS Reporting Area

Source
Orthoimagery from NOAA, 2021.

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Project #:	60708191	

FIGURE 17-1
PROPOSED PFAS GROUNDWATER SAMPLING LOCATIONS IN SHALLOW AQUIFER
PFAS GROUNDWATER SAMPLING PROGRAM

FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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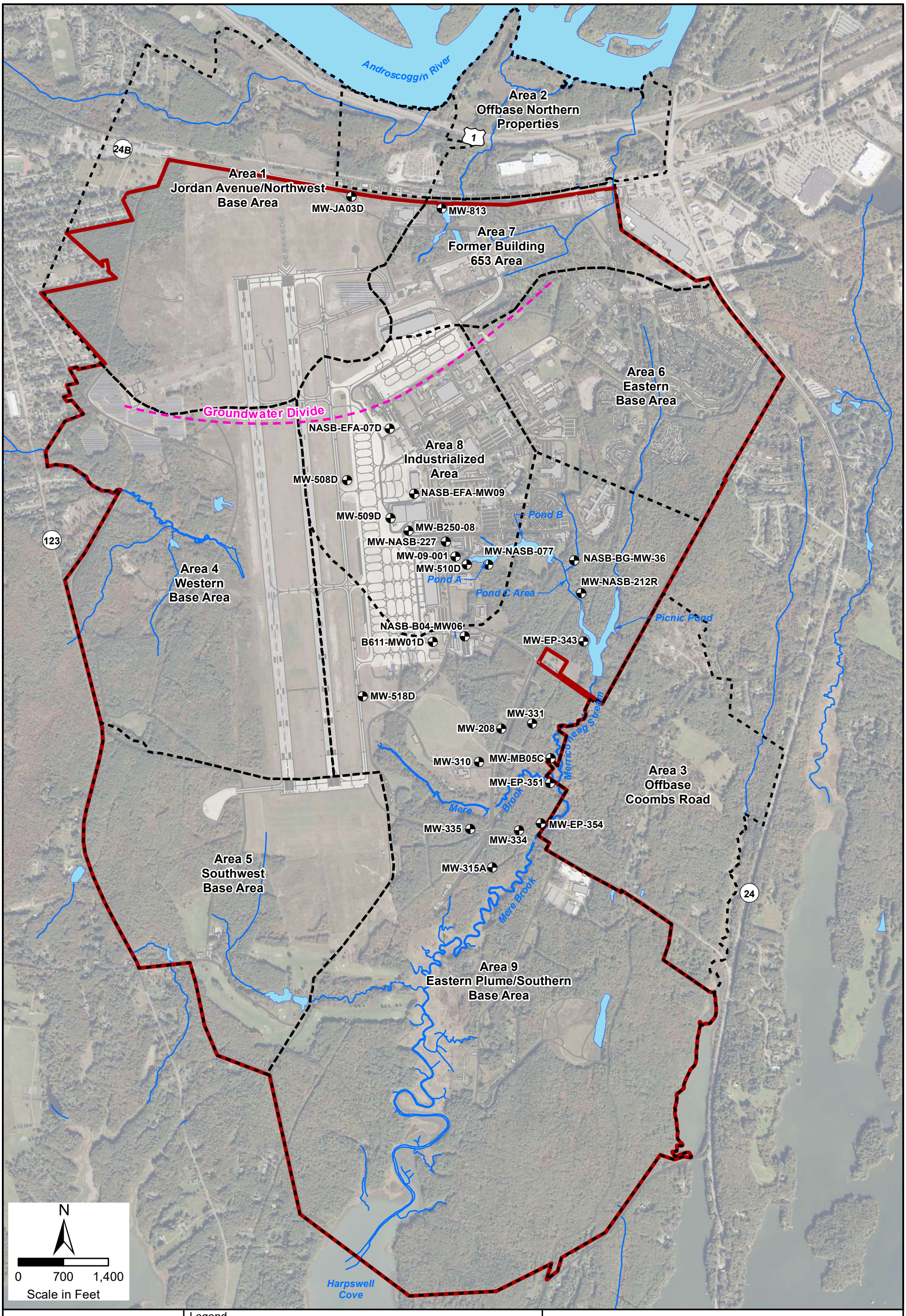

Naval Facilities Engineering Systems Command

Drawn:	JB	10/23/2025
Approved:	CD	10/23/2025
Project #:	60708191	

Legend

- Proposed Groundwater Sampling and Gauging Location
- Building
- PFAS Reporting Area
- Waterbody
- Stream
- Road
- Installation Area

Source Orthoimagery from NOAA, 2021.

FIGURE 17-2
PROPOSED PFAS GROUNDWATER SAMPLING LOCATIONS IN DEEP AQUIFER
PFAS GROUNDWATER SAMPLING PROGRAM

FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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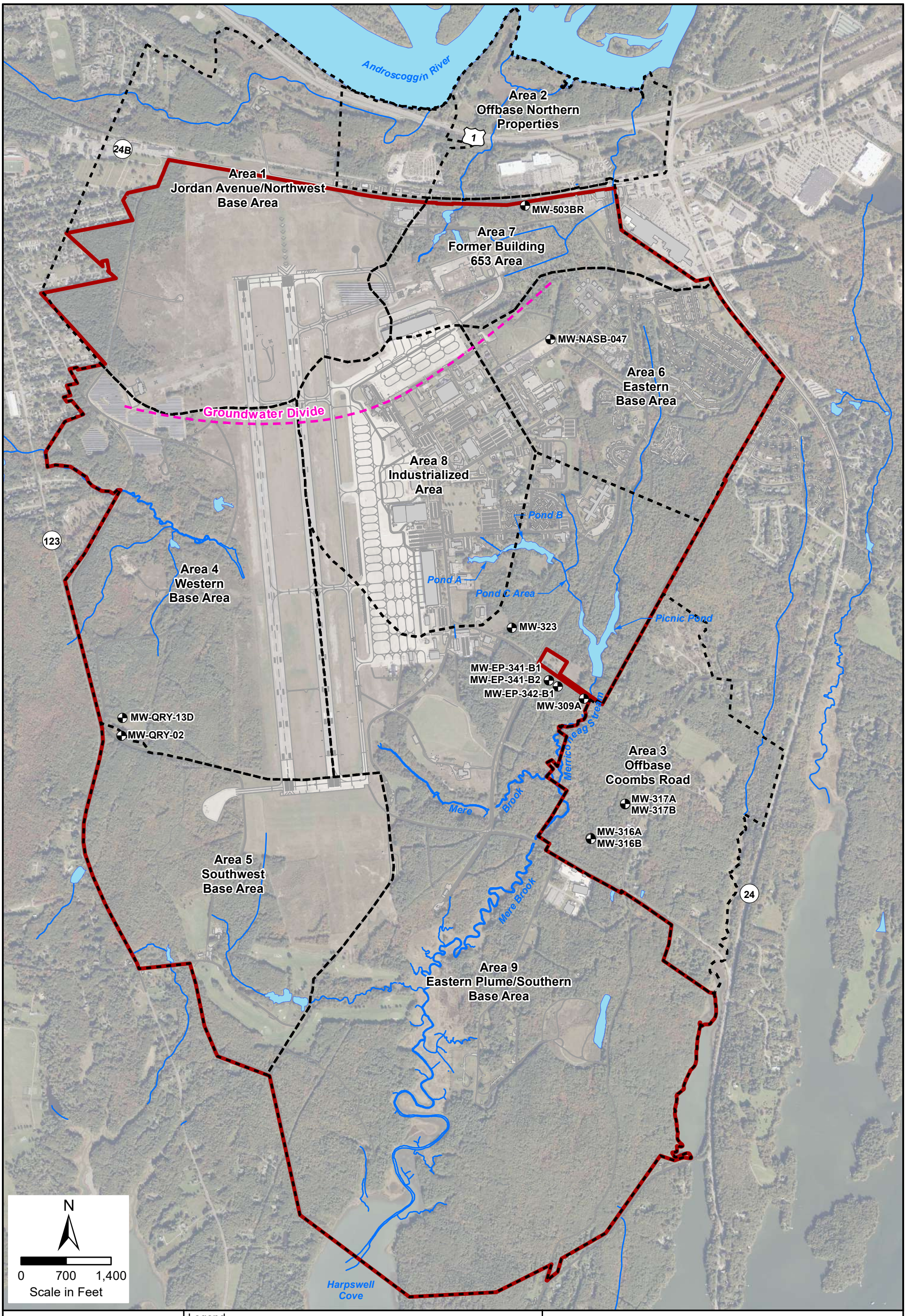

NAVFAC
Naval Facilities Engineering Systems Command

Drawn:	JB	10/23/2025
Approved:	CD	10/23/2025
Project #:	60708191	

Legend

- Proposed Groundwater Sampling and Gauging Location
- Building
- PFAS Reporting Area
- Waterbody
- Stream
- Road
- Installation Area

Source
Orthoimagery from NOAA, 2021.

FIGURE 17-3
PROPOSED PFAS GROUNDWATER SAMPLING LOCATIONS IN BEDROCK AQUIFER
PFAS GROUNDWATER SAMPLING PROGRAM

FORMER NAVAL AIR STATION BRUNSWCK
BRUNSWICK, MAINE

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Appendix A

DoD Environmental Data Quality Workgroup Memorandum Recommendation to Address Shorter Holding Times for Specific Per- and Polyfluoroalkyl Substances (PFAS) When Using EPA Method 1633 for PFAS Investigations

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DoD Environmental Data Quality Workgroup Memorandum

Subject: Recommendation to Address Shorter Holding Times for Specific Per- and Polyfluoroalkyl substances (PFAS) When Using EPA Method 1633 for PFAS Investigations

March 27, 2025

While the standard holding time before samples must be extracted for most analytes listed in EPA Method 1633 is 28 days for water, soil, and tissue samples, there are a few analytes in the method that have shortened holding times. None of these analytes have associated regulatory limits and trying to meet these shortened holding times will be challenging and result in unnecessary expenditure of resources.

Section 8.5 of EPA Methods 1633 and 1633A for the analysis of PFAS identify shortened sample holding times for four PFAS in aqueous samples and one PFAS in soil or sediment. Laboratories are unlikely to extract/analyze samples before these shortened holding times are exceeded.

Aqueous samples analyzed for NMeFOSE, NEtFOSE, NMeFOSAA, and NEtFOSAA have a seven-day holding time if stored at 0 – 6 ºC. NMeFOSE and NEtFOSE may undergo transformation to NMeFOSAA and NEtFOSAA respectively when stored at 0 – 6 ºC if stored for longer than seven days. If the samples are stored at or below -20 ºC the holding time for these PFAS can be extended to 90 days, but very few laboratories have the capability or capacity to routinely store samples at this temperature.

Soil or sediment samples analyzed for NFDHA have a three-day holding time regardless of storage temperature.

Tissue samples analyzed for NFDHA have a three -day holding time if stored at 0 – 6 ºC.

Except for 9Cl-PF3OUdS and 11Cl-PF3ONS, after a sample is extracted, the extract may be held for up to 90 days before analysis. Sample extracts for 9Cl-PF3OUdS and 11Cl-PF3ONS, regardless of matrix type, have a 28-day holding time.

Currently none of the PFAS with shortened holding times have toxicity factors or corresponding EPA Regional Screening Levels, thus any additional uncertainty associated with a holding time exceedance for these analytes will not affect current decision making.

The DoD Environmental Data Quality Workgroup recommends projects continue to request analysis of the PFAS with shortened holding times but accept qualified results if a holding time is exceeded. This qualification can appear along with the result or in the case narrative. Qualifying results will allow any uncertainty to be considered in future decision making. Project planning documents should indicate that DoD does not expect laboratories to prepare and/or analyze samples within the shortened holding time and that DoD is willing to accept any additional uncertainty. This approach should be recorded using worksheets 15 and 19&30 of the Uniform Federal Policy for Quality Assurance

Project Plans optimized worksheets (https://www.epa.gov/sites/default/files/documents/ufp_qapp_worksheets.pdf). The worksheets should be used to indicate which compounds have the shortened holding times and describe how results will be qualified. The worksheets should acknowledge that a holding time exceedance is likely, and that the exceedance will be addressed in data validation and usability. Regulatory acceptance of this approach should be recorded.

Appendix B

Laboratory Certification

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CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Katahdin Analytical Services, LLC
600 Technology Way
Scarborough, ME 04074

Fulfills the requirements of

ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V6.0)

In the field of

TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

Jason Stine, Vice President
Expiry Date: 01 February 2027
Certificate Number: L2223

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V 6.0)

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TESTING

Valid to: **February 1, 2027** Certificate Number: **L2223**

Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2, 4`-DDD
GC/ECD	EPA 8081B	2, 4`-DDE
GC/ECD	EPA 8081B	2, 4`-DDT
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (PCB195)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (PCB 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (PCB 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (PCB 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (PCB 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (PCB 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (PCB 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (PCB 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (PCB 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (PCB 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (PCB 48)
GC/ECD	EPA 8082A	2, 2', 4, 5'-Tetrachlorobiphenyl (PCB 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (PCB 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (PCB 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (PCB 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (PCB 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (PCB 105)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5, 5'-Heptachlorobiphenyl (PCB 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (PCB 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5'-Pentachlorobiphenyl (PCB 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (PCB 66)
GC/ECD	EPA 8082A	2, 3, 4, 4', 5-Pentachlorobiphenyl (PCB 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (PCB 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (PCB 8)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (PCB 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (PCB 77)
GC/ECD	EPA 8082A	3, 4, 4', 5-Tetrachlorobiphenyl (PCB 81)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5'6,6'-Decachlorobiphenyl (PCB 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbon (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	EPA 8260C/D	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260C/D	1, 1, 1-Trichloroethane
GC/MS	EPA 8260C/D	1, 1, 2, 2-Tetrachloroethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C/D	1, 1, 2-Trichloroethane
GC/MS	EPA 8260C/D	1, 1-Dichloroethane
GC/MS	EPA 8260C/D	1, 1-Dichloroethene
GC/MS	EPA 8260C/D	1, 1-Dichloropropene
GC/MS	EPA 8260C/D	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 2, 3-Trichloropropane
GC/MS	EPA 8260C/D	1,2,3-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260C/D	1, 2-Dibromoethane (EDB)
GC/MS	EPA 8260C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 2-Dichloroethane
GC/MS	EPA 8260C/D	1, 2-Dichloropropane
GC/MS	EPA 8260C/D	1,3,5-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 3-Dichloropropane
GC/MS	EPA 8260C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 4-Dioxane
GC/MS	EPA 8260C/D	2, 2-Dichloropropane
GC/MS	EPA 8260C/D	2-Butanone
GC/MS	EPA 8260C/D	2-Chloroethyl vinyl ether
GC/MS	EPA 8260C/D	2-Chlorotoluene
GC/MS	EPA 8260C/D	2-Hexanone
GC/MS	EPA 8260C/D	4-Chlorotoluene
GC/MS	EPA 8260C/D	4-Methyl-2-pentanone

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	Acetone
GC/MS	EPA 8260C/D	Acetonitrile
GC/MS	EPA 8260C/D	Acrolein
GC/MS	EPA 8260C/D	Acrylonitrile
GC/MS	EPA 8260C/D	Allyl chloride
GC/MS	EPA 8260C/D	Benzene
GC/MS	EPA 8260C/D	Bromobenzene
GC/MS	EPA 8260C/D	Bromochloromethane
GC/MS	EPA 8260C/D	Bromodichloromethane
GC/MS	EPA 8260C/D	Bromoform
GC/MS	EPA 8260C/D	Carbon disulfide
GC/MS	EPA 8260C/D	Carbon tetrachloride
GC/MS	EPA 8260C/D	Chlorobenzene
GC/MS	EPA 8260C/D	Chloroethane
GC/MS	EPA 8260C/D	Chloroform
GC/MS	EPA 8260C/D	Chloroprene
GC/MS	EPA 8260C/D	cis-1, 2-Dichloroethene
GC/MS	EPA 8260C/D	cis-1, 3-Dichloropropene
GC/MS	EPA 8260C/D	Cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260C/D	Cyclohexane
GC/MS	EPA 8260C/D	Dibromochloromethane
GC/MS	EPA 8260C/D	Dibromomethane
GC/MS	EPA 8260C/D	Dichlorodifluoromethane
GC/MS	EPA 8260C/D	Diethyl ether
GC/MS	EPA 8260C/D	Di-isopropylether
GC/MS	EPA 8260C/D	Ethyl methacrylate
GC/MS	EPA 8260C/D	Ethylbenzene
GC/MS	EPA 8260C/D	Ethyl-t-butylether

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	Hexachlorobutadiene
GC/MS	EPA 8260C/D	Iodomethane
GC/MS	EPA 8260C/D	Isobutyl alcohol
GC/MS	EPA 8260C/D	Isopropyl benzene
GC/MS	EPA 8260C/D	m p-xylenes
GC/MS	EPA 8260C/D	Methyl acetate
GC/MS	EPA 8260C/D	Methacrylonitrile
GC/MS	EPA 8260C/D	Methyl bromide (Bromomethane)
GC/MS	EPA 8260C/D	Methyl chloride (Chloromethane)
GC/MS	EPA 8260C/D	Methyl methacrylate
GC/MS	EPA 8260C/D	Methyl tert-butyl ether
GC/MS	EPA 8260C/D	Methylcyclohexane
GC/MS	EPA 8260C/D	Methylene chloride
GC/MS	EPA 8260C/D	Naphthalene
GC/MS	EPA 8260C/D	n-Butylbenzene
GC/MS	EPA 8260C/D	n-Propylbenzene
GC/MS	EPA 8260C/D	o-Xylene
GC/MS	EPA 8260C/D	Pentachloroethane
GC/MS	EPA 8260C/D	p-Isopropyltoluene
GC/MS	EPA 8260C/D	Propionitrile
GC/MS	EPA 8260C/D	sec-butylbenzene
GC/MS	EPA 8260C/D	Styrene
GC/MS	EPA 8260C/D	t-Amylmethylether
GC/MS	EPA 8260C/D	tert-Butyl alcohol
GC/MS	EPA 8260C/D	tert-Butylbenzene
GC/MS	EPA 8260C/D	Tetrachloroethene (Perchloroethylene)
GC/MS	EPA 8260C/D	Tetrahydrofuran
GC/MS	EPA 8260C/D	Toluene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260C/D	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260C/D	trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 8260C/D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260C/D	Trichlorofluoromethane
GC/MS	EPA 8260C/D	Vinyl acetate
GC/MS	EPA 8260C/D	Vinyl chloride
GC/MS	EPA 8260C/D	Xylene
GC/MS	EPA 8260C/D SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260C/D SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C/D SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260C/D SIM	1,1-Dichloroethane
GC/MS	EPA 8260C/D SIM	1,1-Dichloroethene
GC/MS	EPA 8260C/D SIM	1,2-Dichloroethane
GC/MS	EPA 8260C/D SIM	Benzene
GC/MS	EPA 8260C/D SIM	Chloroform
GC/MS	EPA 8260C/D SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260C/D SIM	Tetrachloroethene
GC/MS	EPA 8260C/D SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260C/D SIM	Trichloroethene
GC/MS	EPA 8260C/D SIM	Vinyl Chloride
GC/MS	EPA 8270D/E	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 8270D/E	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8270D/E	1, 2-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 2-Diphenylhydrazine
GC/MS	EPA 8270D/E	1, 3, 5-Trinitrobenzene
GC/MS	EPA 8270D/E	1, 3-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 3-Dinitrobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	1, 4-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 4-Dioxane
GC/MS	EPA 8270D/E	1, 4-Naphthoquinone
GC/MS	EPA 8270D/E	1, 4-Phenylenediamine
GC/MS	EPA 8270D/E	1-Chloronaphthalene
GC/MS	EPA 8270D/E	1-Methylnaphthalene
GC/MS	EPA 8270D/E	1-Naphthylamine
GC/MS	EPA 8270D/E	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270D/E	2, 4, 5-Trochlorophenol
GC/MS	EPA 8270D/E	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270D/E	2, 4-Dichlorophenol
GC/MS	EPA 8270D/E	2, 4-Dimethylphenol
GC/MS	EPA 8270D/E	2, 4-Dinitrophenol
GC/MS	EPA 8270D/E	2, 4-Dinitrotoluene (2, 4-DNT)
GC/MS	EPA 8270D/E	2, 6-Dichlorophenol
GC/MS	EPA 8270D/E	2, 6-Dinitrotoluene (2, 6-DNT)
GC/MS	EPA 8270D/E	2-Acetylaminofluorene
GC/MS	EPA 8270D/E	2-Chloronaphthalene
GC/MS	EPA 8270D/E	2-Chlorophenol
GC/MS	EPA 8270D/E	2-Methyl-4 6-dinitrophenol
GC/MS	EPA 8270D/E	2-Methylnaphthalene
GC/MS	EPA 8270D/E	2-Methylphenol
GC/MS	EPA 8270D/E	2-Naphthylamine
GC/MS	EPA 8270D/E	2-Nitroaniline
GC/MS	EPA 8270D/E	2-Nitrophenol
GC/MS	EPA 8270D/E	2-Picoline
GC/MS	EPA 8270D/E	3-Methylcholanthrene
GC/MS	EPA 8270D/E	3-Nitroaniline

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	4-Aminobiphenyl
GC/MS	EPA 8270D/E	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D/E	4-Chloro-3-methylphenol
GC/MS	EPA 8270D/E	4-Chloroaniline
GC/MS	EPA 8270D/E	4-Chlorophenyl phenylether
GC/MS	EPA 8270D/E	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270D/E	3&4-Methylphenol
GC/MS	EPA 8270D/E	4-Nitroaniline
GC/MS	EPA 8270D/E	4-Nitrophenol
GC/MS	EPA 8270D/E	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270D/E	5-Nitro-o-toluidine
GC/MS	EPA 8270D/E	7, 12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270D/E	a a-Dimethylphenethylamine
GC/MS	EPA 8270D/E	Acenaphthene
GC/MS	EPA 8270D/E	Acenaphthylene
GC/MS	EPA 8270D/E	Acetophenone
GC/MS	EPA 8270D/E	Aniline
GC/MS	EPA 8270D/E	Anthracene
GC/MS	EPA 8270D/E	Aramite
GC/MS	EPA 8270D/E	Atrazine
GC/MS	EPA 8270D/E	Azobenzene
GC/MS	EPA 8270D/E	Benzaldehyde
GC/MS	EPA 8270D/E	Benzidine
GC/MS	EPA 8270D/E	Benzo(a)anthracene
GC/MS	EPA 8270D/E	Benzo(a)pyrene
GC/MS	EPA 8270D/E	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E	Benzo(g h i)perylene
GC/MS	EPA 8270D/E	Benzo(k)fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	Benzoic Acid
GC/MS	EPA 8270D/E	Benzyl alcohol
GC/MS	EPA 8270D/E	1,1-Biphenyl
GC/MS	EPA 8270D/E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270D/E	bis(2-Chloroethyl) ether
GC/MS	EPA 8270D/E	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane)
GC/MS	EPA 8270D/E	bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270D/E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270D/E	Butyl benzyl phthalate
GC/MS	EPA 8270D/E	Caprolactam
GC/MS	EPA 8270D/E	Carbazole
GC/MS	EPA 8270D/E	Chlorobenzilate
GC/MS	EPA 8270D/E	Chrysene
GC/MS	EPA 8270D/E	Diallate
GC/MS	EPA 8270D/E	Dibenzo(a,j)acridine
GC/MS	EPA 8270D/E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D/E	Dibenzofuran
GC/MS	EPA 8270D/E	Diethyl phthalate
GC/MS	EPA 8270D/E	Dimethoate
GC/MS	EPA 8270D/E	Dimethyl phthalate
GC/MS	EPA 8270D/E	Di-n-butyl phthalate
GC/MS	EPA 8270D/E	Di-n-octyl phthalate
GC/MS	EPA 8270D/E	Dinoseb
GC/MS	EPA 8270D/E	Disulfoton
GC/MS	EPA 8270D/E	Ethyl methanesulfonate
GC/MS	EPA 8270D/E	Ethyl parathion
GC/MS	EPA 8270D/E	Ethyl methacrylate
GC/MS	EPA 8270D/E	Fluoranthene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	Fluorene
GC/MS	EPA 8270D/E	Hexachlorobenzene
GC/MS	EPA 8270D/E	Hexachlorobutadiene
GC/MS	EPA 8270D/E	Hexachlorocyclopentadiene
GC/MS	EPA 8270D/E	Hexachloroethane
GC/MS	EPA 8270D/E	Hexachloropropene
GC/MS	EPA 8270D/E	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270D/E	Isodrin
GC/MS	EPA 8270D/E	Isophorone
GC/MS	EPA 8270D/E	Isosafrole
GC/MS	EPA 8270D/E	Methapyriline
GC/MS	EPA 8270D/E	Methy methanesulfonate
GC/MS	EPA 8270D/E	Methyl parathion
GC/MS	EPA 8270D/E	Naphthalene
GC/MS	EPA 8270D/E	Nitrobenzene
GC/MS	EPA 8270D/E	Nitroquinoline-1-oxide
GC/MS	EPA 8270D/E	n-Nitrosodiethylamine
GC/MS	EPA 8270D/E	n-Nitrosodimethylamine
GC/MS	EPA 8270D/E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270D/E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D/E	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E	n-Nitrosomethylethylamine
GC/MS	EPA 8270D/E	n-Nitrosomorpholine
GC/MS	EPA 8270D/E	n-Nitrosopiperidine
GC/MS	EPA 8270D/E	n-Nitrosopyrrolidine
GC/MS	EPA 8270D/E	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270D/E	O,O-Diethyl O-2pyrazinyl phosphorothioate
GC/MS	EPA 8270D/E	o-Toluidine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	Pentachlorobenzene
GC/MS	EPA 8270D/E	Pentachloronitrobenzene
GC/MS	EPA 8270D/E	Pentachlorophenol
GC/MS	EPA 8270D/E	Phenacetin
GC/MS	EPA 8270D/E	Phenanthrene
GC/MS	EPA 8270D/E	Phenol
GC/MS	EPA 8270D/E	Phorate
GC/MS	EPA 8270D/E	Pronamide
GC/MS	EPA 8270D/E	Pyrene
GC/MS	EPA 8270D/E	Pyridine
GC/MS	EPA 8270D/E	Safrole
GC/MS	EPA 8270D/E	Sulfotepp
GC/MS	EPA 8270D/E	Thionazin
GC/MS	EPA 8270D/E	3, 3’-Dichlorobenzidine
GC/MS	EPA 8270D/E	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270D/E SIM	1,1'-Biphenyl
GC/MS	EPA 8270D/E SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D/E SIM	1,4-Dioxane
GC/MS	EPA 8270D/E SIM	1-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270D/E SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D/E SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dimethylphenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrophenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270D/E SIM	2,6-Dinitrotoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	2-Chloronaphthalene
GC/MS	EPA 8270D/E SIM	2-Chlorophenol
GC/MS	EPA 8270D/E SIM	2-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2-Methylphenol
GC/MS	EPA 8270D/E SIM	2-Nitroaniline
GC/MS	EPA 8270D/E SIM	2-Nitrophenol
GC/MS	EPA 8270D/E SIM	3&4-Methylphenol
GC/MS	EPA 8270D/E SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D/E SIM	3-Nitroaniline
GC/MS	EPA 8270D/E SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D/E SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270D/E SIM	4-Chloroaniline
GC/MS	EPA 8270D/E SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Nitroaniline
GC/MS	EPA 8270D/E SIM	4-Nitrophenol
GC/MS	EPA 8270D/E SIM	Acenaphthene
GC/MS	EPA 8270D/E SIM	Acenaphthylene
GC/MS	EPA 8270D/E SIM	Acetophenone
GC/MS	EPA 8270D/E SIM	Anthracene
GC/MS	EPA 8270D/E SIM	Atrazine
GC/MS	EPA 8270D/E SIM	Benzaldehyde
GC/MS	EPA 8270D/E SIM	Benzo(a)anthracene
GC/MS	EPA 8270D/E SIM	Benzo(a)pyrene
GC/MS	EPA 8270D/E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270D/E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethoxy)methane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270D/E SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270D/E SIM	Butylbenzylphthalate
GC/MS	EPA 8270D/E SIM	Caprolactam
GC/MS	EPA 8270D/E SIM	Carbazole
GC/MS	EPA 8270D/E SIM	Chrysene
GC/MS	EPA 8270D/E SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D/E SIM	Dibenzofuran
GC/MS	EPA 8270D/E SIM	Diethylphthalate
GC/MS	EPA 8270D/E SIM	Dimethyl phthalate
GC/MS	EPA 8270D/E SIM	Di-n-butylphthalate
GC/MS	EPA 8270D/E SIM	Di-n-octylphthalate
GC/MS	EPA 8270D/E SIM	Fluoranthene
GC/MS	EPA 8270D/E SIM	Fluorene
GC/MS	EPA 8270D/E SIM	Hexachlorobenzene
GC/MS	EPA 8270D/E SIM	Hexachlorobutadiene
GC/MS	EPA 8270D/E SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270D/E SIM	Hexachloroethane
GC/MS	EPA 8270D/E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D/E SIM	Isophorone
GC/MS	EPA 8270D/E SIM	Naphthalene
GC/MS	EPA 8270D/E SIM	Nitrobenzene
GC/MS	EPA 8270D/E SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270D/E SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E SIM	Pentachlorophenol
GC/MS	EPA 8270D/E SIM	Phenanthrene
GC/MS	EPA 8270D/E SIM	Phenol
GC/MS	EPA 8270D/E SIM	Pyrene

Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A/B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A/B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4, 6 -Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	4-Amino-2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene
HPLC/UV	EPA 8330A/B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A/B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A/B	Tetryl
CVAA	EPA 245.1; EPA 7470A	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 200.7; EPA 6010C/D	Aluminum
ICP/AES	EPA 200.7; EPA 6010C/D	Antimony
ICP/AES	EPA 200.7; EPA 6010C/D	Arsenic
ICP/AES	EPA 200.7; EPA 6010C/D	Barium
ICP/AES	EPA 200.7; EPA 6010C/D	Beryllium
ICP/AES	EPA 200.7; EPA 6010C/D	Boron

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/AES	EPA 200.7; EPA 6010C/D	Cadmium
ICP/AES	EPA 200.7; EPA 6010C/D	Calcium
ICP/AES	EPA 200.7; EPA 6010C/D	Chromium
ICP/AES	EPA 200.7; EPA 6010C/D	Cobalt
ICP/AES	EPA 200.7; EPA 6010C/D	Copper
ICP/AES	EPA 200.7; EPA 6010C/D	Iron
ICP/AES	EPA 200.7; EPA 6010C/D	Lead
ICP/AES	EPA 200.7; EPA 6010C/D	Magnesium
ICP/AES	EPA 200.7; EPA 6010C/D	Manganese
ICP/AES	EPA 200.7; EPA 6010C/D	Molybdenum
ICP/AES	EPA 200.7; EPA 6010C/D	Nickel
ICP/AES	EPA 200.7; EPA 6010C/D	Potassium
ICP/AES	EPA 200.7; EPA 6010C/D	Selenium
ICP/AES	EPA 200.7; EPA 6010C/D	Silicon
ICP/AES	EPA 200.7; EPA 6010C/D	Silver
ICP/AES	EPA 200.7; EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Strontium
ICP/AES	EPA 6010C/D	Thallium
ICP/AES	EPA 200.7; EPA 6010C/D	Tin
ICP/AES	EPA 200.7; EPA 6010C/D	Titanium
ICP/AES	EPA 200.7; EPA 6010C/D	Vanadium
ICP/AES	EPA 200.7; EPA 6010C/D	Zinc
ICP/MS	EPA 200.8; EPA 6020A/B	Aluminum
ICP/MS	EPA 200.8; EPA 6020A/B	Antimony
ICP/MS	EPA 200.8; EPA 6020A/B	Arsenic
ICP/MS	EPA 200.8; EPA 6020A/B	Barium
ICP/MS	EPA 200.8; EPA 6020A/B	Beryllium
ICP/MS	EPA 200.8; EPA 6020A/B	Boron

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 200.8; EPA 6020A/B	Cadmium
ICP/MS	EPA 200.8; EPA 6020A/B	Calcium
ICP/MS	EPA 200.8; EPA 6020A/B	Chromium
ICP/MS	EPA 200.8; EPA 6020A/B	Cobalt
ICP/MS	EPA 200.8; EPA 6020A/B	Copper
ICP/MS	EPA 200.8; EPA 6020A/B	Iron
ICP/MS	EPA 200.8; EPA 6020A/B	Lead
ICP/MS	EPA 200.8; EPA 6020A/B	Magnesium
ICP/MS	EPA 200.8; EPA 6020A/B	Manganese
ICP/MS	EPA 200.8; EPA 6020A/B	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A/B	Nickel
ICP/MS	EPA 200.8; EPA 6020A/B	Potassium
ICP/MS	EPA 200.8; EPA 6020A/B	Selenium
ICP/MS	EPA 200.8; EPA 6020A/B	Silver
ICP/MS	EPA 200.8; EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Strontium
ICP/MS	EPA 200.8; EPA 6020A/B	Thallium
ICP/MS	EPA 200.8; EPA 6020A/B	Tin
ICP/MS	EPA 200.8; EPA 6020A/B	Tungsten
ICP/MS	EPA 200.8	Uranium
ICP/MS	EPA 200.8; EPA 6020A/B	Vanadium
ICP/MS	EPA 200.8; EPA 6020A/B	Zinc
IC	EPA 300.0; EPA 9056A	Chloride
IC	EPA 300.0; EPA 9056A	Fluoride
IC	EPA 300.0; EPA 9056A	Nitrate as N
IC	EPA 300.0; EPA 9056A	Nitrite as N
IC	EPA 300.0; EPA 9056A	Nitrate + Nitrite
IC	EPA 300.0; EPA 9056A	Sulfate

Non-Potable Water		
Technology	**Method**	**Analyte**
Titration	EPA 310.1; SM 2320B	Alkalinity
Calculation	SM 2340B	Hardness
Gravimetric	EPA 1664A; EPA 9070A	Oil and Grease, Oil and Grease with SGT
Gravimetric	SM 2540B/C/D	Solids
ISE	EPA 120.1; SM 2510B	Conductivity
ISE	SM 2520B	Practical Salinity
ISE	SM 4500F- C	Fluoride
ISE	SM 4500H+ B	pH
ISE	SM 5210B	TBOD / CBOD
Physical	EPA 1010A	Ignitability
Physical	EPA 9040C	pH
Titration	EPA 9034; SM 4500-S^{2-} F	Sulfide
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	EPA 9060A; SM 5310B	Total organic carbon
Turbidimetric	EPA 180.1; SM 2130B	Turbidity
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 335.4; EPA 9012B; SM 4500-CN G	Amenable cyanide
UV/VIS	EPA 350.1; SM 4500-NH3 H	Ammonia as N
UV/VIS	SM 3500Fe D	Ferrous Iron
UV/VIS	EPA 351.2	Kjeldahl nitrogen - total
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrate + Nitrite
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrate as N
UV/VIS	EPA 353.2; SM 4500-NO3 F	Nitrite as N
UV/VIS	EPA 365.2; SM 4500-P E	Orthophosphate as P
UV/VIS	EPA 365.4	Phosphorus total
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	EPA 410.4	COD

Non-Potable Water		
Technology	**Method**	**Analyte**
UV/VIS	EPA 420.1; EPA 9065	Total Phenolics
UV/VIS	SM 4500-Cl G	Total Residual Chlorine
UV/VIS	SM 5540C	MBAS
UV/VIS	EPA 7196A; SM 3500-Cr D	Chromium VI
UV/VIS	EPA 9012B; EPA 335.4	Total Cyanide
UV/VIS	EPA 9251; SM 4500-Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
LC/MS/MS	EPA Method 1633 Final Version	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroundecanoic acid (PFUnA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorotridecanoic acid (PFTrDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorotetradecanoic acid (PFTeDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoropentansulfonic acid (PFPeS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroheptanesulfonic acid (PFHpS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorononanesulfonic acid (PFNS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorodecanesulfonic acid (PFDS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorododecanesulfonic acid (PFDoS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Method 1633 Final Version	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Method 1633 Final Version	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Method 1633 Final Version	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Method 1633 Final Version	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633 Final Version	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Method 1633 Final Version	3-Perfluoropropyl propanoic acid (3:3FTCA)
LC/MS/MS	EPA Method 1633 Final Version	2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)
LC/MS/MS	EPA Method 1633 Final Version	3-Perfluoroheptyl propanoic acid (7:3FTCA)
Preparation	**Method**	**Type**
Cleanup Methods	EPA 3640A	Gel Permeation Clean-up
Cleanup Methods	EPA 3630C	Silica Gel
Cleanup Methods	EPA 3660B	Sulfur Clean-Up
Cleanup Methods	EPA 3665A	Sulfuric Acid Clean-Up
Organic Preparation	EPA 3510C	Separatory Funnel Extraction
Organic Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030C	Purge and Trap

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2,4`-DDD
GC/ECD	EPA 8081B	2,4`-DDE
GC/ECD	EPA 8081B	2,4`-DDT
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	Cis-Nonachlor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	Trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 5', 6-Nonachlorobiphenyl (PCB 206)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 6-Octachlorobiphenyl (PCB 195)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5-Heptachlorobiphenyl (PCB 170)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4'-Hexachlorobiphenyl (PCB 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (PCB 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (PCB 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (PCB 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (PCB 184)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (PCB 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (PCB 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (PCB 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (PCB 48)
GC/ECD	EPA 8082A	2, 2', 4, 5'-Tetrachlorobiphenyl (PCB 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (PCB 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (PCB 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (PCB 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (PCB 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (PCB 105)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5, 5'-Heptachlorobiphenyl (PCB 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (PCB 118)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2, 3', 4, 4',5'-Pentachlorobiphenyl (PCB 123)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (PCB 187)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (PCB 66)
GC/ECD	EPA 8082A	2, 3, 4, 4', 5-Pentachlorobiphenyl (PCB 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (PCB 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (PCB 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (PCB 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (PCB 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (PCB 77)
GC/ECD	EPA 8082A	3, 4, 4', 5-Tetrachlorobiphenyl (PCB 81)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5'6,6'-Decachlorobiphenyl (PCB 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbons (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/FID	MA DEP EPH EPA 3546	Extractable Petroleum Hydrocarbons Microwave Extraction Preparation
GC/FID	FL-PRO	Petroleum Range Organics
GC/MS	EPA 8260C/D	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260C/D	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260C/D	1, 1, 1-Trichloroethane
GC/MS	EPA 8260C/D	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260C/D	1, 1, 2-Trichloroethane
GC/MS	EPA 8260C/D	1, 1-Dichloroethane
GC/MS	EPA 8260C/D	1, 1-Dichloroethylene
GC/MS	EPA 8260C/D	1, 1-Dichloropropene
GC/MS	EPA 8260C/D	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 2, 3-Trichloropropane
GC/MS	EPA 8260C/D	1,2,3-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260C/D	1, 2-Dibromoethane
GC/MS	EPA 8260C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 2-Dichloroethane
GC/MS	EPA 8260C/D	1, 2-Dichloropropane
GC/MS	EPA 8260C/D	1,3,5-Trichlorobenzene
GC/MS	EPA 8260C/D	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 3-Dichloropropane
GC/MS	EPA 8260C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8260C/D	1, 4-Dioxane
GC/MS	EPA 8260C/D	2, 2-Dichloropropane
GC/MS	EPA 8260C/D	2-Butanone

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	2-Chloroethyl vinyl ether
GC/MS	EPA 8260C/D	2-Chlorotoluene
GC/MS	EPA 8260C/D	2-Hexanone
GC/MS	EPA 8260C/D	4-Chlorotoluene
GC/MS	EPA 8260C/D	4-Methyl-2-pentanone
GC/MS	EPA 8260C/D	Acetone
GC/MS	EPA 8260C/D	Acetonitrile
GC/MS	EPA 8260C/D	Acrolein
GC/MS	EPA 8260C/D	Acrylonitrile
GC/MS	EPA 8260C/D	Allyl chloride
GC/MS	EPA 8260C/D	Benzene
GC/MS	EPA 8260C/D	Bromobenzene
GC/MS	EPA 8260C/D	Bromochloromethane
GC/MS	EPA 8260C/D	Bromodichloromethane
GC/MS	EPA 8260C/D	Bromoform
GC/MS	EPA 8260C/D	Carbon disulfide
GC/MS	EPA 8260C/D	Carbon tetrachloride
GC/MS	EPA 8260C/D	Chlorobenzene
GC/MS	EPA 8260C/D	Chloroethane
GC/MS	EPA 8260C/D	Chloroform
GC/MS	EPA 8260C/D	Chloroprene
GC/MS	EPA 8260C/D	cis-1, 2-Dichloroethene
GC/MS	EPA 8260C/D	cis-1, 3-Dichloropropene
GC/MS	EPA 8260C/D	cis-1,3-Dichloro-2-butene
GC/MS	EPA 8260C/D	Cyclohexane
GC/MS	EPA 8260C/D	Dibromochloromethane
GC/MS	EPA 8260C/D	Dibromomethane
GC/MS	EPA 8260C/D	Dichlorodifluoromethane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	Diethyl ether
GC/MS	EPA 8260C/D	Di-isopropylether
GC/MS	EPA 8260C/D	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260C/D	Ethyl methacrylate
GC/MS	EPA 8260C/D	Ethylbenzene
GC/MS	EPA 8260C/D	Ethyl-t-butylether
GC/MS	EPA 8260C/D	Hexachlorobutadiene
GC/MS	EPA 8260C/D	Iodomethane
GC/MS	EPA 8260C/D	Isobutyl alcohol
GC/MS	EPA 8260C/D	Isopropyl benzene
GC/MS	EPA 8260C/D	m p-xylenes
GC/MS	EPA 8260C/D	Methyl acetate
GC/MS	EPA 8260C/D	Methacrylonitrile
GC/MS	EPA 8260C/D	Methyl bromide (Bromomethane)
GC/MS	EPA 8260C/D	Methyl chloride (Chloromethane)
GC/MS	EPA 8260C/D	Methyl methacrylate
GC/MS	EPA 8260C/D	Methyl tert-butyl ether
GC/MS	EPA 8260C/D	Methylcyclohexane
GC/MS	EPA 8260C/D	Methylene chloride
GC/MS	EPA 8260C/D	Naphthalene
GC/MS	EPA 8260C/D	n-Butylbenzene
GC/MS	EPA 8260C/D	n-proplybenzene
GC/MS	EPA 8260C/D	o-Xylene
GC/MS	EPA 8260C/D	pentachloroethane
GC/MS	EPA 8260C/D	p-Isopropyltoluene
GC/MS	EPA 8260C/D	Propionitrile
GC/MS	EPA 8260C/D	sec-butylbenzene
GC/MS	EPA 8260C/D	Styrene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260C/D	t-Amylmethylether
GC/MS	EPA 8260C/D	tert-Butyl alcohol
GC/MS	EPA 8260C/D	tert-Butylbenzene
GC/MS	EPA 8260C/D	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260C/D	Tetrahydrofuran
GC/MS	EPA 8260C/D	Toluene
GC/MS	EPA 8260C/D	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260C/D	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260C/D	Trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 8260C/D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260C/D	Trichlorofluoromethane
GC/MS	EPA 8260C/D	Vinyl acetate
GC/MS	EPA 8260C/D	Vinyl chloride
GC/MS	EPA 8260C/D	Xylene
GC/MS	EPA 8270D/E	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 8270D/E	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8270D/E	1, 2-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 2-Diphenylhydrazine
GC/MS	EPA 8270D/E	1, 3, 5-Trinitrobenzene
GC/MS	EPA 8270D/E	1, 3-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 3-Dinitrobenzene
GC/MS	EPA 8270D/E	1, 4-Dichlorobenzene
GC/MS	EPA 8270D/E	1, 4-Dioxane
GC/MS	EPA 8270D/E	1, 4-Naphthoquinone
GC/MS	EPA 8270D/E	1, 4-Phenylenediamine
GC/MS	EPA 8270D/E	1,1-Biphenyl
GC/MS	EPA 8270D/E	1-Chloronaphthalene
GC/MS	EPA 8270D/E	1-Methylnaphthalene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	1-Naphthylamine
GC/MS	EPA 8270D/E	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270D/E	2, 4, 5-Trichlorophenol
GC/MS	EPA 8270D/E	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270D/E	2, 4-Dichlorophenol
GC/MS	EPA 8270D/E	2, 4-Dimethylphenol
GC/MS	EPA 8270D/E	2, 4-Dinitrophenol
GC/MS	EPA 8270D/E	2, 4-Dinitrotoluene (2 4-DNT)
GC/MS	EPA 8270D/E	2, 6-Dichlorophenol
GC/MS	EPA 8270D/E	2, 6-Dinitrotoluene (2 6-DNT)
GC/MS	EPA 8270D/E	2-Acetylaminofluorene
GC/MS	EPA 8270D/E	2-Chloronaphthalene
GC/MS	EPA 8270D/E	2-Chlorophenol
GC/MS	EPA 8270D/E	2-Methyl-4, 6-dinitrophenol
GC/MS	EPA 8270D/E	2-Methylnaphthalene
GC/MS	EPA 8270D/E	2-Methylphenol
GC/MS	EPA 8270D/E	2-Naphthylamine
GC/MS	EPA 8270D/E	2-Nitroaniline
GC/MS	EPA 8270D/E	2-Nitrophenol
GC/MS	EPA 8270D/E	2-Picoline
GC/MS	EPA 8270D/E	3, 3`-Dichlorobenzidine
GC/MS	EPA 8270D/E	3, 3'-Dimethylbenzidine
GC/MS	EPA 8270D/E	3&4-Methylphenol
GC/MS	EPA 8270D/E	3-Methylcholanthrene
GC/MS	EPA 8270D/E	3-Nitroaniline
GC/MS	EPA 8270D/E	4-Aminobiphenyl
GC/MS	EPA 8270D/E	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D/E	4-Chloro-3-methylphenol

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	4-Chloroaniline
GC/MS	EPA 8270D/E	4-Chlorophenyl phenylether
GC/MS	EPA 8270D/E	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270D/E	4-Nitroaniline
GC/MS	EPA 8270D/E	4-Nitrophenol
GC/MS	EPA 8270D/E	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270D/E	5-Nitro-o-toluidine
GC/MS	EPA 8270D/E	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270D/E	a a-Dimethylphenethylamine
GC/MS	EPA 8270D/E	Acenaphthene
GC/MS	EPA 8270D/E	Acenaphthylene
GC/MS	EPA 8270D/E	Acetophenone
GC/MS	EPA 8270D/E	Aniline
GC/MS	EPA 8270D/E	Anthracene
GC/MS	EPA 8270D/E	Aramite
GC/MS	EPA 8270D/E	Atrazine
GC/MS	EPA 8270D/E	Azobenzene
GC/MS	EPA 8270D/E	Benzaldehyde
GC/MS	EPA 8270D/E	Benzidine
GC/MS	EPA 8270D/E	Benzo(a)anthracene
GC/MS	EPA 8270D/E	Benzo(a)pyrene
GC/MS	EPA 8270D/E	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E	Benzo(g h i)perylene
GC/MS	EPA 8270D/E	Benzo(k)fluoranthene
GC/MS	EPA 8270D/E	Benzoic Acid
GC/MS	EPA 8270D/E	Benzyl alcohol
GC/MS	EPA 8270D/E	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270D/E	bis(2-Chloroethyl) ether

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270D/E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270D/E	Bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270D/E	Butyl benzyl phthalate
GC/MS	EPA 8270D/E	Caprolactam
GC/MS	EPA 8270D/E	Carbazole
GC/MS	EPA 8270D/E	Chlorobenzilate
GC/MS	EPA 8270D/E	Chrysene
GC/MS	EPA 8270D/E	Diallate
GC/MS	EPA 8270D/E	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D/E	Dibenzo(a,j)acridine
GC/MS	EPA 8270D/E	Dibenzofuran
GC/MS	EPA 8270D/E	Diethyl phthalate
GC/MS	EPA 8270D/E	Dimethoate
GC/MS	EPA 8270D/E	Dimethyl phthalate
GC/MS	EPA 8270D/E	Di-n-butyl phthalate
GC/MS	EPA 8270D/E	Di-n-octyl phthalate
GC/MS	EPA 8270D/E	Dinoseb
GC/MS	EPA 8270D/E	Disulfoton
GC/MS	EPA 8270D/E	Ethyl methacrylate
GC/MS	EPA 8270D/E	Ethyl methanesulfonate
GC/MS	EPA 8270D/E	Ethyl parathion
GC/MS	EPA 8270D/E	Fluoranthene
GC/MS	EPA 8270D/E	Fluorene
GC/MS	EPA 8270D/E	Hexachlorobenzene
GC/MS	EPA 8270D/E	Hexachlorobutadiene
GC/MS	EPA 8270D/E	Hexachlorocyclopentadiene
GC/MS	EPA 8270D/E	Hexachloroethane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	Hexachloropropene
GC/MS	EPA 8270D/E	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270D/E	Isodrin
GC/MS	EPA 8270D/E	Isophorone
GC/MS	EPA 8270D/E	Isosafrole
GC/MS	EPA 8270D/E	Methapyriline
GC/MS	EPA 8270D/E	Methyl methanesulfonate
GC/MS	EPA 8270D/E	Methyl parathion
GC/MS	EPA 8270D/E	Naphthalene
GC/MS	EPA 8270D/E	Nitrobenzene
GC/MS	EPA 8270D/E	n-Nitrosodiethylamine
GC/MS	EPA 8270D/E	n-Nitrosodimethylamine
GC/MS	EPA 8270D/E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270D/E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D/E	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E	n-Nitrosomethylethylamine
GC/MS	EPA 8270D/E	n-Nitrosomorpholine
GC/MS	EPA 8270D/E	n-Nitrosopiperidine
GC/MS	EPA 8270D/E	n-Nitrosopyrrolidine
GC/MS	EPA 8270D/E	O, O, O-Triethyl phosphorothioate
GC/MS	EPA 8270D/E	O,O-Diethyl O-2-pyrazinyl phosphorothioate
GC/MS	EPA 8270D/E	o-Toluidine
GC/MS	EPA 8270D/E	Pentachlorobenzene
GC/MS	EPA 8270D/E	Pentachloronitrobenzene
GC/MS	EPA 8270D/E	Pentachlorophenol
GC/MS	EPA 8270D/E	Phenacetin
GC/MS	EPA 8270D/E	Phenanthrene
GC/MS	EPA 8270D/E	Phenol

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E	Phorate
GC/MS	EPA 8270D/E	Pronamide
GC/MS	EPA 8270D/E	Pyrene
GC/MS	EPA 8270D/E	Pyridine
GC/MS	EPA 8270D/E	Safrole
GC/MS	EPA 8270D/E	Sulfotepp
GC/MS	EPA 8270D/E	Thionazin
GC/MS	EPA 8270D/E SIM	1,1'-Biphenyl
GC/MS	EPA 8270D/E SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D/E SIM	1,4-Dioxane
GC/MS	EPA 8270D/E SIM	1-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270D/E SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D/E SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dimethylphenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrophenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270D/E SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270D/E SIM	2-Chloronaphthalene
GC/MS	EPA 8270D/E SIM	2-Chlorophenol
GC/MS	EPA 8270D/E SIM	2-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2-Methylphenol
GC/MS	EPA 8270D/E SIM	2-Nitroaniline
GC/MS	EPA 8270D/E SIM	2-Nitrophenol
GC/MS	EPA 8270D/E SIM	3&4-Methylphenol
GC/MS	EPA 8270D/E SIM	3,3'-Dichlorobenzidine

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	3,4-Dimethylphenol
GC/MS	EPA 8270D/E SIM	3-Nitroaniline
GC/MS	EPA 8270D/E SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D/E SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270D/E SIM	4-Chloroaniline
GC/MS	EPA 8270D/E SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Nitroaniline
GC/MS	EPA 8270D/E SIM	4-Nitrophenol
GC/MS	EPA 8270D/E SIM	Acenaphthene
GC/MS	EPA 8270D/E SIM	Acenaphthylene
GC/MS	EPA 8270D/E SIM	Acetophenone
GC/MS	EPA 8270D/E SIM	Anthracene
GC/MS	EPA 8270D/E SIM	Atrazine
GC/MS	EPA 8270D/E SIM	Benzaldehyde
GC/MS	EPA 8270D/E SIM	Benzo(a)anthracene
GC/MS	EPA 8270D/E SIM	Benzo(a)pyrene
GC/MS	EPA 8270D/E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270D/E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270D/E SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270D/E SIM	Butylbenzylphthalate
GC/MS	EPA 8270D/E SIM	Caprolactam
GC/MS	EPA 8270D/E SIM	Carbazole
GC/MS	EPA 8270D/E SIM	Chrysene
GC/MS	EPA 8270D/E SIM	Dibenzo(a,h)anthracene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	Dibenzofuran
GC/MS	EPA 8270D/E SIM	Diethylphthalate
GC/MS	EPA 8270D/E SIM	Dimethyl phthalate
GC/MS	EPA 8270D/E SIM	Di-n-butylphthalate
GC/MS	EPA 8270D/E SIM	Di-n-octylphthalate
GC/MS	EPA 8270D/E SIM	Fluoranthene
GC/MS	EPA 8270D/E SIM	Fluorene
GC/MS	EPA 8270D/E SIM	Hexachlorobenzene
GC/MS	EPA 8270D/E SIM	Hexachlorobutadiene
GC/MS	EPA 8270D/E SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270D/E SIM	Hexachloroethane
GC/MS	EPA 8270D/E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D/E SIM	Isophorone
GC/MS	EPA 8270D/E SIM	Naphthalene
GC/MS	EPA 8270D/E SIM	Nitrobenzene
GC/MS	EPA 8270D/E SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270D/E SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E SIM	Pentachlorophenol
GC/MS	EPA 8270D/E SIM	Phenanthrene
GC/MS	EPA 8270D/E SIM	Phenol
GC/MS	EPA 8270D/E SIM	Pyrene
HPLC/UV	EPA 8330A	1 ,3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4, 6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene
HPLC/UV	EPA 8330A	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A	Tetryl
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4, 6 –Dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6,Dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene
HPLC/UV	EPA 8330B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330B	Tetryl
HPLC/UV	EPA 8330B	Nitroguanidine
CVAA	EPA 7471B	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 6010C/D	Aluminum
ICP/AES	EPA 6010C/D	Antimony
ICP/AES	EPA 6010C/D	Arsenic
ICP/AES	EPA 6010C/D	Barium
ICP/AES	EPA 6010C/D	Beryllium
ICP/AES	EPA 6010C/D	Boron
ICP/AES	EPA 6010C/D	Cadmium
ICP/AES	EPA 6010C/D	Calcium
ICP/AES	EPA 6010C/D	Chromium
ICP/AES	EPA 6010C/D	Cobalt
ICP/AES	EPA 6010C/D	Copper
ICP/AES	EPA 6010C/D	Iron
ICP/AES	EPA 6010C/D	Lead
ICP/AES	EPA 6010C/D	Magnesium
ICP/AES	EPA 6010C/D	Manganese
ICP/AES	EPA 6010C/D	Molybdenum
ICP/AES	EPA 6010C/D	Nickel
ICP/AES	EPA 6010C/D	Potassium
ICP/AES	EPA 6010C/D	Selenium
ICP/AES	EPA 6010C/D	Silicon
ICP/AES	EPA 6010C/D	Silver
ICP/AES	EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Strontium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010C/D	Thallium
ICP/AES	EPA 6010C/D	Tin
ICP/AES	EPA 6010C/D	Titanium
ICP/AES	EPA 6010C/D	Vanadium
ICP/AES	EPA 6010C/D	Zinc
ICP/MS	EPA 6020A/B	Aluminum
ICP/MS	EPA 6020A/B	Antimony
ICP/MS	EPA 6020A/B	Arsenic
ICP/MS	EPA 6020A/B	Barium
ICP/MS	EPA 6020A/B	Beryllium
ICP/MS	EPA 6020A/B	Boron
ICP/MS	EPA 6020A/B	Cadmium
ICP/MS	EPA 6020A/B	Calcium
ICP/MS	EPA 6020A/B	Chromium
ICP/MS	EPA 6020A/B	Cobalt
ICP/MS	EPA 6020A/B	Copper
ICP/MS	EPA 6020A/B	Iron
ICP/MS	EPA 6020A/B	Lead
ICP/MS	EPA 6020A/B	Magnesium
ICP/MS	EPA 6020A/B	Manganese
ICP/MS	EPA 6020A/B	Molybdenum
ICP/MS	EPA 6020A/B	Nickel
ICP/MS	EPA 6020A/B	Potassium
ICP/MS	EPA 6020A/B	Selenium
ICP/MS	EPA 6020A/B	Silver
ICP/MS	EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Strontium
ICP/MS	EPA 6020A/B	Thallium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020A/B	Tin
ICP/MS	EPA 6020A/B	Tungsten
ICP/MS	EPA 6020A/B	Vanadium
ICP/MS	EPA 6020A/B	Zinc
Gravimetric	EPA 9071A/B	Oil and Grease, Oil and Grease with SGT
Physical	EPA 1010A	Ignitability
Physical	EPA 9045D	pH
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	Lloyd Kahn	Total organic carbon
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 350.1; SM 4500-NH3 H	Ammonia as N
UV/VIS	EPA 9251; SM 4500-Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
UV/VIS	EPA 821/R-91-100	AVS-SEM
Cleanup Methods	EPA 3630C	Silica Gel
UV/VIS	EPA 7196A	Chromium VI
UV/VIS	EPA 9012B	Total cyanide
Sieves, Hydrometer	ASTM D422	Grain Size
LC/MS/MS	EPA Method 1633 Final Version	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroheptanoic acid (PFHpA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorononanoic acid (PFNA)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633 Final Version	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroundecanoic acid (PFUnA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorotridecanoic acid (PFTrDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorotetradecanoic acid (PFTeDA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoropentansulfonic acid (PFPeS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorononanesulfonic acid (PFNS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorodecanesulfonic acid (PFDS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorododecanesulfonic acid (PFDoS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorohexane sulfonic acid (4:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorooctane sulfonic acid (6:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	1H,1H,2H,2H-Perfluorodecane sulfonic acid (8:2FTS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)
LC/MS/MS	EPA Method 1633 Final Version	N-methyl perfluorooctanesulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Method 1633 Final Version	N-ethyl perfluorooctanesulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Method 1633 Final Version	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Method 1633 Final Version	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Method 1633 Final Version	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Method 1633 Final Version	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Method 1633 Final Version	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Method 1633 Final Version	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Method 1633 Final Version	3-Perfluoropropyl propanoic acid (3:3FTCA)
LC/MS/MS	EPA Method 1633 Final Version	2H,2H,3H,3H-Perfluorooctanoic acid (5:3FTCA)
LC/MS/MS	EPA Method 1633 Final Version	3-Perfluoroheptyl propanoic acid (7:3FTCA)
Preparation	**Method**	**Type**
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	EPA 3660B	Sulfur Clean-up
Cleanup Methods	EPA 3630C	Silica Gel Clean-up
Cleanup Methods	EPA 3640A	GPC Clean-up
Organic Preparation	EPA 3540C	Soxhlet Extraction
Organic Preparation	EPA 3550C	Sonication

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
Inorganics Preparation	EPA 3050B	Hotblock
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Volatile Organics Preparation	EPA 5035/5035A	Closed System Purge and Trap
Organic Preparation	EPA 8330A/B	ISM

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane/cis-Chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane/trans-Chlordane

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5'-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5'-Pentachlorobiphenyl (PCB 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)

Biological Tissue		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/MS	EPA 8270D/E SIM	1,1'-Biphenyl
GC/MS	EPA 8270D/E SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D/E SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D/E SIM	1,2-Dichlorobenzene
GC/MS	EPA 8270D/E SIM	1,3-Dichlorobenzene
GC/MS	EPA 8270D/E SIM	1,4-Dichlorobenzene
GC/MS	EPA 8270D/E SIM	1-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270D/E SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D/E SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dichlorophenol
GC/MS	EPA 8270D/E SIM	2,4-Dimethylphenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrophenol
GC/MS	EPA 8270D/E SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270D/E SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270D/E SIM	2-Chloronaphthalene
GC/MS	EPA 8270D/E SIM	2-Chlorophenol
GC/MS	EPA 8270D/E SIM	2-Methylnaphthalene
GC/MS	EPA 8270D/E SIM	2-Methylphenol
GC/MS	EPA 8270D/E SIM	2-Nitroaniline
GC/MS	EPA 8270D/E SIM	2-Nitrophenol
GC/MS	EPA 8270D/E SIM	3&4-Methylphenol
GC/MS	EPA 8270D/E SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270D/E SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Chloro-3-methylphenol

Biological Tissue		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	4-Chloroaniline
GC/MS	EPA 8270D/E SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270D/E SIM	4-Nitrophenol
GC/MS	EPA 8270D/E SIM	Acenaphthene
GC/MS	EPA 8270D/E SIM	Acenaphthylene
GC/MS	EPA 8270D/E SIM	Acetophenone
GC/MS	EPA 8270D/E SIM	Anthracene
GC/MS	EPA 8270D/E SIM	Atrazine
GC/MS	EPA 8270D/E SIM	Benzo(a)anthracene
GC/MS	EPA 8270D/E SIM	Benzo(a)pyrene
GC/MS	EPA 8270D/E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270D/E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270D/E SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270D/E SIM	Butylbenzylphthalate
GC/MS	EPA 8270D/E SIM	Caprolactam
GC/MS	EPA 8270D/E SIM	Carbazole
GC/MS	EPA 8270D/E SIM	Chrysene
GC/MS	EPA 8270D/E SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270D/E SIM	Dibenzofuran
GC/MS	EPA 8270D/E SIM	Diethylphthalate
GC/MS	EPA 8270D/E SIM	Dimethyl phthalate
GC/MS	EPA 8270D/E SIM	Di-n-butylphthalate
GC/MS	EPA 8270D/E SIM	Di-n-octylphthalate
GC/MS	EPA 8270D/E SIM	Fluoranthene
GC/MS	EPA 8270D/E SIM	Fluorene
GC/MS	EPA 8270D/E SIM	Hexachlorobenzene

Biological Tissue		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D/E SIM	Hexachlorobutadiene
GC/MS	EPA 8270D/E SIM	Hexachloroethane
GC/MS	EPA 8270D/E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D/E SIM	Isophorone
GC/MS	EPA 8270D/E SIM	Naphthalene
GC/MS	EPA 8270D/E SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270D/E SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E SIM	Pentachlorophenol
GC/MS	EPA 8270D/E SIM	Phenanthrene
GC/MS	EPA 8270D/E SIM	Phenol
GC/MS	EPA 8270D/E SIM	Pyrene
ICP/AES	EPA 6010C/D	Aluminum
ICP/AES	EPA 6010C/D	Antimony
ICP/AES	EPA 6010C/D	Arsenic
ICP/AES	EPA 6010C/D	Barium
ICP/AES	EPA 6010C/D	Beryllium
ICP/AES	EPA 6010C/D	Boron
ICP/AES	EPA 6010C/D	Cadmium
ICP/AES	EPA 6010C/D	Calcium
ICP/AES	EPA 6010C/D	Chromium
ICP/AES	EPA 6010C/D	Cobalt
ICP/AES	EPA 6010C/D	Copper
ICP/AES	EPA 6010C/D	Iron
ICP/AES	EPA 6010C/D	Lead
ICP/AES	EPA 6010C/D	Magnesium
ICP/AES	EPA 6010C/D	Manganese
ICP/AES	EPA 6010C/D	Molybdenum
ICP/AES	EPA 6010C/D	Nickel

Biological Tissue		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010C/D	Potassium
ICP/AES	EPA 6010C/D	Selenium
ICP/AES	EPA 6010C/D	Silver
ICP/AES	EPA 6010C/D	Sodium
ICP/AES	EPA 6010C/D	Thallium
ICP/AES	EPA 6010C/D	Tin
ICP/AES	EPA 6010C/D	Vanadium
ICP/AES	EPA 6010C/D	Zinc
ICP/MS	EPA 6020A/B	Aluminum
ICP/MS	EPA 6020A/B	Antimony
ICP/MS	EPA 6020A/B	Arsenic
ICP/MS	EPA 6020A/B	Barium
ICP/MS	EPA 6020A/B	Beryllium
ICP/MS	EPA 6020A/B	Boron
ICP/MS	EPA 6020A/B	Cadmium
ICP/MS	EPA 6020A/B	Calcium
ICP/MS	EPA 6020A/B	Chromium
ICP/MS	EPA 6020A/B	Cobalt
ICP/MS	EPA 6020A/B	Copper
ICP/MS	EPA 6020A/B	Iron
ICP/MS	EPA 6020A/B	Lead
ICP/MS	EPA 6020A/B	Magnesium
ICP/MS	EPA 6020A/B	Manganese
ICP/MS	EPA 6020A/B	Molybdenum
ICP/MS	EPA 6020A/B	Nickel
ICP/MS	EPA 6020A/B	Potassium
ICP/MS	EPA 6020A/B	Selenium
ICP/MS	EPA 6020A/B	Silver

Biological Tissue		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Thallium
ICP/MS	EPA 6020A/B	Tin
ICP/MS	EPA 6020A/B	Vanadium
ICP/MS	EPA 6020A/B	Zinc
CVAA	EPA 7471B	Mercury

Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 533	11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Method 533	9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Method 533	4,8-dioxa-3H-perfluorononanoic acid (DONA)
LC/MS/MS	EPA Method 533	1H, 1H, 2H, 2H-Perfluorodecanesulfonic acid (8:2 FTS)
LC/MS/MS	EPA Method 533	1H, 1H, 2H, 2H-Perfluorohexanesulfonic acid (4:2 FTS)
LC/MS/MS	EPA Method 533	1H, 1H, 2H, 2H-Perfluorooctanesulfonic acid (6:2 FTS)
LC/MS/MS	EPA Method 533	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Method 533	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Method 533	Perfluorobutanesulfonic acid (PFBS)
LC/MS/MS	EPA Method 533	Perfluorobutanoic acid (PFBA)
LC/MS/MS	EPA Method 533	Perfluorodecanoic acid (PFDA)
LC/MS/MS	EPA Method 533	Perfluorododecanoic acid (PFDoA)
LC/MS/MS	EPA Method 533	Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)
LC/MS/MS	EPA Method 533	Perfluoroheptane sulfonic acid (PFHpS)
LC/MS/MS	EPA Method 533	Perfluoroheptanoic acid (PFHpA)

Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA Method 533	Perfluorohexanesulfonic acid (PFHxS)
LC/MS/MS	EPA Method 533	Perfluorohexanoic acid (PFHxA)
LC/MS/MS	EPA Method 533	Perfluoro-3-methoxypropanoic acid (PFMPA
LC/MS/MS	EPA Method 533	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Method 533	Perfluorononanoic acid (PFNA)
LC/MS/MS	EPA Method 533	Perfluorooctanesulfonic acid (PFOS)
LC/MS/MS	EPA Method 533	Perfluorooctanoic acid (PFOA)
LC/MS/MS	EPA Method 533	Perfluoropentanoic acid (PFPeA)
LC/MS/MS	EPA Method 533	Perfluoropentane sulfonic acid (PFPeS)
LC/MS/MS	EPA Method 533	Perfluoroundecanoic acid (PFUnDA)

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2223.

Jason Stine, Vice President

Appendix C

Field Standard Operating Procedures

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Logbooks

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-02

1.0 Purpose and Scope

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

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

2.0 Safety

2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

3.0 Terms and Definitions

3.1 **Logbook**

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

3.2 **Data Form**

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

4.0 Training and Qualifications

4.1 The **Task Order (TO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **TO Manager** shall review the field logbook on at least a monthly basis. The **TO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

4.2 A knowledgeable individual such as the **Field Manager**, **TO Manager**, or **Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.

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

4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **TO Manager**, who is responsible for filing them and submitting a copy (if required by the TO Statement of Work).

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

4.6 All **field personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with numbered pages.

5.2 Entries will be recorded using pens with permanent ink.

6.0 Procedure

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Define all acronyms used. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (24-hour format) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- List of Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), and Scope of Work (SOW) documents being followed.
- Descriptions of, and rationale for, approved deviations from the QAPPs/SAPs/SOWs;
- Field instrumentation calibration information and individual readings;
- Names, job functions, and organizational affiliations of on-site personnel during meetings and/or field activities;
- Photograph references;
- List of equipment used, source of equipment (e.g., rental company name), serial numbers of equipment, and decontamination procedures.
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (24-hour format) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample matrix information, physical description of sample, other pertinent field

observations related to the sample, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain of custody (CoC) information such as sample identification numbers cross-referenced to COC sample numbers;

- Sample naming convention;
- Field quality control (QC) sample information (including duplicate sample parent sample IDs);
- Condition of ice in coolers, if applicable;
- Site observations, field descriptions, and field activities accomplished to reconstruct field operations;
- Important times and dates of telephone conversations, correspondence, or deliverables;
- Field calculations;
- PPE level;
- Calibration records;
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
- Equipment decontamination procedures and effectiveness;
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
- User signatures.

6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialling and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 Blank spaces or pages should not be present in logbooks. Blank areas should be single-lined through and initialled and dated to prevent backfilling.

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

6.8 Enter logbook page numbers for each day on each page to facilitate identification of photocopies.

6.9 If a person's initials are used for identification, or if acronyms are used, identify these on a page at the beginning of the logbook.

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

7.0 Quality Control and Assurance

7.1 Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

8.1 Retain the field logbook as a permanent project record. If a particular TO requires submittal of photocopies of logbooks, perform this as required.

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

9.0 Attachments or References

9.1 Attachment 1 – Description of Logbook Entries

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

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Gordon Hicks, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Attachment 1
Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

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

Recordkeeping, Sample Labelling, and Chain-of-Custody

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-03

1.0 Purpose and Scope

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

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

2.0 Safety

Not applicable.

3.0 Terms and Definitions

3.1 **Logbook**

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

3.2 **Chain-of-Custody**

A CoC is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

4.1 The **Task Order (TO) Manager** is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and CoC forms to ensure compliance with these procedures. The **TO Manager** shall review CoC forms on a monthly basis at a minimum.

4.2 The **TO Manager** and **Program Quality Manager** are responsible for evaluating project compliance with the Project Procedures Manual.

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

4.4 The **Laboratory Project Manager** or **Sample Control Department Manager** is responsible for reporting any sample documentation or CoC problems to the **TO Manager** or **TO Laboratory Coordinator** within 24 hours of sample receipt.

4.5 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures. The **TO Laboratory Coordinator** is responsible for verifying that the CoC/analytical request forms have been completed properly and match the sampling and analysis plan. The **TO Manager** or **TO Laboratory Coordinator** is responsible for notifying the **laboratory**, **data managers**, and **data validators** in writing

if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract (e.g., client remedial action contract).

4.6 All **field personnel** are responsible for following these procedures while conducting sampling activities. **Field personnel** are responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. As few field personnel as possible should handle samples from collection to shipment.

5.0 Procedure

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

5.1 Recordkeeping

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

5.2 Sample Labelling

Affix a sample label with adhesive backing to each individual sample container. Place clear tape over each label (preferably prior to sampling) to prevent the labels from tearing off, falling off, being smeared, and to prevent loss of information on the label. Record the following information legibly with a ballpoint pen with permanent ink or use pre-printed text on each label:

- Unique sample identification (“ID”);
- Project name or number (optional);
- CoC sample number;
- Date and time of collection;
- Sampler's initials;
- Matrix (optional);
- Container type;
- Sample preservatives (if applicable); and
- Analysis to be performed on sample (this shall be identified by the method number or name identified in the subcontract with the laboratory).

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

5.3 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. Maintain custody of samples in accordance with the U.S. Environmental Protection Agency (EPA) CoC guidelines (Section 8.0).

A description of sample custody procedures is provided below.

5.3.1 Sample Collection Custody Procedures

According to the U.S. EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

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

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

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

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

Field personnel shall also log individual samples onto CoC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 5.4, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The **samplers** will also sign the CoC form signifying that they were the personnel who collected the samples. The CoC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the **person delivering the samples for transport** will sign and indicate the date and time on the accompanying CoC form. One copy of the CoC form will be retained by the **sampler** and the remaining copies of the CoC form shall be placed inside a self-sealing bag and taped to the inside lid of the cooler. Each cooler must be associated with a unique CoC form. Whenever a transfer of custody takes place, **both parties** shall sign and date the accompanying carbon copy CoC forms, and the **individual relinquishing the samples** shall retain a copy of each form. One exception is when the samples are shipped; the **delivery service personnel** (e.g., FedEx) will not sign or receive a copy because they do not open the coolers (as demonstrated by intact custody seals upon receipt by the laboratory). The **laboratory** shall attach copies of the completed CoC forms to the reports containing the results of the analytical tests. An example CoC form is provided in Attachment 2.

5.3.2 Laboratory Custody Procedures

The following custody procedures are to be followed by an **independent laboratory** receiving samples for chemical analysis and must also be reflected in the laboratory's Naval Facilities Engineering Service Center-evaluated Laboratory Quality Assurance Plan. A **designated sample custodian** shall take custody of all samples upon their arrival at the analytical laboratory. The **custodian** shall inspect all sample labels and CoC forms to ensure that the information is consistent, that each is properly completed, and that sample labels match their respective line items on the CoC. The **custodian** will also measure the temperature of the temperature blank in the coolers (if present) upon arrival using either a National Institute for Standards and Technology calibrated thermometer or an infra-red temperature gun. The **custodian** shall note the condition of the samples including:

- If the samples show signs of damage or tampering;
- That sample radioactivity is below appropriate threshold values;
- If the containers are broken or leaking;
- If headspace is present in sample vials, when applicable (e.g., for volatile organic compound analysis);
- If sample custody procedures were properly documented;
- If proper preservation of samples has occurred (made by pH measurement, except volatile organic compounds [VOCs] and purgeable total petroleum hydrocarbons [TPH] and temperature). The pH of VOC and purgeable TPH samples will be checked by the **laboratory analyst** after the sample aliquot has been removed from the vial for analysis; and
- If any sample holding times have been exceeded.

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

Discrepancies or improper preservation shall be noted by the **laboratory** as an out-of-control event and shall be documented on an out-of-control form with corrective action taken. The out-of-control form shall be signed and dated by the **sample control custodian** and **any other persons** responsible for corrective action. An example out-of-control form is included as Attachment 4.

The **custodian** shall then assign a unique laboratory number to each sample and distribute the samples to secured and appropriately cooled storage areas (soil samples for VOC analysis are to be stored in a frozen state until analysis). The unique laboratory number for each sample, CoC sample number, client name, date and time received, analysis due date, and storage shall also be manually logged onto a sample receipt record and later entered into the laboratory's computerized data management system. The **custodian** shall sign the shipping bill and maintain a copy.

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

5.4 Completing CoC/Analytical Request Forms

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

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

CoC forms tailored to each TO can be drafted and printed onto multi-ply forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number as well as other information/general comments each time. At minimum, photographic copies should be made of CoC forms prior to sealing them in coolers.

Complete one CoC form per cooler. Whenever possible, place all VOC analyte vials into one cooler in order to reduce the number of trip blanks – a trip blank must be present in all samples with VOC vials. Complete all sections and be sure to sign and date the CoC form. One copy of the CoC form must remain with the field personnel.

Explanation of Fields (i.e., Boxes) on Attachment 2

Box 1 **Project information, including project number, manager, sampler information, turnaround time (TAT) requested, and list of recipients to receive data package.**

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

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

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

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

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

QC Level: Enter the reporting quality control (QC) requirements as specified in the project documents (e.g., SAP, QAPP).

Turnaround time (TAT): TAT will be determined by a sample delivery group (SDG), which may be formed over a 14-day period, not to exceed 20 samples. Once the SDG has been completed, standard TAT is 21 calendar days from receipt of the last sample in the SDG. Entering NORMAL or STANDARD in this field will be acceptable. If quicker TAT is required, it shall be in the subcontract with the laboratory and reiterated on each CoC to remind the laboratory.

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

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

Box 6 **Sample Identification (ID) Number:** This is typically a five-character alphanumeric identifier used by the contractor to identify samples. The use of this identifier is important since the laboratories are restricted to the number of characters they are able to use. Sample numbering shall be in accordance with the project-specific sampling and analysis plan.

Description (Sample ID): This name will be determined by the location and description of the sample, as described in the project-specific sampling and analysis plan. This sample identification should not be submitted to the laboratory, but should be left blank. If a computer CoC version is used, the sample identification can be input, but printed with this block black. A cross-referenced list of the CoC Sample Number and sample identification must be maintained separately.

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

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

time; the laboratory is responsible for calculating holding times to local time. Note: For trip blanks, record the time the blank was placed in company with samples.

Lab ID: This is for laboratory use only.

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

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

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

Box 9 **Sampler's Signature:** The person who collected samples must sign here when relinquishing custody of the samples.

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

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

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

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

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

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

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

Box 13 **Totals:** Sum the number of containers in each column. Because CoC forms contain different formats depending on who produced the form, not all of the information listed in items 1 to 13 may be recorded; however, as much of this information as possible shall be included.

6.0 Quality Control and Assurance

6.1 Recordkeeping, sample labelling, and CoC activities must incorporate quality control measures to ensure accuracy and completeness.

6.2 Deviations from this procedure or the project-specific TO Quality Assurance Project Plan (QAPP) shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

7.0 Records, Data Analysis, Calculations

7.1 The CoC/analytical request form shall be faxed/emailed approximately daily to the **TO Laboratory Coordinator** for verification of accuracy. Following the completion of sampling activities, the sample logbook and CoC forms will be transmitted to the **TO Manager** for storage in project files. The **data validators** shall receive a copy also. The original CoC/analytical request form shall be submitted by the **laboratory** along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

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

8.0 Attachments or References

8.1 Attachment 1 – Chain-of-Custody Seal

8.2 Attachment 2 – Generic Chain-of-Custody/Analytical Request Form

8.3 Attachment 3 – Sample Completed Chain-of-Custody

8.4 Attachment 4 – Sample Out-of-Control Form

8.5 Environmental Protection Agency, United States (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Interim Final. EPA/540/G-89/004. Office of Emergency and Remedial Response. October.

8.6 EPA NEIC Policies and Procedures, National Enforcement Investigations Center, Denver, Colorado, revised May 1986.

8.7 EPA RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD); Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA OSWER Directive 9355 3 01).

8.8 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

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

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

8.11 Procedure 3-02, *Logbooks.*

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Gordon Hicks, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Attachment 1
Chain of Custody Seal

CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE *(Inspector, Analyst or Technician*		

Attachment 2
Generic Chain-of-Custody/Analytical Request Form

	CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD	COC No.		Page	of
	Project Name:	PO No.	Project No.	Phase	
	Site Location:	**Sample Analysis Requested** (*Enter number of containers for each test*)			
Sampler/Site Phone#:					
	Turnaround Time(specify): Standard				

Lab ID	Sample ID	Location ID (sys_loc_code)	Date (mm/dd/yy)	Time (Military) (hhmm)	Matrix Code (1)	Sample Type (2)	Depth fbgs	Total No. of Containers	(3)→										Extra Volume for MS/MSD	HOLD

***Field* Comments:**			***Lab* Comments:**			**Sample Shipment and Delivery Details**
						Number of coolers in shipment:
Relinquished by (signature)	Date	Time	Received by (signature)	Date	Time	Samples Iced?(check) Yes____ No______
1			1			Method of Shipment:
2			2			Airbill No:
3			3			Date Picked Up:

(1) Matrix Code: **AA**=Air, **AQ**=Air QC Matrix, **CK**= Caulk, **GS**=Soil Gas, **LF**=Free Product, **LH**=Liquid Waste, **MS**=Mastic, **Oil**=Oil, **PT**=Paint, **SC**=Cement/Concrete, **SE**=Sediment, **SF**=Filter Sandpack, **SL**=Sludge, **SN**=Miscellaneous Solid/Building Materials, **SO**=Soil, **SQ**=Soil/Solid QC Matrix, **ST**=Solid Waste, **SW**=Swab/Wipe, **TA**=Animal Tissue, **TP**=Plant Tissue, **WG**=Ground Water, **WL**=Leachate, **WO**=Ocean Water, **WP**=Drinking Water, **WQ**=Water QC Matrix, **WS**=Surface Water, **SU**=Sewer Water, **WW**=Waste Water

(2) Sample Type: **AB**=Ambient Blank, **EB**=Equipment Blank, **FB**=Field Blank, **FD**=Field Duplicate Sample, **FR**=Field Replicate, **MB**=Material Blank, **N**=Normal Environmental Sample, **RB**=Material Rinse Blank, **TB**=Trip Blank

(3) Preservative added: **HA**=Hydrochloric Acid, **NI**=Nitric Acid, **SH**=Sodium Hydroxide, **SA**=Sulfuric Acid, **AA**=Ascorbic Acid, **HX**=Hexane, **ME**=Methanol, **SB**=sodium bisulfate, **ST**=Sodium Thiosulfate, If **NO preservativ**e added leave blank

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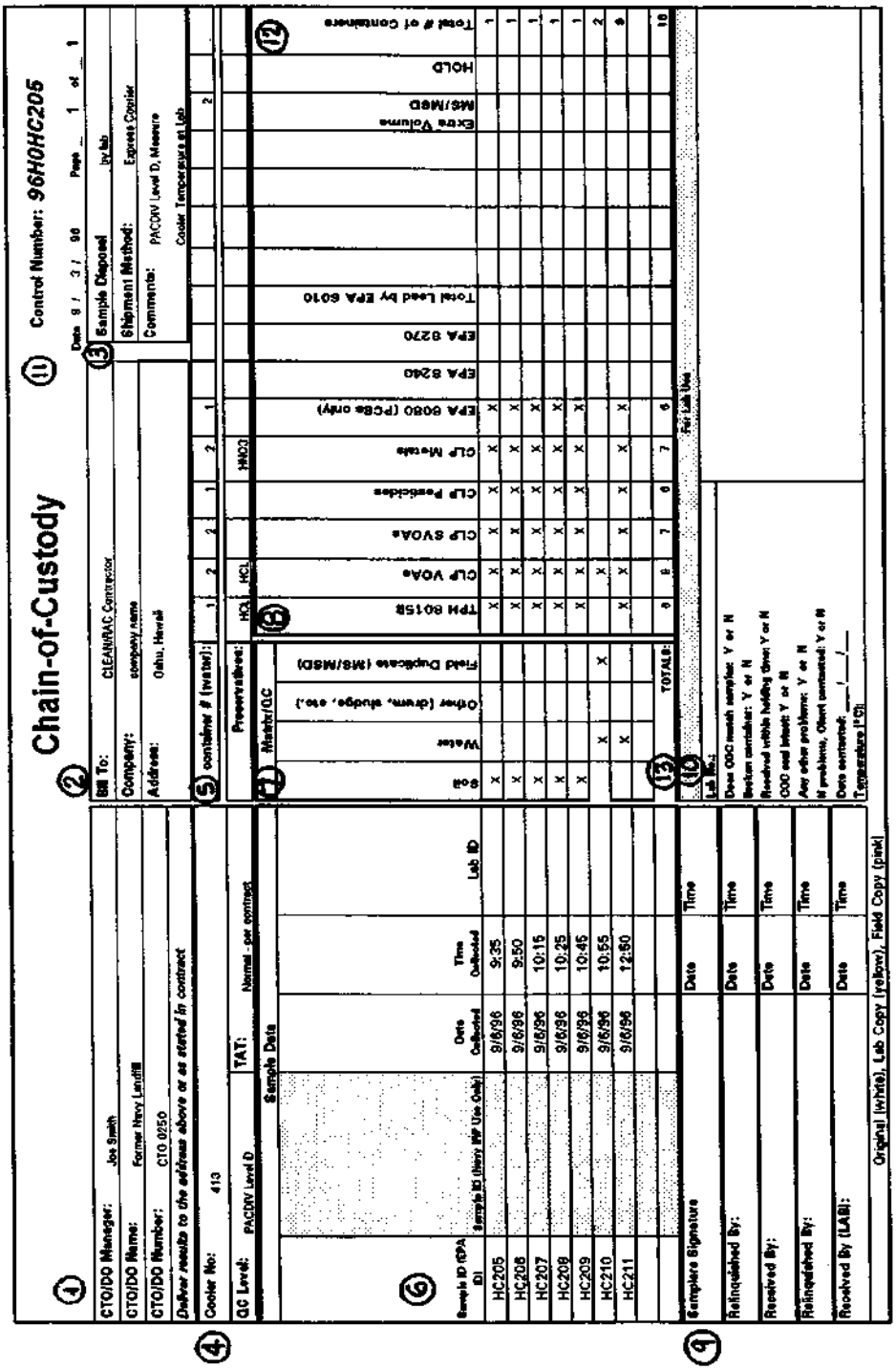
Attachment 3
Sample Completed Chain-of-Custody



Attachment 4
Sample Out-of-Control Form

OUT OF CONTROL FORM	Status	Date	Initial
	Noted OOC		
	Submit for CA*		
	Resubmit for CA*		
	Completed		

Date Recognized:	By:
Dated Occurred:	Matrix
Parameter (Test Code):	Method:
Analyst:	Supervisor:

Samples Affected (List by Accession AND Sample No.)

1. Type of Event (Check all that apply)		2. Corrective Action (CA)* (Check all that apply)	
	Calibration Corr. Coefficient <0.995		Repeat calibration
	%RSD>20%		Made new standards
	Blank >MDL		Reran analysis
	Does not meet criteria:		Sample(s) redigested and rerun
	Spike		Sample(s) reextracted and rerun
	Duplicate		Recalculated
	LCS		Cleaned system
	Calibration Verification		Ran standard additions
	Standard Additions		Notified
	MS/MSD		Other (please explain)
	BS/BSD		
	Surrogate Recovery		
	Calculations Error		
	Holding Times Missed		
	Other (Please explain	Comments:	

3. Results of Corrective Action	
	Return to Control (indicated with)
	Corrective Actions Not Successful - DATA IS TO BE FLAGGED with _____.

Analyst:	Date:
Supervisor:	Date:
QA Department:	Date:

Sample Handling, Storage, and Shipping

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-04

1.0 Purpose and Scope

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

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

2.0 Safety

2.1 Proper safety procedures must be followed when handling, storing, and shipping samples. Refer to the project-specific health and safety plan for guidelines on safety precautions.

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

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

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **Task Order (TO) Manager** and the **Laboratory Project Manager** are responsible for identifying instances of non-compliance with this procedure and ensuring that future sample transport activities comply with this procedure.

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

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

4.4 The **Program Quality Manager** is responsible for ensuring that sample handling, storage, and transport activities conducted during all TOs comply with this procedure.

4.5 All **field personnel** are responsible for the implementation of this procedure.

5.0 Procedure

5.1 **Handling and Storage**

Immediately following collection, label all samples according to Procedure 3-03, *Recordkeeping, Sample Labelling, and Chain of Custody*. The lids of the containers shall not be sealed with duct tape but may be covered with custody seals or placed directly into self-sealing polyethylene (e.g., Ziploc brand) bags. Allow sufficient headspace (ullage), approximately 10%, in all bottles (except volatile organic analysis bottles with a septum/Teflon seal) to allow for temperature and pressure changes during shipment.

Tighten lids to prevent leakage. Place the sample containers in an insulated cooler in good condition and with its drain plugs, if present, taped shut, with water ice in double, sealed self-sealing Ziploc bags. Samples should occupy the lower portion of the cooler, while the ice should occupy the upper portion. Place an absorbent material (e.g., proper absorbent cloth material) on the bottom of the cooler to contain liquids in case of spillage. As containers are added to the cooler, place double, sealed self-sealing Ziploc bags filled with ice between the sample packages. Prior to shipping, wrap glass sample containers on the sides, tops, and bottoms with polyethylene plastic wrap or other appropriate padding and/or surround them in Styrofoam to prevent breakage during transport. Pack all glass containers for water samples in an upright position, never stacked or on their sides. Prior to shipment, replace the ice in the coolers so that samples will be maintained as close to 4 degrees Celsius (°C) as possible from the time of collection through transport to the analytical laboratory. Ship samples within 24 hours or on a schedule allowing the laboratory to meet holding times for analyses. The procedures for maintaining sample temperatures at 4°C pertain to all field samples.

5.2 Shipping

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

5.2.1 Hazardous Materials Shipment

Field personnel must state whether any sample is suspected to be a hazardous material. A sample should be assumed hazardous unless enough evidence exists to indicate it is non-hazardous. If not suspected to be hazardous, shipments may be made as described in the Section 5.2.2 for non-hazardous materials. If hazardous, follow the procedures summarized below.

Any substance or material that is capable of posing an unreasonable risk to life, health, or property when transported is classified as hazardous. Perform hazardous materials identification by checking the list of dangerous goods for the anticipated mode of transportation. If not on that list, materials can be classified by checking the Hazardous Materials Table (49 CFR 172.102 including Appendix A) or by determining if the material meets the definition of any hazard class or division (49 CFR Part 173), as listed in Attachment 2.

All **persons shipping hazardous materials** must be properly trained in the appropriate regulations, as required by HM-126F, Training for Safe Transportation of Hazardous Materials (49 CFR HM-126F Subpart H). The training covers loading, unloading, handling, storing, and transporting of hazardous materials, as well as emergency preparedness in the case of accidents. **Carriers**, such as commercial couriers, must also be trained. Modes of shipment include air, highway, rail, and water.

When shipping hazardous materials, including bulk chemicals or samples suspected of being hazardous, the proper shipping papers (49 CFR 172 Subpart C), package marking (49 CFR 172 Subpart D), labelling (49 CFR 172 Subpart E), placarding (49 CFR 172 Subpart F, generally for carriers), and packaging must be used. Attachment 1 shows an example of proper package markings. Refer to a copy of 49 CFR each time hazardous materials/potentially hazardous samples are shipped.

According to Section 2.7 of the International Air Transport Association Dangerous Goods Regulations publication, very small quantities of certain dangerous goods may be transported without certain marking and documentation requirements as described in 49 CFR Part 172; however, other labelling and packing requirements must still be followed. Attachment 2 shows the volume or weight for different classes of substances. A “Dangerous Goods in Excepted Quantities” label must be completed and attached to the associated shipping cooler (Attachment 3). Certain dangerous goods are not allowed on certain airlines in any quantity.

As stated in item 4 of Attachment 4, the Hazardous Materials Regulations do not apply to hydrochloric acid (HCl), nitric acid (HNO_3), sulfuric acid (H_2SO_4), and sodium hydroxide (NaOH) added to water

samples if their pH or percentage by weight criteria is met. These samples may be shipped as non-hazardous materials as discussed below.

5.2.2 Non-Hazardous Materials Shipment

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, place two copies of the chain of custody (CoC) form inside a self-sealing polyethylene (e.g., Ziploc brand) bag and tape it to the inside of the insulated cooler lid. Then, seal the cooler with waterproof tape and label it with "Fragile," "This-End-Up" (or directional arrows pointing up), or other appropriate notices. Place custody seals on the coolers as discussed in Procedure 3-03, *Recordkeeping, Sample Labelling, and Chain of Custody*.

5.2.3 Shipments from Outside the Continental United States

Shipment of sample coolers to the United States from locations outside the continental United States is controlled by the U.S. Department of Agriculture (USDA) and is subject to their inspection and regulation. A "USDA Soil Import Permit" is required to prove that the receiving analytical laboratory is certified by the USDA to receive and properly dispose of soil. In addition, all sample coolers must be inspected by a **USDA representative**, affixed with a label indicating that the coolers contain environmental samples, and accompanied by shipping forms stamped by the **USDA inspector** prior to shipment.

In addition, the U.S. Customs Service must clear samples shipped from U.S. territorial possessions or foreign countries upon entry into the United States. As long as the commercial invoice is properly completed (see below), shipments typically pass through U.S. Customs Service without the need to open coolers for inspection.

Completion and use of proper paperwork will, in most cases, minimize or eliminate the need for the USDA and U.S. Customs Service to inspect the contents. Attachment 5 shows an example of how paperwork may be placed on the outside of coolers for non-hazardous materials. For hazardous materials, refer to Section 5.2.1.

In summary, tape the paperwork listed below to the outside of the coolers to accompany sample shipments. If a shipment is made up of multiple pieces (e.g., more than one cooler), the paperwork need only be attached to one cooler, provided that the **courier** agrees. All other coolers in the shipment need only to be taped and have the address and custody seals affixed.

1. **Courier Shipping Form & Commercial Invoice:** See Attachment 6 and Attachment 7 for examples of the information to be included on the commercial invoices for soil and water, respectively. Place the courier shipping form and commercial invoice inside a clear, plastic, adhesive-backed pouch that adheres to the package (typically supplied by the courier) and place it on the cooler lid as shown in Attachment 5.
2. **Soil Import Permit (soil only):** See Attachment 8 and Attachment 9 for examples of the soil import permit and soil samples restricted entry labels, respectively. The **laboratory** shall supply these documents prior to mobilization. The USDA often stops shipments of soil without these documents. Staple together the 2-inch × 2-inch USDA label (described below) and soil import permit and place them inside a clear plastic pouch. The **courier** typically supplies the clear, plastic, adhesive-backed pouches that adhere to the package.

   Placing one restricted entry label as shown in Attachment 5 (covered with clear packing tape) and one stapled to the actual permit is suggested.

   The USDA does not control water samples, so the requirements for soil listed above do not apply.

3. **Custody Seals:** The **laboratory** should supply the seals. **TO personnel** must sign and date these. At least two seals should be placed in such a manner that they stick to both the cooler lid and body such that the cooler cannot be opened without breaking the seal. Placing the seals over the tape (as shown in Attachment 5), then covering it with clear packing tape is suggested. This prevents the seal from coming loose and enables detection of tampering.
4. **Address Label:** Affix a label stating the destination (laboratory address) to each cooler.
5. **Special Requirements for Hazardous Materials:** See Section 5.2.1.

Upon receipt of sample coolers at the laboratory, the **sample custodian** shall inspect the sample containers as discussed in Procedure 3-03, *Recordkeeping, Sample Labelling, and Chain of Custody*. The samples shall then be immediately extracted and/or analysed, or stored in a refrigerated storage area, until they are removed for extraction and/or analysis. Whenever the samples are not being extracted or analysed, they shall be returned to refrigerated storage.

6.0 Quality Control and Assurance

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

7.0 Records, Data Analysis, Calculations

7.1 Maintain records as required by implementing these procedures.

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

8.0 Attachments or Reference

8.1 Attachment 1 – Example Hazardous Material Package Marking

8.2 Attachment 2 – Packing Groups

8.3 Attachment 3 – Label for Dangerous Goods in Excepted Quantities

8.4 Attachment 4 – SW-846 Preservative Exception

8.5 Attachment 5 – Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States

8.6 Attachment 6 – Commercial Invoice – Soil

8.7 Attachment 7 – Commercial Invoice – Water

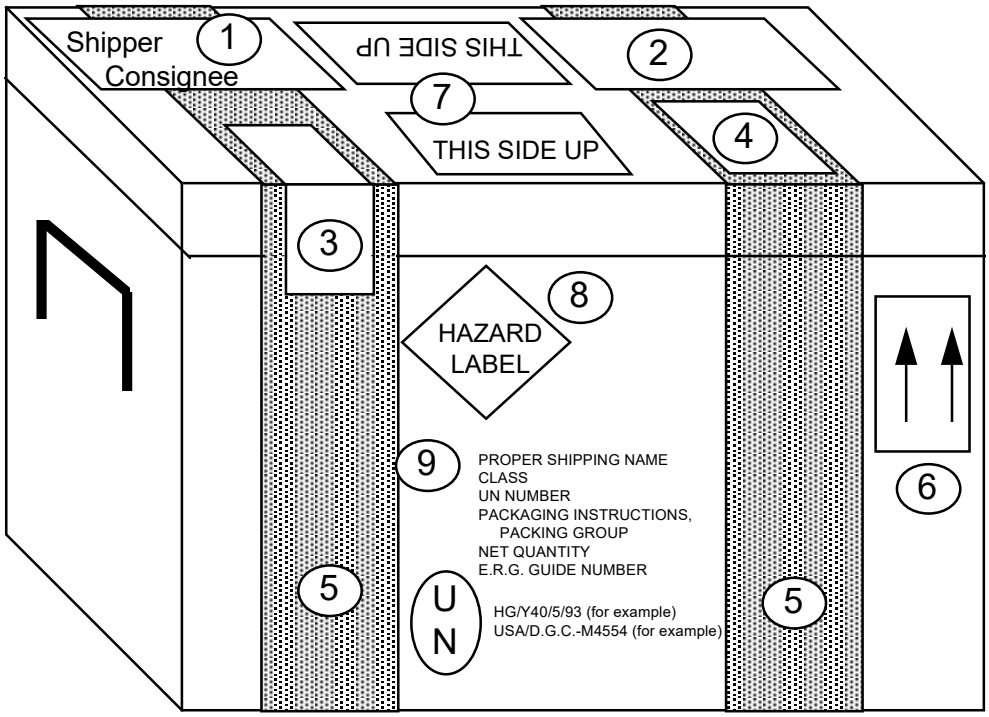
8.8 Attachment 8 – Soil Import Permit

8.9 Attachment 9 – Soil Samples Restricted Entry Labels

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

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Gordon Hicks, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)
Dana Miller Project Chemist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 4 – Update & Review (February 2023)

Attachment 1
Example Hazardous Material Package Marking



1. **AIR BILL/COMMERCIAL INVOICE**
2. **USDA PERMIT (Letter to Laboratory from USDA)**
3. **CUSTODY SEAL**
4. **USDA 2" X 2" SOIL IMPORT PERMIT**
5. **WATERPROOF STRAPPING TAPE**
6. **DIRECTION ARROWS STICKER - TWO REQUIRED**
7. **THIS SIDE UP STICKERS**
8. **HAZARD LABEL**
9. **HAZARDOUS MATERIAL INFORMATION**
10. **PACKAGE SPECIFICATIONS**

Attachment 2
Packing Groups

PACKING GROUP OF THE SUBSTANCE	PACKING GROUP 1		PACKING GROUP II		PACKING GROUP III	
CLASS or DIVISION of PRIMARY or SUBSIDIARY RISK	Packagings		Packagings		Packagings	
	Inner	Outer	Inner	Outer	Inner	Outer
1: Explosives	---------- Forbidden (Note A) ----------					
2.1: Flammable Gas	---------- Forbidden (Note B) ----------					
2.2: Non-Flammable, non-toxic gas	---------- See Notes A and B ----------					
2.3: Toxic gas	---------- Forbidden (Note A) ----------					
3. Flammable liquid	30 mL	300 mL	30 mL	500 mL	30 mL	1 L
4.1 Self-reactive substances	Forbidden		Forbidden		Forbidden	
4.1: Other flammable solids	Forbidden		30 g	500 g	30 g	1 kg
4.2: Pyrophoric substances	Forbidden		Not Applicable		Not Applicable	
4.2 Spontaneously combustible substances	Not Applicable		30 g	500 g	30 g	1 kg
4.3: Water reactive substances	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.1: Oxidizers	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
5.2: Organic peroxides (Note C)	See Note A		30 g or 30 mL	500 g or 250 mL	Not Applicable	
6.1: Poisons - Inhalation toxicity	Forbidden		1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - oral toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.1: Poisons - dermal toxicity	1 g or 1 mL	300 g or 300 mL	1 g or 1 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
6.2: Infectious substances	---------- Forbidden (Note A) ----------					
7: Radioactive material (Note D)	---------- Forbidden (Note A) ----------					
8: Corrosive materials	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L
9: Magnetized materials	---------- Forbidden (Note A) ----------					
9: Other miscellaneous materials (Note E)	Forbidden		30 g or 30 mL	500 g or 500 mL	30 g or 30 mL	1 kg or 1 L

Note A: *Packing groups are not used for this class or division.*
Note B: *For inner packagings, the quantity contained in receptacle with a water capacity of 30 mL. For outer packagings, the sum of the water capacities of all the inner packagings contained must not exceed 1 L.*
Note C: *Applies only to Organic Peroxides when contained in a chemical kit, first aid kit or polyester resin kit.*
Note D: *See 6.1.4.1, 6.1.4.2, and 6.2.1.1 through 6.2.1.7, radioactive material in excepted packages.*
Note E: *For substances in Class 9 for which no packing group is indicated in the List of Dangerous Goods, Packing Group II quantities must be used.*

Attachment 3
Dangerous Goods in Excepted Quantities

DANGEROUS GOODS IN EXCEPTED QUANTITIES

This package contains dangerous goods in excepted small quantities and is in all respects in compliance with the applicable international and national government regulations and the IATA Dangerous Goods Regulations.

_____
Signature of Shipper

_____ _____
Title Date

_____

_____
Name and address of Shipper

This package contains substance(s) in Class(es)
(check applicable box(es))

Class:	2	3	4	5	6	8	9
	☐	☐	☐	☐	☐	☐	☐

and the applicable UN Numbers are:

Attachment 4
SW-846 Preservative Exception

Measurement	Vol. Req. (mL)	Container[2]	Preservative[3,4]	Holding Time[5]
MBAS	250	P, G	Cool, 4ºC	48 Hours
NTA	50	P, G	Cool, 4ºC	24 Hours

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-82 (1976) Method D-3370.

2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

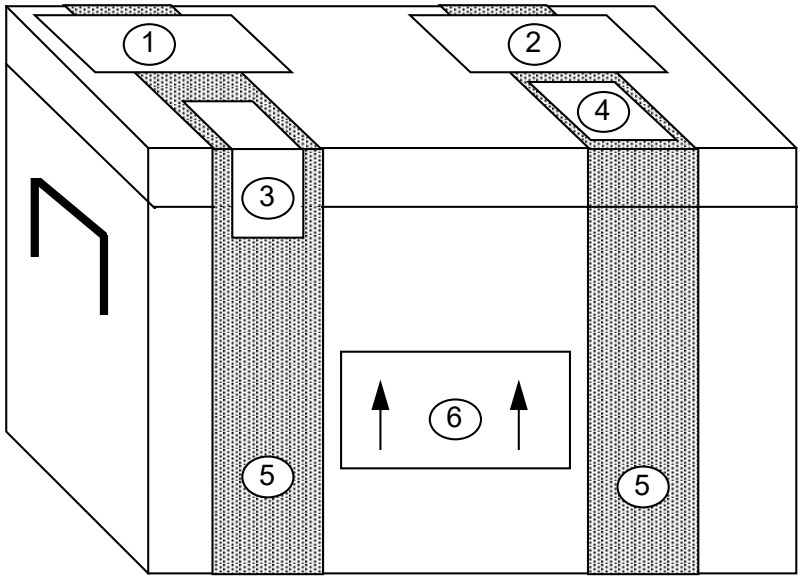
3. Sample preservation should be performed immediately upon sample collection. For composite samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4ºC until compositing and sample splitting is completed.

4. When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. for the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentration of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

5. Samples should be analysed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.

6. Should only be used in the presence of residual chlorine.

Attachment 5
Non-Hazardous Material Cooler Marking Figure for Shipment from Outside the Continental United States



1. **AIR BILL/COMMERCIAL INVOICE**
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4. **USDA 2" X 2" SOIL IMPORT PERMIT**
5. **WATERPROOF STRAPPING TAPE**
6. **DIRECTION ARROWS STICKER - TWO REQUIRED**

Attachment 6
Commercial Invoice – Soil

DATE OF EXPORTATION 1/1/94	EXPORT REFERENCES (i.e., order no., invoice no., etc.) <TO #>
SHIPPER/EXPORTER (complete name and address) Joe Smith Ogden c/o <hotel name> <hotel address>	CONSIGNEE Sample Receipt <Lab Name> <Lab Address>
COUNTRY OF EXPORT Guam, USA	IMPORTER - IF OTHER THAN CONSIGNEE
COUNTRY OF ORIGIN OF GOODS Guam, USA	
COUNTRY OF ULTIMATE DESTINATION USA	
INTERNATIONAL AIR WAYBILL NO.	(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)

MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	3	coolers	Soil samples for laboratory analysis only				$1.00	$3.00
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE
	3							$3.00
								Check one ☐ F.O.B. ☐ C&F ☐ C.I.F.

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden	Joe Smith	1/1/94
Name/Title	Signature	Date

Attachment 7
Commercial Invoice – Water

DATE OF EXPORTATION 1/1/94	EXPORT REFERENCES (i.e., order no., invoice no., etc.) <TO #>
SHIPPER/EXPORTER (complete name and address) Joe Smith Ogden c/o <hotel name> <hotel address>	CONSIGNEE Sample Receipt <Lab Name> <Lab Address>
COUNTRY OF EXPORT Guam, USA	IMPORTER - IF OTHER THAN CONSIGNEE
COUNTRY OF ORIGIN OF GOODS Guam, USA	
COUNTRY OF ULTIMATE DESTINATION USA	
INTERNATIONAL AIR WAYBILL NO.	(NOTE: All shipments must be accompanied by a Federal Express International Air Waybill)

MARKS/NOS	NO. OF PKGS	TYPE OF PACKAGING	FULL DESCRIPTION OF GOODS	QTY	UNIT OF MEASURE	WEIGHT	UNIT VALUE	TOTAL VALUE
	3	coolers	Water samples for laboratory analysis only				$1.00	$3.00
	TOTAL NO. OF PKGS.					TOTAL WEIGHT		TOTAL INVOICE VALUE
	3							$3.00

Check one
☐ F.O.B.
☐ C&F
☐ C.I.F.

THESE COMMODITIES ARE LICENSED FOR THE ULTIMATE DESTINATION SHOWN.

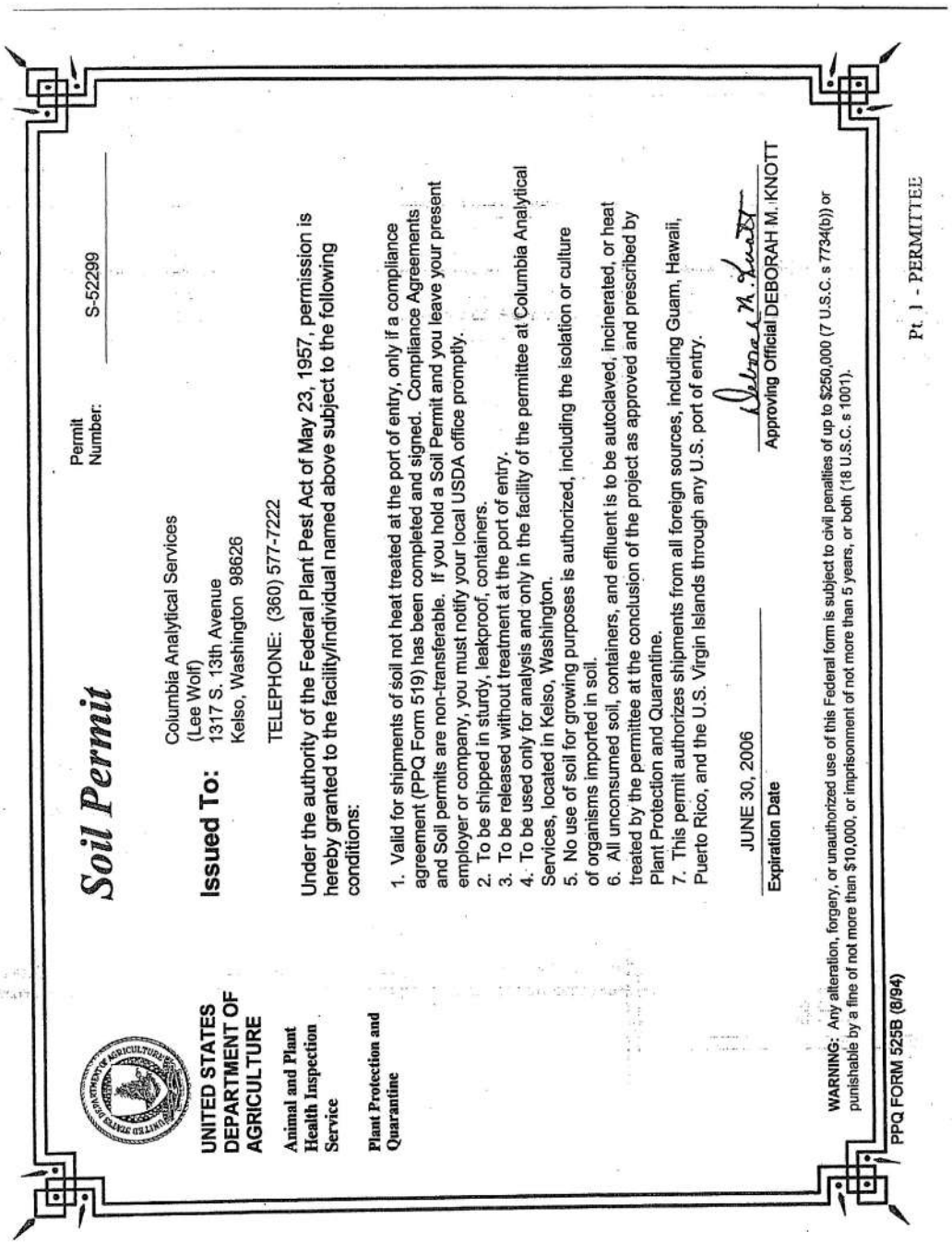
DIVERSION CONTRARY TO UNITED STATES LAW IS PROHIBITED.

I DECLARE ALL THE INFORMATION CONTAINED IN THIS INVOICE TO BE TRUE AND CORRECT

SIGNATURE OF SHIPPER/EXPORTER (Type name and title and sign)

Joe Smith, Ogden | Joe Smith | 1/1/94

Attachment 8
Soil Import Permit



Soil Permit

Permit Number: S-52299

Issued To: Columbia Analytical Services
(Lee Wolf)
1317 S. 13th Avenue
Kelso, Washington 98626

TELEPHONE: (360) 577-7222

UNITED STATES DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

Under the authority of the Federal Plant Pest Act of May 23, 1957, permission is hereby granted to the facility/individual named above subject to the following conditions:

1. Valid for shipments of soil not heat treated at the port of entry, only if a compliance agreement (PPQ Form 519) has been completed and signed. Compliance Agreements and Soil permits are non-transferable. If you hold a Soil Permit and you leave your present employer or company, you must notify your local USDA office promptly.
2. To be shipped in sturdy, leakproof, containers.
3. To be released without treatment at the port of entry.
4. To be used only for analysis and only in the facility of the permittee at Columbia Analytical Services, located in Kelso, Washington.
5. No use of soil for growing purposes is authorized, including the isolation or culture of organisms imported in soil.
6. All unconsumed soil, containers, and effluent is to be autoclaved, incinerated, or heat treated by the permittee at the conclusion of the project as approved and prescribed by Plant Protection and Quarantine.
7. This permit authorizes shipments from all foreign sources, including Guam, Hawaii, Puerto Rico, and the U.S. Virgin Islands through any U.S. port of entry.

JUNE 30, 2006
Expiration Date

Approving Official DEBORAH M. KNOTT

WARNING: Any alteration, forgery, or unauthorized use of this Federal form is subject to civil penalties of up to $250,000 (7 U.S.C. s 7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C. s 1001).

PPQ FORM 525B (8/94)

Pt. 1 - PERMITTEE

Attachment 9
Soil Samples Restricted Entry Labels

U.S. DEPARTMENT OF AGRICULTURE

ANIMAL AND PLANT HEALTH INSPECTION SERVICE

PLANT PROTECTION AND QUARANTINE

HYATTSVILLE, MARYLAND 20782

SOIL SAMPLES

RESTRICTED ENTRY

The material contained in this package is imported under authority of the Federal Plant Pest Act of May 23, 1957.

For release without treatment if addressee is currently listed as approved by Plant Protection and Quarantine.

PPQ FORM 550 *Edition of 12/77 may be used*

(JAN 83)

Investigation Derived Waste Management

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP 3-41, *Per- and Polyfluoroalkyl Substance Field Sampling Protocol* and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-05

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the activities and responsibilities to properly manage investigation-derived waste (IDW). This procedure was developed to serve as guidance for generating, minimizing, segregating, handling, labelling, storing, and inventorying IDW and for methods and processes related to sampling, characterizing, and disposing of IDW.

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

1.3 If there are other Installation-specific, Resolution Consultants, state, and/or federal procedures that are not addressed in this SOP but are applicable to IDW, those procedures should be reviewed and potentially added as an appendix to the Sampling and Analysis Plan (SAP).

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

2.0 Safety

2.1 Field and subcontractor personnel shall adhere to the site safety and health plan (SSHP), Task Hazard Analyses (THAs), and the accident prevention plan (APP) pertaining to IDW management. Physical, chemical, and biological hazards are potentially present during IDW management activities.

3.0 Terms and Definition

3.1 IDW

IDW may include personal protective equipment (PPE), disposable sampling equipment, decontamination fluids, purge water, development water, residues (e.g. spent granular activated carbon), soil/sediment cuttings, and excavated materials generated during implementation of environmental investigations.

3.2 Solid Waste

For the purposes of this SOP, solid wastes are wastes generated during environmental investigations which include IDW (40 CFR 261.2) and general refuse (non-contaminated materials).

3.3 Hazardous Waste

A Resource Conservation and Recovery Act (RCRA) hazardous waste is a solid waste that is a listed waste (F, K, P, and U lists) or is considered hazardous by characteristic. The U.S. Environmental Protection Agency (EPA) has established four characteristic waste categories: ignitability, corrosivity, reactivity, and toxicity. Each characteristic waste category has a specific criterion that, if met, will result in the waste being characterized as hazardous.

As of November 2024, hazardous waste criteria have not been developed for PFAS wastes.

3.4 Non-hazardous Waste

A RCRA non-hazardous waste is a solid waste that is not a listed waste and does not meet characteristic waste criteria.

3.5 Toxicity Characteristic Leaching Procedure (TCLP)

The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphase wastes. The intent of the leaching procedure is to simulate conditions in a landfill. The produced leachate undergoes chemical analysis to determine if a waste is hazardous by toxicity. For more information on TCLP, please refer to: https://www.epa.gov/hw-sw846/sw-846-test-method-1311-toxicity-characteristic-leaching-procedure.

4.0 Roles, Responsibilities, Training, and Qualifications

4.1 Qualifications and Training

The individuals executing this SOP must have read and be familiar with the requirements of this SOP.

4.2 Roles and Responsibilities

The **Task Order (TO) Manager** is responsible for:

- Confirming that field personnel conducting IDW management possess all required training, registrations, and certifications.
- Ensuring that the SSHP, THAs, and APP have been reviewed and approved by the Safety Health and Environment (SH&E) Manager and were provided to the field team prior to commencing work.
- Providing authorization (with the concurrence of the Field Manager and SH&E Manager) for work to resume if interrupted due to unexpected conditions or events.

The **SH&E Manager** is responsible for:

- Assisting the field team by providing guidance and clarification to issues that may arise.
- Reviewing the SSHP to confirm compliance with jurisdictional regulations and providing technical guidance as needed when a variance is pursued related to this procedure.

The **Field Manager** is responsible for:

- Ensuring that IDW management activities are performed in accordance with this procedure.
- Confirming the appropriate PPE, equipment, and materials are available to conduct IDW management.
- Reviewing the SSHP, THA, and this SOP with field personnel prior to commencing work.

Field Personnel are responsible for:

- Reviewing the SSHP, THA, and this SOP with the Field Manager prior to commencing work.
- As appropriate to the anticipated or encountered hazards and as addressed in safety documentation, utilize personal protective equipment (PPE) and applicable training, practices, and operating procedures.
- Immediately notifying the Field Manager of any unanticipated conditions or events. If assigned equipment, perform appropriate inspections and confirmations of maintenance and/or repairs.

The **Project Chemist** is responsible for:

- Working with the Field Manager and TO Manager to determine the sampling requirements for proper IDW classification.

5.0 Equipment and Supplies

5.1 Materials and Supplies

Materials and supplies necessary to implement this SOP include the following:

- Secondary containment and drum cover
  - Polyethylene (Poly) sheeting (minimum 3-millimeter thickness)
  - Tie downs or other means to secure the drum cover (plastic sheeting, tarp, or plywood)
  - Lumber or other materials wrapped in plastic sheeting to create a secondary containment berm
  - Wooden pallets or drum spill pallets
- Drum Kit
  - Paint pens and permanent pens
  - Hazardous/Non-hazardous waste drum labels (weatherproof)
  - Inventory form/Drum log
  - PPE
  - Socket wrench and bung wrench
  - pH test strips
  - Miscellaneous supplies (garbage bags, Ziplock bags, tape, wasp and bug spray)
- Spill kit
  - Absorbent materials
  - Broom and dustpan
  - Shovel or scoop
  - Trash bags
  - PPE
- PID
- Waste sampling supplies
- Field logbook
- First aid kit and fire extinguisher (on-hand)

5.2 IDW Containers

Several types of containers may be used to store IDW generated during environmental investigations and remedial actions.

5.2.1 Drums

IDW should be containerized using Department of Transportation (DOT)-approved containers made of steel or poly, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Typically, brand new, 55-gallon drums are used, however smaller drums may be used depending on the amount of waste generated. Large overpack drums may be used if smaller drums become damaged. Reusable drums and drums with bungs on the wall are not acceptable**.**

5.2.2 Tanks

Frac tanks or poly tanks may be used for storing large volumes of aqueous IDW. Tanks are used for temporary and moveable storage IDW with capacities generally ranging from 8,000 to 21,000 gallons. Frac and poly tanks are emptied via vacuum truck or are hauled offsite.

5.2.3 **Roll-Offs/Dump Trucks**

These containers are commonly used for storing and transporting solid wastes IDW. Roll-offs and dump truck beds are made of heavy-duty steel and have a typical capacity between 10 and 40 cubic yards. Roll-offs and dump truck beds are often fitted with a liner to prevent leakage and covered with a tarp to prevent the spread of contaminated dust during transport.

5.2.4 **Super Sacks**

Super sacks are large durable bags used for storing and transporting bulk soil. These large bags are made from a woven polypropylene and are designed to hold anywhere from a few hundred pounds to approximately 4,000 pounds.

5.2.5 **Soil Staging Piles**

For some projects, excavated soil may be segregated in staging piles based on composition and source location. Soil staging piles may serve as a repository for excavated material that requires screening, treatment, or pending disposal.

6.0 Procedure

The following steps are recommended to effectively manage IDW.

6.1 IDW Staging Area Location

An IDW staging area should be identified prior to executing investigation activities at the site. The IDW staging area should preferably be located to not interfere with Installation activities, on relatively flat, hard, open ground, upwind from site activities, and within a secure area. The staging area should be easily accessible with a designated loading and unloading area. The Field Manager should solicit input and approval from the Navy prior to establishing the location of the IDW staging area.

6.2 Setup of IDW Staging Area

6.2.1 The dimensions of the IDW staging area(s) should be sized based on the estimated number of drums/containers necessary for IDW generated during the field event. Once the dimensions of the staging area are determined, the Field Manager will oversee the construction of a secondary containment area within the IDW staging area by the field team or a subcontractor. The secondary containment area is typically constructed by rolling out plastic sheeting and cutting sections to the desired length. A 1” by 6” wooden board or equivalent is placed at each section end and rolled up at least 2 rotations in the plastic sheeting. Each board is secured in an upright position, and these steps are repeated at different orientations until a rectangular “bermed” area is formed. Once complete, secondary containment should look like an empty kiddie pool.

6.2.2 State and federal regulations require specific handling and storage requirements such as secondary containment for IDW. Check state and federal regulations regarding secondary containment. Additionally, Installation--specific requirements for IDW management must be documented and followed.

6.2.3 Liquid, soil/sediment, soiled PPE, and construction debris must be segregated into individual drums. Wooden pallets or drum spill pallets are then strategically placed within the secondary containment. The pallets are used as an intermediary to support IDW drums above the plastic sheeting. The pallets serve to:

1. Protect the plastic sheeting from drum abrasion;
2. Allow the field team to inspect drums for visible signs of leaks; and
3. Aid the field team with moving and staging drums

6.2.4 A spill kit and drum kit should be available at the IDW staging area. The spill kit and drum kit should include the necessary supplies needed to clean up a solid or liquid spill and to perform IDW management, respectively (see Section 5.1).

6.3 Decontamination Station

The decontamination station should be located in close proximity to the IDW staging area. Refer to Resolution Consultants SOP 3-06 *Equipment Decontamination* for information on setting up a decontamination station.

6.4 Waste Planning and Generation

Several types of waste streams are generated during environmental investigations that should be appropriately managed. These wastes fall into one of the following five categories: soil/sediment, water, PPE and disposable sampling supplies, inert construction and demolition debris, and Munition Response Program (MRP) materials (material documented as safe [MDAS] and material documented as an explosive hazard [MDEH]).

6.4.1 Soil/Sediment

Soil/Sediment IDW may include cuttings and drilling muds.

6.4.2 Water

Water IDW includes liquids generated from monitoring well development, well purging, groundwater sampling, and decontamination.

6.4.3 Disposable PPE and Sampling Supplies

Disposable PPE includes but is not limited to nitrile gloves, outer gloves, hearing protection, respirator cartridges, Tyvek suits and booties, and aprons. Disposable sampling supplies may include pump tubing, trowels/spoons, Ziploc bags, direct push technology (DPT) acetate liners, sampling bottles, bailers, flagging, pin flags, paper towels, and excess sample packaging materials.

6.4.4 Construction and Demolition Debris

Construction and demolition debris includes but is not limited to concrete, asphalt pavement, fencing, brick, wood, glass, and piping.

6.4.5 MRP Materials

MRP materials loosely refers to MDAS and MDEH, which are terms used to designate the final deposition of material potentially presenting and explosive hazard (MPPEH). MPPEH includes but is not limited to the following: small arms ammunition, unexploded ordinance, munitions, munitions debris, discarded military munitions, propellants, and potentially munitions constituents.

6.5 Waste Segregation

It is a best practice to keep waste streams segregated by waste category, waste source location, and waste designation. Examples of best practices for waste segregation include:

- **Waste Category**
    - Soil/Sediment, water, PPE, non-contaminated construction and demolition debris, and MRP materials should be segregated before placing in drums/container.
    - Waste streams such as non-grossly contaminated PPE and disposable sampling equipment are typically not subject to IDW requirements and may be disposed as general refuse.
    - For non-contaminated construction and demolition debris, refer to investigation planning documents and develop consensus with your stakeholders (internal and external) to determine how these materials should be disposed.

- **Waste Source Location**
    - Media identified as having gross contamination (i.e. presence of free product, staining, discoloration, strong odor, etc.) should be placed in drums/containers or stockpiles separate from media without gross contamination.
    - Media from different locations within the site should be segregated based on a review of the conceptual site model (CSM). This may include incompatible wastes (listed wastes vs characteristic wastes), wastes slated for treatment, or wastes that require unique analytical characterization requirements.
    - Generally, wastes generated from one environmental site should not be mixed with wastes generated from another site.
- **Waste Designation**
    - Materials that are known or anticipated to be characterized as a RCRA hazardous waste (listed waste or characteristic waste) should be segregated from non-hazardous IDW.
    - Materials managed under TSCA such as PCBs and PFAS cannot be categorized as a RCRA hazardous waste. However, regulations may require these materials to be managed as hazardous waste (e.g., total PCB concentration > 50 parts per million). Regulations for PFAS are continually evolving, and it is anticipated that PFAS wastes will have a hazardous characteristic requirement in the future.

6.6 Waste Minimization

Waste minimization practices should be implemented to reduce the amount of IDW generated. The team should evaluate alternatives that reduce the amount of IDW generated yet meet the project objectives. The field team should review the SOW and engage the TO Manager and RPM to obtain concurrence on waste minimization practices. Potential minimization practices include but are not limited to:

- Generating soil cuttings from DPT drilling versus Hollow Stem Auger drilling;
- Treating IDW ex-situ through landfarming, evaporation ponds/basins, phytoremediation, granulated activated carbon (GAC) cannisters, etc. (field treatment activities are not covered under this SOP);
- Compacting and/or consolidating similar wastes;
- Discharging liquid IDW to an Installation wastewater treatment system; and
- Properly monitoring and/or controlling the amount of liquids generated from well development, groundwater purging, and decontamination activities.

In special cases, non-hazardous IDW may be placed on the ground or returned to the source if doing so does not endanger human health or the environment or violate federal or state regulations.

6.7 IDW Storage Practices

6.7.1 For long-term IDW storage, DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring for the drum lid prior to sealing drums.

6.7.2 Stacking drums is prohibited.

6.7.3 Lids or bungs on drums must be secured and opened only during filling or pumping activities.

6.7.4 IDW should be segregated by media (water, soil) and classification (non-hazardous, hazardous) within the IDW staging area to facilitate characterization sampling and reduce the need to rearrange drums for IDW pickup(s). Soil/sediment drums should be staged with soil/sediment drums, water drums should be staged with water drums, etc.

6.7.5 Drums should not be overfilled filled such that the material is compacted. Compressed materials can cause the drum lid to pop open when opening the drum thereby creating a pinch point hazard

6.7.6 State and federal regulations include storage requirements such as waste removal deadlines.

- Non-hazardous or "characterization pending analysis" IDW should be disposed of as soon as possible.
- Hazardous IDW **must be** shipped to a disposal facility within 90 days of generation.

6.7.7 To prevent damage to drums, loss of drum integrity/containment, and/or presenting hazards to drum handlers, the following best practices should be applied when filling drums:

- Soil/sediment drums will be filled to no more than two thirds of the drum capacity. Drums completely full can weigh over 600 pounds. Although drum handling tools and carts provide some assistance, moving excessively heavy drums presents significant hazards resulting in muscle strain, pinch points (foot and fingers), and drum tipping. Drum tipping may result in spillage.
- Compatibility between the chemical component(s) of the IDW and the container material must be considered before choosing the type of container to use. Steel drums are susceptible to corrosion and loss of integrity when in contact with high pH water. Lime-based products (cement, concrete, grout, etc.) should not be disposed or mixed in steel drums containing water or soil-water mixtures. If high (>12) or low (<2) pH conditions are suspected, IDW liquids should be measured for pH using a calibrated pH meter or pH test strips. Plastic drum liners or polyethylene drums should be used for high or low pH liquids.
- A **void space of approximately 6 inches** from the top of the drum (the upper drum ring on most drums) will be left in the drum to allow room for ice expansion when filling drums with water or oil/water emulsions. Under freezing temperatures, expanding ice in a full drum can deform the bottom of a drum such that it is no longer DOT compliant, cause ruptures, and/or dislodge the drum lid and present a containment breach. The consequences of this damage can be both economic and environmental.

6.8 Drum Labelling

6.8.1 To prepare IDW drums for labelling, the outer wall surfaces and drum lids should be wiped clean. If potentially contaminated material adheres to the outer surface of a drum, the paper towel or rag should be managed as IDW with gross-contaminated PPE and disposable sampling equipment.

6.8.2 Containers used to store IDW must be properly labelled. The following should be filled out on the side of the drum and the lid using a paint pen:

- Site name (Site 22, SWMU 5, UXO 03, etc.);
- Media and Drum # (Soil 001, Water 008, etc.);
- Description of waste (purge water, soil cuttings, decontamination fluids, PPE, etc.);
- Location (MW04-MW07, SB01-SB02, North Central Area, etc.);
- Date when the waste was first accumulated (Oct 28, 2023, 11/28/23, 28 Oct 2023, etc.);
- EPA identification number [Hazardous Waste only]; and
- Generator information (i.e., contact name, affiliation, and work telephone number. Typically, this is the Installation Environmental Manager for active installations and BRAC Environmental Coordinator for BRAC installations, but check with the RPM)

6.8.3 An adhesive, weatherproof label should be placed on the on the side of each drum (see examples below).

- "On hold pending analysis" label is used when waste characteristics are unknown.

- "Non-hazardous waste" label is used when the waste is known to be a RCRA non-hazardous waste.
- "Hazardous waste" label is used when the waste is a RCRA listed waste or exhibits a hazardous characteristic.

6.8.4 After the waste has been characterized, the field team should apply an updated adhesive label to the drum.

6.8.5 As a best practice, if paint pen or sharpie markings on a label are faded or illegible, then the field team should reapply the markings.

6.8.6 Each IDW drum or container should be documented in the onsite drum log and Resolution Consultants IDW Tracker (https://ensafe.sharepoint.com/sites/navyclean2/idw).

6.8.7 After the waste is transported offsite for disposal or treatment, the field logbook, drum log, and Resolution Consultants IDW Tracker should be updated to reflect the disposition of the IDW drum/container.

6.9 IDW Sampling

6.9.1 Sampling is required to characterize IDW. The field team should discuss the sample analytical requirements with the IDW subcontractor after collectively reviewing and evaluating site characterization data as well as state regulatory and disposal facility requirements that may influence sampling methods and tools, analytical requirements, and timeframe. Consult with the IDW subcontractor for sampling and analysis needs to satisfy waste disposal facility requirements. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

6.9.2 IDW samples must be collected using discrete, composite, or incremental sampling methods.

- For collecting discrete, composite, or incremental samples from soil IDW containers or stockpiles, please refer to Resolution Consultants SOPs 3-21 *Surface and Subsurface Soil Sampling* and 3-41, *Per- and Polyfluoroalkyl Substance Field Sampling Protocol 3-41*, state regulatory guidance, and Interstate Technology Regulatory Council (ITRC) Incremental Sampling Methodology Guidance.
- For collecting discrete or composite samples from liquid IDW containers, a bailer, drum thief, or other tool may be used to collect representative samples. Please refer to Resolution Consultants SOPs 3-10 *Surface Water Sampling,* 3-14 *Monitoring Well Sampling*, and 3-41, *Per- and Polyfluoroalkyl Substance Field Sampling Protocol*, and state regulatory guidance.

6.10 IDW Waste Characterization

6.10.1 EPA's Contained-in Policy (53 FR 31138, 31142, 31148, 57 FR 21453, 61 FR 18795) states that environmental media contaminated with a hazardous waste must be managed as hazardous waste until

it no longer contains a listed waste (F, K, P, and U lists), no longer exhibits one of the four waste characteristics, or was delisted.

6.10.2 A solid waste is a hazardous waste if it is specifically listed as a known hazardous waste or meets the characteristics of a hazardous waste. Listed wastes are wastes from common manufacturing and industrial processes, specific industries and can be generated from discarded commercial products. Characteristic wastes are wastes that exhibit any one or more of the following characteristic properties: ignitability, corrosivity, reactivity, or toxicity.

6.10.3 A solid waste derived from a hazardous waste listed solely for exhibiting a characteristic of ignitability, corrosivity, and/or reactivity is not a hazardous waste when it no longer exhibits any characteristic of hazardous waste (40 CFR Section 261.3(g)(2)(ii)). However, a waste listed solely for exhibiting the characteristic of ignitability, corrosivity, and/or reactivity that exhibits the characteristic at the point of generation and subsequently loses the characteristic is still subject to the land disposal restrictions requirements (LDR). There are also special LDR standards specific to contaminated debris (40 CFR §268.45).

6.10.4 **Listed Waste**

The Site owner/operator (e.g., Navy or BRAC RPM) is responsible for determining whether the IDW contains a listed waste (F, K, P, and U lists) based on the CSM, source(s) of contamination, contaminant types, analytical data, and past waste disposal documentation. If available documentation indicates that a listed hazardous waste is present in IDW, then IDW will be considered a RCRA hazardous waste. If site documentation on IDW is inconclusive, then IDW is not considered a listed waste, and further evaluation is necessary to evaluate whether IDW is hazardous by characteristic.

Listed wastes are provided in the following link: https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes#listed.

6.10.5 **Characteristic Waste**

If IDW is not a listed waste, then IDW should be evaluated for the following characteristics to determine if the waste is hazardous or non-hazardous:

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

Each characteristic waste category has a specific criterion that, if met, will result in the waste being characterized as hazardous. Generally, contaminated media managed as IDW will not exhibit characteristics of ignitability, corrosivity, and reactivity but may exhibit a toxicity characteristic. The analytical results are used to determine if IDW is hazardous by toxicity.

Criteria for characteristic wastes are provided in the following link: https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes#characteristic.

6.10.6 **PFAS Wastes**

PFAS compounds are managed under TSCA; therefore, media contaminated with PFAS cannot be classified as a RCRA hazardous waste. It is anticipated that EPA regulations will evolve to include a hazardous waste characteristic requirement for PFAS contaminated media in the future.

6.11 **On-Site PFAS Treatment Options**

The TO Manager should consider onsite treatment of PFAS-impacted liquids using GAC. Onsite treatment potentially 1) serves to reduce the volume of liquid IDW slated for disposal by allowing ground surface disposal of treated liquids (PFAS-free) at the direction of the RPM or 2) allows for treated liquids

to be disposed at a waste facility without the need for sequestration, solidification, or incineration. The TO Manager should take into consideration the CTO scope, risks, a cost-benefit analysis, viability, volume of PFAS-impacted liquids, updating safety plans, and level of subcontractor involvement before developing a plan. The proposed treatment plan should be shared with Technical Leadership for feedback prior to soliciting approval from the client. Sharing the plan with Technical Leadership will also provide opportunities to disseminate successes and lessons learned from on-site treatment of PFAS-impacted liquids.

PFAS in water will adsorb to GAC as the liquid passes through the GAC bed/filter. Based on the EPA 2024 Interim Guidance (EPA, 2024), treatment rates are based on common and best-case scenarios and range from 0.00001 grams to 0.02 grams of PFAS to grams of GAC (0.001% to 2% by weight).

6.12 Waste Pickup and Transport

6.12.1 IDW disposal requirements can vary based on the Installation's EPA Region and/or Navy Command's Area of Responsibility (AOR). Below are two examples of Regions and Commands that have unique circumstances.

- **EPA Region 1:** Disposal facilities for waste generated during activities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) may require EPA approval under the Off-Site Rule (OSR) procedures (40 CFR 300.440) to ensure the facility is operating in compliance with RCRA or other Federal and State requirements. The disposal facility will prepare a waste profile based on IDW and/or site characterization analytical data. After the waste profile is finalized, the generator will submit the waste profile with an OSR Compliance Request Form (Attachment 1) to the EPA Regional Off-Site Contact for approval. IDW may not be shipped to the disposal facility until OSR approval (valid for 90 days) is granted by EPA Region 1.
- **NAVFAC SE:** For IDW destined for landfill disposal, NAVFAC SE has requested using only those firms who are listed on the Defense Logistics Agency (DLA) Qualified Facilities List: https://www.dla.mil/Portals/104/Documents/DispositionServices/Hazardous/QFL%2027NOV24.pdf?ver=IIH_M9ifhR5dtxyLCA5Asg%3d%3d.

6.12.2 The Resolution Consultants field manager or designee must be present for waste pickup by the IDW subcontractor. The field manager or designee should review the IDW subcontractor's THA and cover the THA, APP, and SSHP with the IDW subcontractor prior to waste pickup. The IDW subcontractor should be given the opportunity to review and sign each safety document.

6.12.3 Resolution Consultants personnel are not permitted to sign off on waste manifests (hazardous waste) and bills of lading (non-hazardous waste). Waste manifests and bills of lading for hazardous and non-hazardous waste shipments must be signed by the client or the client's designee. If the Navy is requesting Resolution Consultants to sign documents on their behalf for non-hazardous waste shipments, the CTO Manager should consult with Technical Leadership and/or PMO before any action is taken.

6.12.4 For BRAC sites where sample locations may be on property that has been transferred and private property sampling, Resolution Consultants staff may be required to temporarily transport IDW from the work location over public roads to the IDW staging area. Resolution Consultants staff should acquire and review transfer documents and access agreements and consult with the client/owner prior to developing an IDW Plan that involves temporarily transporting of IDW over public roads by Resolution Consultants personnel.

6.12.5 A state-certified hazardous waste hauler shall load and transport IDW classified as hazardous waste. Shipped hazardous waste shall be transported and disposed of in accordance with DOT/RCRA/EPA requirements.

6.12.6 Resolution Consultants personnel who will perform any duties related to management of RCRA hazardous wastes or shipping of DOT Hazardous Materials will be properly trained in accordance with 40

CFR § 262.34 and §265.16 for RCRA Waste Generators, as well as 49 CFR § 172.704 for DOT Hazardous Materials Shippers. RCRA Hazardous Wastes are by definition DOT Hazardous Materials.

6.13 Non-PFAS Waste Disposal

6.13.1 Non-PFAS disposal options should be discussed with the IDW Subcontractor to evaluate cost-effectiveness and green and sustainable best practices.

6.13.2 Hazardous waste IDW must be disposed at a Subtitle C Hazardous Waste Treatment, Storage, or Disposal Facility.

6.13.3 Non-hazardous IDW must be disposed at a permitted waste treatment, storage, or disposal facility if other disposal options such as recycling/reuse, composting, placing in evaporation ponds or Installation waste treatment systems, and waste-to-energy incineration are not viable.

6.14 PFAS Waste Disposal

6.14.1 Incineration of PFAS-containing materials at a non-RCRA- and non-Clean Air Act (CAA)-permitted Hazardous Waste Incinerator **is prohibited** until DoD issues guidance implementing the EPA *Interim Guidance on the Destruction and Disposal of Perfluoroalkyl and Polyfluoroalkyl Substances and Materials Containing Perfluoroalkyl and Polyfluoroalkyl Substances* (EPA, 2024).

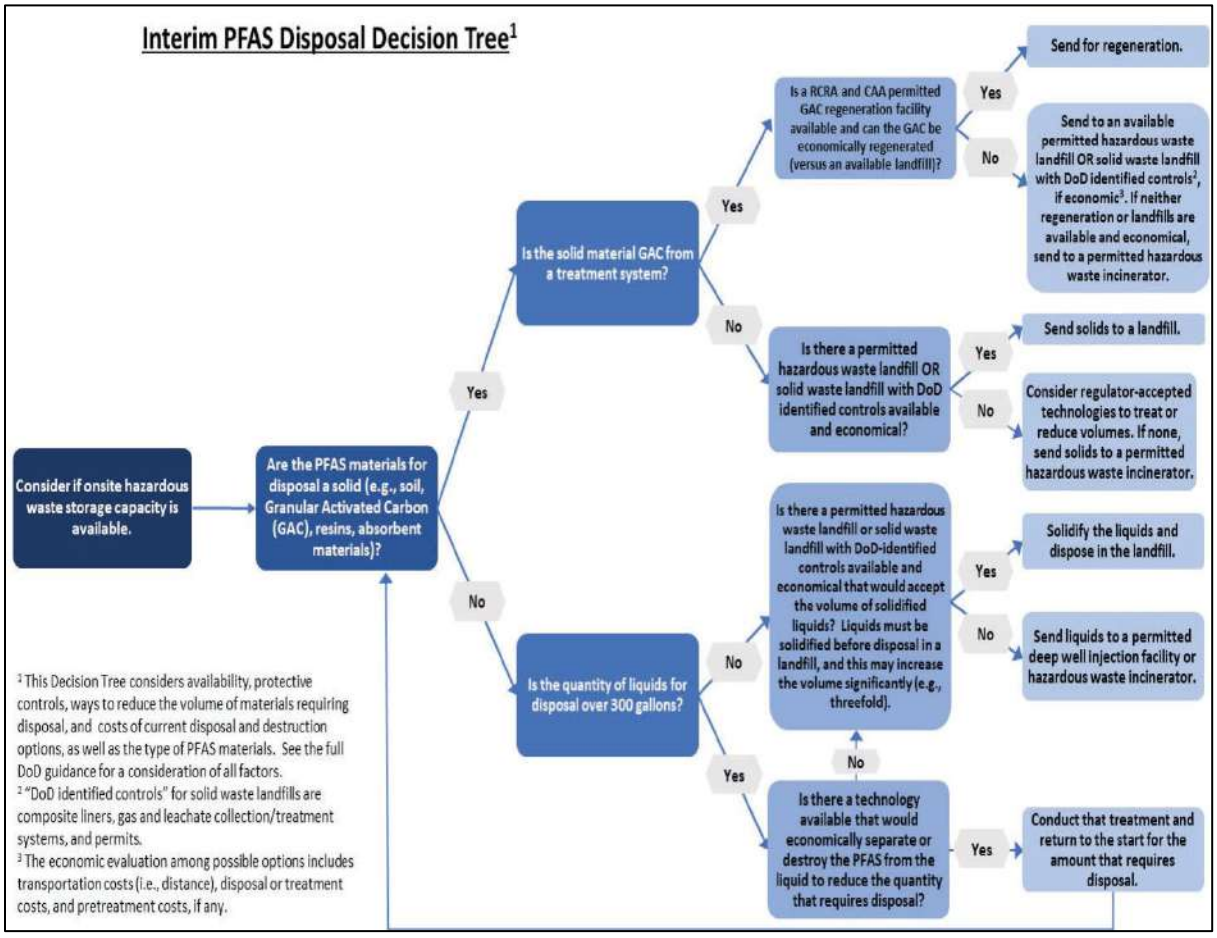
6.14.2 DoD has identified viable options to manage, destroy, or dispose of DoD PFAS-containing material (DoD, 2023). Refer to the **DoD Interim PFAS Disposal Decision Tree** figure below. The outlined decision logic may change if PFAS-containing material is classified as a RCRA hazardous waste by EPA in the future.

- Carbon reactivation units with environmental permits (e.g. activated carbon)
- Permitted hazardous waste landfills
- Permitted solid waste landfills that have composite liners, and gas and leachate collection and treatment system
- RCRA- and CAA-permitted Hazardous Waste Incinerators/Combustors
- Onsite waste storage for >90 days
- Class I Underground injection wells
- Other existing and developing PFAS treatment/destruction technologies that are accepted/permitted by the regulators upon notification to the Office of the Assistant Secretary of Defense for Energy, Installations, and Environment

6.14.3 EPA has identified three widely-used, commercially available destruction and disposal technologies that may be effective strategies for managing PFAS wastes (EPA 2024). These technologies have a lower potential for environmental release of PFAS compared to other technologies in the same category and are viewed as the more protective technologies.

- Underground Injection – Permitted Class I non-hazardous or hazardous waste injection wells
- Permitted Hazardous Waste Landfills
- RCRA- and CAA-permitted Hazardous Waste Incinerators/Combustors

6.14.4 It is recommended that TO Managers evaluate waste disposal technologies as part of the IDW Subcontractor bid process from a cost and a green and sustainability best practices standpoint.



6.14.5 EPA recommends that decision-makers consider the nature of the waste, location, potential for environmental release, and other factors to determine the most appropriate destruction, disposal, or storage method; and prioritize the use of destruction and disposal technologies that have a lower potential for PFAS release to the environment, over destruction and disposal technology options with a greater potential for environmental release of PFAS.

6.14.6 EPA recommends that managers of PFAS-containing materials use the technology evaluation framework presented in Table 6-1 of the *Interim Guidance on Destruction and Disposal of Per- and Polyfluoroalkyl Substances and Materials Containing Per- and Polyfluoroalkyl Substances* (EPA, 2024) to evaluate emerging destruction and disposal technologies and to inform their decisions about managing PFAS-containing materials.

6.15 Regulatory Requirements

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

- **General:** Code of Federal Regulations (CFR), Title 40, Part 262 *Standards Applicable to Generators of Hazardous Waste* and Part 270 *EPA Administered Permit Programs: The Hazardous Waste Permit Program*
- **Storage:** 40 CFR Part 264 *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*; 40 CFR Part 265 *Interim Status Standards for Owners and Operators of Hazardous Waste TSDFs.*

- **Transport:** 49 CFR Parts 171-180 *Hazardous Materials Regulations by the Department of Transportation (DOT)*; 40 CFR Part 263: *Standards Applicable to Transporters of Hazardous Waste*.
- ***Disposal:*** 40 CFR Part 268: *Land Disposal Restrictions*; 40 CFR Part 261: *Identification and Listing of Hazardous Waste*; 40 CFR Part 257: *Criteria for Classification of Solid Waste Disposal Facilities and Practices*; 40 CFR Part 258: *Criteria for Municipal Solid Waste Landfills*.

The CTO Manager should also check for applicable Installation-specific, state, and local regulations.

6.16 **IDW Tracking**

The Resolution Consultants SharePoint IDW tracker ((**https://ensafe.sharepoint.com/sites/navyclean2/idw)** must be used by the CTO Manager or designee to effectively track IDW generated from investigation activities for CTO or project site.

7.0 Quality Control and Assurance

7.1 A drum inspection and inventory check should be conducted periodically to verify containers are functioning as intended and accuracy of inventory.

7.2 Weekly storage area inspections should be performed and documented to ensure compliance while site work in on-going.

7.3 Monthly storage area inspections should be performed following the completion of active site work.

7.4 For hazardous waste, periodic inspections are required depending on the scenario. Check the Installation-specific, state, and federal regulations for the required frequency of the specific situation.

8.0 Records

8.1 Copies of waste manifests, disposal certificates, characterization data, bills of lading, and other IDW records should be maintained in the project files.

8.2 Deviations from this SOP shall be documented in field records. Significant changes shall be approved by the **Technical Leadership** or the **Program Quality Manager**.

9.0 References

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

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

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SOP Revision Table

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)
Joshua Millard Senior Geologist	Andrew Borden Geologist	Rev 1 – Technical (Jan 2017)
Ken 'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 2 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist Mark MacEwan PFAS Subject Matter Expert	Rev 3 – Update & Review (June 2022)
Brad Reddick, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 4 – Update & Review (September 2022)
Naomi Ouellette	Michelle Colon	Rev 5 – Included updated OSR form (December 2023)
Trent Sims, PE PMP Project Manager	Gordon Hicks, PG Geologist	Rev 6 – Overhaul & Review (December 2024)

Attachment 1
Off Site Rule Request Form

United States Environmental Protection Agency – Region 1

Off-Site Rule Compliance Request Form

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

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

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

[Form: Off-Site Compliance Request] [Revised July 18, 2023] [maisano.ryan@epa.gov]

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

	Regional Off-Site Contacts (listed as of January 4, 2021)	
Region # U.S. & DC,PR,VI	**Contact Name**	**Telephone #**
1 CT,MA,ME,NH,RI,VT	Ryan Maisano (maisano.ryan@epa.gov)	**617.918.1309**
2 NY,NJ,PR,VI	Kathryn Drisco (Region2_OSR@epa.gov)	**732.906.6874**
3 DC,DE,MD,PA,VA,WV	Claudia Scott (R3CERCLA_Offsite@epa.gov)	**215.814.3240**
4 AL,FL,GA,KY,MS,NC,SC,TN	Raj Aiyar (r4cercla_offsitecontact@epa.gov)	**404.562.8993**
5 IL,IN,MI,MN,OH,WI	William Damico (r5cercla.roc@epa.gov)	**312.353.8207**
6 AR,LA,NM,OK,TX	Wilkin (Ron) Shannon (shannon.wilkin@epa.gov)	**214.665.2282**
7 IA,KS,MO,NE	Mike Martin (martin.mike@epa.gov)	**913.551.7149**
8 CO,MT,ND,SD,UT,WY	Linda Jacobson (jacobson.linda@epa.gov)	**303.312.6503**
9 AZ,CA,HI,NV	Jennifer MacArthur (macarthur.jennifer@epa.gov)	**415.972.3994**
10 AK,ID,OR,WA	Xiangyu Chu (chu.xiangyu@epa.gov)	**206.553.3859**

Equipment Decontamination

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-06

1.0 Purpose and Scope

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

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

2.0 Safety

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

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

No eating, smoking, drinking, chewing, or other hand to mouth contact should be permitted during decontamination activities.

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

2.1 **Chemical Hazards associated with Equipment Decontamination**

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

2.2 **Physical Hazards associated with Equipment Decontamination**

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

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

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

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

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

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

5.0 Procedure

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

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

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

5.1 **Decontamination Area**

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

5.2 Types of Equipment

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

5.3 Frequency of Equipment Decontamination

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

5.4 Cleaning Solutions and Techniques

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

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

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

After decontamination and final rinse, decontaminated equipment should be stored away from the decontamination area and other surficial and atmospheric contamination and wrapped in aluminium foil, plastic bags, or other acceptable materials as defined by the sampling and analysis plan.

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

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

5.5 Containment of Residual Contaminants and Cleaning Solutions

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

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

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

6.0 Quality Control and Assurance

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

7.0 Records, Data Analysis, Calculations

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

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

8.0 Attachments or References

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

8.2 Procedure 3-05, *IDW Management*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Gordon Hicks, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Monitoring Well Sampling

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-14

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the actions to be used during monitoring well sampling activities and establishes the method for sampling groundwater monitoring wells for water-borne contaminants and general groundwater chemistry. The objective is to obtain groundwater samples that are representative of aquifer conditions with as little alteration to water chemistry as possible.

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

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

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. All field sampling personnel responsible for sampling activities must review the project-specific Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP) paying particular attention to the control measures planned for the well sampling tasks. Conduct preliminary area monitoring of sampling wells to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor phase and liquid matrix through the use of appropriate personal protective equipment (PPE).

2.2 Observe standard health and safety practices according to the project-specific APP/SSHP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves and rubberized steel-toed boots. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on evaluation for PFAS and on the contaminant concentrations. Refer to the project-specific APP/SSHP for the required PPE.

2.3 Physical Hazards associated with Well Sampling

- To avoid lifting injuries associated with pump and bailers retrieval, use the large muscles of the legs, not the back.
- Stay clear of all moving equipment, and avoid wearing loose fitting clothing.
- When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid slip/trip/fall conditions as a result of pump discharge, use textured boots/boot cover bottoms.
- To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
- Be aware of restricted mobility due to PPE.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Potential interferences could result from cross-contamination between samples or sample locations. Minimization of the cross-contamination will occur through the following:

- The use of clean sampling tools at each location as necessary; and
- Avoidance of material that is not representative of the media to be sampled.

5.0 Training and Qualifications

5.1 Qualifications and Training

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

5.2 Responsibilities

5.2.1 The **Task Order (TO) Manager** is responsible for ensuring that monitoring well sampling activities comply with this procedure. The **TO Manager** is responsible for ensuring that all field sampling personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks.

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

5.2.3 The **Field Manager** is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the groundwater sampling procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

6.1 Purging and Sampling Equipment

- Pump (Peristaltic, Portable Bladder, Submersible)
- Polyethylene bladders (for portable bladder pumps)
- Bladder pump controller (for portable bladder pumps)
- Air compressor (for portable bladder pumps)
- Nitrogen cylinders (for portable bladder pumps)
- 12-volt power source
- Polyethylene inlet and discharge tubing
- Silicone tubing appropriate for peristaltic pump head
- HDPE bailer appropriately sized for well
- Disposable bailer string (polypropylene)
- Individual or multi-parameter water quality meter(s) with flow-through cell to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity

- Turbidity meter
- Teflon-free water level meter
- Oil/water interface probe

6.2 General Equipment

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, wet ice)
- Sample Chain-of-Custody (COC) forms
- Sample Collection Records
- Sample packaging and shipping supplies
- Fine-tipped Sharpie® marker
- Deionized water supply
- Polyethylene water dispenser bottles
- HDPE flow measurement cup or bucket
- 5-gallon buckets
- Instrument calibration solutions
- Stopwatch or watch
- Disposable, powderless Nitrile gloves
- Cotton towels
- Trash bags
- Zipper-lock (e.g., Ziploc brand) bags
- Equipment decontamination supplies (e.g., Alconox®, Liquinox®, NOT Decon 90™)
- Health and safety supplies (as required by the APP/SSHP)
- Approved plans such as: project-specific APP/SSHP and Quality Assurance Project Plan (QAPP)
- Well keys or combinations
- Monitoring well location map(s)
- Field project logbook/ballpoint pen

7.0 Calibration or Standardization

7.1 Field instruments will be calibrated daily according to the requirements of the QAPP and manufacturer's specifications for each piece of equipment. Equipment will be checked daily with the calibration solutions at the end of use of the equipment. Calibration records shall be recorded in the field logbook or appropriate field form.

7.2 If readings are suspected to be inaccurate, the equipment shall be checked with the calibration solutions and/or re-calibrated.

8.0 Procedure

8.1 Preparation

8.1.1 Site Background Information

Establish a thorough understanding of the purposes of the sampling event prior to field activities. Conduct a review of all available data obtained from the site and pertinent to the water sampling. Review well history data including, but not limited to, well locations, sampling history, purging rates, turbidity problems, previously used purging methods, well installation methods, well completion records, well development methods, previous analytical results, presence of an immiscible phase, historical water levels, and general hydrogeologic conditions.

Previous groundwater development and sampling logs give a good indication of well purging rates and the types of problems that might be encountered during sampling, such as excessive turbidity and low well yield. They may also indicate where dedicated pumps are placed in the water column. To help minimize the potential for cross-contamination, well purging and sampling and water level measurement collection shall proceed from the least contaminated to the most contaminated well as indicated by previous analytical results. This order may be changed in the field if conditions warrant it, particularly if dedicated sampling equipment is used. A review of prior sampling procedures and results may also identify which purging and sampling techniques are appropriate for the parameters to be tested under a given set of field conditions.

8.1.2 Groundwater Analysis Selection

Establish the requisite field and laboratory analyses prior to water sampling. Decide on the types and numbers of quality assurance/quality control (QA/QC) samples to be collected (refer to the project-specific QAPP), as well as the type and volume of sample preservatives, the type and number of sample containers, the number of coolers required, and the quantity of ice or other chilling materials. The field sampling personnel shall ensure that the appropriate number and size sample containers are brought to the site, including extras in case of breakage or unexpected field conditions. Refer to the project-specific QAPP for the project analytical requirements.

8.2 Groundwater Sampling Procedures

Groundwater sampling procedures at a site shall include:

1) An evaluation of the well security and condition prior to sampling;
2) Pre-sampling activities;
3) Decontamination of equipment;
4) Measurement of well depth to groundwater;
5) Assessment of the presence or absence of an immiscible phase;
6) Assessment of purge parameter stabilization;
7) Purging of static water within the well and well bore; and
8) Obtaining a groundwater sample.

Each step is discussed in sequence below. Depending upon specific field conditions, additional steps may be necessary. As a rule, at least 24 hours should separate well development and well sampling events. In all cases, consult the State and local regulations for the site, which may require more stringent time separation between well development and sampling.

8.2.1 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information may be noted on a Groundwater Sample Collection Record (Attachment 1) or in the field logbook:

- Condition of the well's identification marker;
- Condition of the well lock and associated locking cap;

- Integrity of the well – well pad condition, protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing; and
- Condition of the general area surrounding the well.

8.2.2 Pre-Sampling Activities

Place polyethylene sheeting on the ground and assemble all necessary sampling equipment on top of it. This helps to prevent contamination of the sampling equipment by the ground surface, reduces wear on the sampling equipment, and reduces the likelihood that contaminated purge water will spill onto the ground surface.

8.2.3 Decontamination of Equipment

Where possible, dedicated supplies should be used at each well location to minimize the potential for cross-contamination and minimize the amount of investigation derived waste (IDW) fluids resulting from the decontamination process. If decontamination is necessary, establish a decontamination station before beginning sampling. The station shall consist of an area of at least 4 feet by 2 feet covered with PE plastic sheeting and be located upwind of the well being sampled. The station shall be large enough to fit the appropriate number of wash and rinse buckets, and have sufficient room to place equipment after decontamination. One central cleaning area may be used throughout the entire sampling event. The area around the well being sampled shall also be covered with plastic sheeting to prevent spillage. Further details are presented in SOP 3-06, Equipment Decontamination.

Decontaminate each piece of equipment prior to entering the well. Also, conduct decontamination prior to sampling at a site, even if the equipment has been decontaminated subsequent to its last usage. Additionally, decontaminate each piece of equipment used at the site prior to leaving the site. It is only necessary to decontaminate dedicated sampling equipment prior to installation within the well. Do not place clean sampling equipment directly on the ground or other contaminated surfaces prior to insertion into the well. Dedicated sampling equipment that has been certified by the manufacturer as being decontaminated can be placed in the well without on-site decontamination.

8.2.4 Measurement of Static Water Level Elevation

Before purging the well, measure water levels in all of the wells within the zone of influence of the well being purged. The best practice, if possible, is to measure all site wells (or wells within the monitoring well network) prior to sampling. If the well cap is not vented, remove the cap several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

Measure the depth to standing water and the total depth of the well to the nearest 0.01 foot to provide baseline hydrologic data, to calculate the volume of water in the well, and to provide information on the integrity of the well (e.g., identification of siltation problems). If not already present, mark an easily identified reference point for water level measurements which will become the measuring point for all water level measurements. This location and elevation must be surveyed.

The device used to measure the water level surface and depth of the well shall be sufficiently sensitive and accurate in order to obtain a measurement to the nearest 0.01 foot reliably. A Teflon-free electronic water level meter will usually be appropriate for this measurement; however, when the groundwater within a particular well is highly contaminated, an inexpensive weighted tape measure can be used to determine well depth to prevent adsorption of contaminants onto the meter tape. The presence of light, non-aqueous phase liquids (LNAPLs) and/or dense, non-aqueous phase liquids (DNAPLs) in a well requires measurement of the elevation of the top and the bottom of the product, generally using an interface probe. Water levels in such wells must then be corrected for density effects to accurately determine the elevation of the water table.

At each location, measure water levels several times in quick succession to ensure that the well has equilibrated to atmospheric conditions prior to recording the measurement. As stated above, measure all site wells (or wells within the monitoring well network) prior to sampling whenever possible. This will provide a water level database that describes water levels across the site at one time (a synoptic sampling). Prior to sampling, measure the water level in each well immediately prior to purging the well to ascertain that static conditions have been achieved prior to sampling.

8.2.5 Detection of Immiscible Phase Layers

Complete the following steps for detecting the presence of LNAPL and DNAPL before the well is purged for conventional sampling. These procedures may not be required for all wells. Consult the project-specific QAPP to determine if assessing the presence of LNAPL and/or DNAPL is necessary.

1) Sample the headspace in the wellhead immediately after the well is opened for organic vapors using either a PID or an organic vapor analyzer, and record the measurements.

2) Lower an interface probe into the well to determine the existence of any immiscible layer(s), LNAPL and/or DNAPL, and record the measurements.

3) Confirm the presence or absence of an immiscible phase by slowly lowering a clear bailer to the appropriate depth, then visually observing the results after sample recovery.

4) In rare instances, such as when very viscous product is present, it may be necessary to utilize hydrocarbon- and water-sensitive pastes for measurement of LNAPL thickness. This is accomplished by smearing adjacent, thin layers of both hydrocarbon- and water-sensitive pastes along a steel measuring tape and inserting the tape into the well. An engineering tape showing tenths and hundredths of feet is required. Record depth to water, as shown by the mark on the water-sensitive paste, and depth to product, as shown by the mark on the product-sensitive paste. In wells where the approximate depth to water and product thickness are not known, it is best to apply both pastes to the tape over a fairly long interval (5 feet or more). Under these conditions, measurements are obtained by trial and error and may require several insertions and retrievals of the tape before the paste-covered interval of the tape encounters product and water. In wells where approximate depths of air-product and product-water interfaces are known, pastes may be applied over shorter intervals. Water depth measurements should not be used in preparation of water table contour maps until they are corrected for depression by the product.

5) If the well contains an immiscible phase, it may be desirable to sample this phase separately. Section 8.2.7 presents immiscible phase sampling procedures. It may not be meaningful to conduct water sample analysis of water obtained from a well containing LNAPLs or DNAPLs. Consult the **TO Manager** and **Program Quality Manager** if this situation is encountered.

8.2.6 Purging Equipment and Use

General Requirements

The water present in a well prior to sampling may not be representative of in situ groundwater quality and shall be removed prior to sampling. Handle all groundwater removed from potentially contaminated wells in accordance with the IDW handling procedures in SOP 3-05, IDW Management. Purging shall be accomplished by methods as indicated in the project-specific QAPP or by those required by State requirements. For the purposes of this SOP, purging methods will be described by removing groundwater from the well using low-flow techniques.

According to the U.S. Environmental Protection Agency (EPA) (EPA, 1996), the rate at which groundwater is removed from the well during purging ideally should be less than 0.2 to 0.3 liters/minute. EPA further states that wells should be purged at rates below those used to develop the well to prevent further development of the well, to prevent damage to the well, and to

avoid disturbing accumulated corrosion or reaction products in the well. EPA also indicates that wells should be purged at or below their recovery rate so that migration of water in the formation above the well screen does not occur.

Realistically, the purge rate should be low enough that substantial drawdown in the well does not occur during purging. In addition, a low purge rate will reduce the possibility of stripping volatile organic compounds (VOCs) from the water, and will reduce the likelihood of increasing the turbidity of the sample due to mobilizing colloids in the subsurface that are immobile under natural flow conditions.

The field sampler shall ensure that purging does not cause formation water to cascade down the sides of the well screen. Wells should not be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated based on the results of either the well development task or historical sampling events. In general, place the intake of the purge pump in the middle of the saturated screened interval within the well to allow purging and at the same time minimize disturbance/overdevelopment of the screened interval in the well. Water shall be purged from the well at a rate that does not cause recharge water to be excessively agitated unless an extremely slow recharging well is encountered where complete evacuation is unavoidable. During the well purging procedure, collect water level and/or product level measurements to assess the hydraulic effects of purging. Sample the well when it recovers sufficiently to provide enough water for the analytical parameters specified. If the well is purged dry, allow the well to recover sufficiently to provide enough water for the specified analytical parameters, and then sample it.

Evaluate water samples on a regular basis during well purging and analyze them in the field preferably using in-line devices (i.e., flow through cell) for temperature, pH, specific conductivity, dissolved oxygen (DO), and oxidation-reduction (redox) potential. Turbidity should be measured separately (outside of the flow-through cell) with a nephelometer or similar device.

Readings should be taken every 2 to 5 minutes during the purging process. These parameters are measured to demonstrate that the natural character of the formation waters has been restored.

Purging shall be considered complete per the requirements set forth in the project-specific QAPP, State requirements, or when three consecutive field parameter measurements of temperature, pH, specific conductivity, DO and ORP stabilize within approximately 10 percent and the turbidity is at or below 10 nephelometric turbidity units (NTU) or within ± 10% if above 10 NTU. This criterion may not be applicable to temperature if a submersible pump is used during purging due to the heating of the water by the pump motor. Enter all information obtained during the purging and sampling process into a groundwater sampling log. Attachment 1 shows an example of a groundwater sampling log and the information typically included in the form. Whatever form is used, all blanks need to be completed on the field log during field sampling.

Groundwater removed during purging shall be stored according to the project-specific QAPP or per SOP 3-05, IDW Management.

Purging Equipment and Methods

Submersible Pump

A stainless steel submersible pump may be utilized for purging both shallow and deep wells prior to sampling the groundwater for semivolatile and non-volatile constituents, but are generally not preferred for VOCs unless there are no other options (e.g., well over 200 feet deep). For wells over 200 feet deep, the submersible pump is one of the few technologies available to feasibly accomplish purging under any yield conditions. For shallow wells with low yields, submersible pumps are generally inappropriate due to overpumpage of the wells (<1 gallon per minute), which causes increased aeration of the water within the well.

Steam clean or otherwise decontaminate the pump and discharge tubing prior to placing the pump in the well. The submersible pump shall be equipped with an anti-backflow check valve to limit the amount of water that will flow back down the drop pipe into the well. Place the pump in the middle of the saturated screened interval within the well and maintain it in that position during purging.

Bladder Pump

A stainless-steel bladder pump can be utilized for purging and sampling wells up to 200 feet in depth for volatile, semivolatile, and non-volatile constituents. Bladder pumps are most effective in low to moderate yield wells and are often the preferred method for low-flow sampling. When sampling for VOCs and/or SVOCs and PFAS, polyethylene bladders and PFAS-free O-rings and pump accessories should be used.

Either compressed dry nitrogen or compressed dry air, depending upon availability, can operate the bladder pump. The driving gas utilized must be dry to avoid damage to the bladder pump control box. Decontaminate the bladder pump prior to use.

Centrifugal, Peristaltic, or Diaphragm Pump

A centrifugal, peristaltic, or diaphragm pump may be utilized to purge a well if the water level is within 20 feet of ground surface. New or dedicated HDPE tubing is inserted into the midpoint of the saturated screened interval of the well. Water should be purged at a rate that satisfies low-flow requirements (i.e., does not cause drawdown). Centrifugal, peristaltic, or diaphragm pump are generally discouraged for VOCs sampling; however, follow methods allowed per the project-specific QAPP or State requirements.

Air Lift Pump

Airlift pumps are not appropriate for purging or sampling.

Bailer

Avoid using a bailer to purge a well because it can result in overdevelopment of the well and create excessive purge rates. If a bailer must be used, the bailer should either be dedicated or disposable. An HDPE bailer with polypropylene string mounted on a reel is recommended for lowering the bailer in and out of the well.

Lower the bailer below the water level of the well with as little disturbance of the water as possible to minimize aeration of the water in the well. One way to gauge the depth of water on the reel is to mark the depth to water on the bailer wire with a stainless steel clip. In this manner, less time is spent trying to identify the water level in the well.

8.2.7 Monitoring Well Sampling Methodologies

Sampling Light, Non-Aqueous Phase Liquids (LNAPL)

Collect LNAPL, if present, prior to any purging activities. The sampling device shall generally consist of a dedicated or disposable bailer equipped with a bottom-discharging device. Lower the bailer slowly until contact is made with the surface of the LNAPL, and to a depth less than that of the immiscible fluid/water interface depth as determined by measurement with the interface probe. Allow the bailer to fill with LNAPL and retrieve it.

When sampling LNAPLs, never drop bailers into a well and always remove them from the well in a manner that causes as little agitation of the sample as possible. For example, the bailer should not be removed in a jerky fashion or be allowed to continually bang against the well casing as it is raised. Teflon bailers should always be used when sampling LNAPL. The cable used to raise and lower the bailer shall be composed of an inert material (e.g., stainless steel) or coated with an inert material (e.g., Teflon).

Sampling Dense, Non-Aqueous Phase Liquids (DNAPL)

Collect DNAPL prior to any purging activities. The best method for collecting DNAPL is to use a double-check valve, stainless steel bailer, or a Kemmerer (discrete interval) sampler. The sample shall be collected by slow, controlled lowering of the bailer to the bottom of the well, activation of the closing device, and retrieval.

Groundwater Sampling Methodology

The well shall be sampled when groundwater within it is representative of aquifer conditions per the methods described in Section 8.2.5. Prior to sampling the flow-through cell shall be removed and the samples collected directly from the purge tubing. Flow rates shall not be adjusted once aquifer conditions are met. Additionally, a period of no more than 2 hours shall elapse between purging and sampling to prevent groundwater interaction with the casing and atmosphere. This may not be possible with a slowly recharging well. Measure and record the water level prior to sampling in order to monitor drawdown when using low-flow techniques and gauge well volumes removed and recharged when using non-low-flow techniques.

Sampling equipment (e.g., especially bailers) shall never be dropped into the well, as this could cause aeration of the water upon impact. Additionally, the sampling methodology utilized shall allow for the collection of a groundwater sample in as undisturbed a condition as possible, minimizing the potential for volatilization or aeration. This includes minimizing agitation and aeration during transfer to sample containers, minimizing exposure to sunlight, and immediately placing the sample on ice once collected.

Sampling equipment shall be constructed of inert material. Equipment with neoprene fittings, polyvinyl chloride (PVC) bailers, Tygon® tubing, silicon rubber bladders, neoprene impellers, polyethylene, and Viton® are not acceptable when sampling for organics and PFAS. If bailers are used, an inert cable/chain (e.g., polypropylene string or stainless steel wire or cable) shall be used to raise and lower the bailer. Dedicated equipment is highly recommended for all sampling programs.

Submersible Pumps

The submersible pump must be specifically designed for groundwater sampling (i.e., pump composed of stainless steel and HDPE, sample discharge lines composed of HDPE) and must have a controller mechanism allowing the required low-flow rate. Adjust the pump rate so that flow is continuous and does not pulsate to avoid aeration and agitation within the sample discharge lines. Run the pump for several minutes at the low-flow rate used for sampling to ensure that the groundwater in the lines was obtained at the low-flow rate.

Bladder Pumps

A gas-operated stainless steel bladder pump with adjustable flow control and equipped with a polyethylene bladder and HDPE tubing can be effectively utilized to collect a groundwater sample and is considered to be the best overall device for sampling inorganic and organic constituents. If only inorganics are being sampled, polyvinyl bladders and tubing may be used. Operate positive gas displacement bladder pumps in a continuous manner so that they minimize discharge pulsation that can aerate samples in the return tube or upon discharge.

When using a compressor, take several precautions. If the compressor is being powered by a gasoline generator, position the generator downwind of the well. Ground fault circuit interrupters (GFCIs) should always be used when using electric powered equipment. Do not connect the compression hose from the compressor to the pump controller until after the engine has been started.

When all precautions are completed and the compressor has been started, connect the compression hose to the pump controller. Slowly adjust the control knobs to discharge water in the shortest amount of time while maintaining a near constant flow. This does not mean that the

compressor must be set to discharge the water as hard as possible. The optimal setting is one that produces the largest volume of purge water per minute (not per purge cycle) while maintaining a near constant flow rate.

Prior to sampling, adjust the flow rate (purge rate) to yield 100 to 300 mL/minute. Avoid settings that produce pulsating streams of water instead of a steady stream if possible. Operate the pump at this low flow rate for several minutes to ensure that drawdown is not occurring. At no time shall the sample flow rate exceed the flow rate used while purging.

For those samples requiring filtration, it is recommended to use an in-line high capacity filter after all non-filtered samples have been collected.

Peristaltic Pumps:

A peristaltic pump is a type of positive displacement pump that moves water via the process of peristalsis. The pump uses a flexible hose fitted inside a circular pump casing. A rotor with cams compresses the flexible tube as the rotor turns, which forces the water to be pumped to move through the tube. In peristaltic pumps, no moving parts of the pump are in contact with the water being pumped. Displacement is determined by tube size, so delivery rate can only be changed during operation by varying pump speed. Peristaltic pumps are simple and quite inexpensive for the flow rates they provide.

There are several methods available for transferring the sample into the laboratory containers. The selected method may vary based on State requirements and should be documented in the project-specific QAPP. Samples typically can be collected directly from the discharge end of the HDPE tubing, after it has been disconnected from the flow through cell. For volatile analyses, the sampler should make sure that the pump is set such that a smooth laminar flow is achieved. In all cases, the project team should consult their local regulatory requirements and document the selected sample collection procedure in the project-specific QAPP.

Bailers

A single- or double-check valve HDPE or stainless steel bailer equipped with a bottom discharging device can be utilized to collect groundwater samples. Bailers have a number of disadvantages, however, including a tendency to alter the chemistry of groundwater samples due to degassing, volatilization, and aeration; the possibility of creating high groundwater entrance velocities; differences in operator techniques resulting in variable samples; and difficulty in determining where in the water column the sample was collected. Therefore, use bailers for groundwater sampling only when other types of sampling devices cannot be utilized for technical, regulatory, or logistical reasons.

Dedicated or disposable bailers should always be used in order to eliminate the need for decontamination and to limit the potential of cross-contamination. Each time the bailer is lowered to the water table, lower it in such a way as to minimize disturbance and aeration of the water column within the well.

8.2.8 Sample Handling and Preservation

Many of the chemical constituents and physiochemical parameters to be measured or evaluated during groundwater monitoring programs are chemically unstable and require preservation. The U.S. EPA document entitled, *Test Methods for Evaluating Solid Waste – Physical/Chemical Methods (SW-846)* (EPA 1997), includes a discussion of appropriate sample preservation procedures. In addition, SW-846 provides guidance on the types of sample containers to use for each constituent or common set of parameters. In general, check with specific laboratory or State requirements prior to obtaining field samples. In many cases, the laboratory will supply the necessary sample bottles and required preservatives. In some cases, the field sampling personnel may add preservatives in the field.

Improper sample handling may alter the analytical results of the sample. Therefore, transfer samples in the field from the sampling equipment directly into the container that has been prepared specifically for that analysis or set of compatible parameters as described in the project-specific QAPP. It is not an acceptable practice for samples to be composited in a common container in the field and then split in the laboratory, or poured first into a wide mouth container and then transferred into smaller containers.

Collect groundwater samples and place them in their proper containers in the order of decreasing volatility and increasing stability. A preferred collection order for some common groundwater parameters is:

1. VOCs and total organic halogens (TOX)
2. Dissolved gases, total organic carbon (TOC), total fuel hydrocarbons
3. Semivolatile organics, pesticides
4. Total metals, general minerals (unfiltered)
5. Dissolved metals, general minerals (filtered)
6. Phenols
7. Cyanide
8. Sulfate and chloride
9. Nitrate and ammonia
10. Radionuclides

When sampling for VOCs, collect water samples in vials or containers specifically designed to prevent loss of VOCs from the sample. The analytical laboratory performing the analysis shall provide these vials. Collect groundwater from the sampling device in vials by allowing the groundwater to slowly flow along the sides of the vial. Sampling equipment shall not touch the interior of the vial. Fill the vial above the top of the vial to form a positive meniscus with no overflow. No headspace shall be present in the sample container once the container has been capped. This can be checked by inverting the bottle once the sample is collected and tapping the side of the vial to dislodge air bubbles. Sometimes it is not possible to collect a sample without air bubbles, particularly water that has high concentrations of dissolved gasses. In these cases, the field sampling personnel shall document the occurrence in the field logbook and/or sampling worksheet at the time the sample was collected. Likewise, the analytical laboratory shall note in the laboratory analysis reports any headspace in the sample container(s) at the time of receipt by the laboratory.

Special Handling Considerations

In general, samples for organic analyses should not be filtered. However, high turbidity samples for PCB analysis may require filtering. Consult the project-specific QAPP for details on filtering requirements. Samples shall not be transferred from one container to another because this could cause aeration or a loss of organic material onto the walls of the container. TOX and TOC samples should be handled in the same manner as VOC samples.

When collecting total and dissolved metals samples, the samples should be collected sequentially. The total metals sample is collected from the pump unfiltered. The dissolved metals sample is collected after filtering with a 0.45-micron membrane in-line filter. Allow at least 500 mL of effluent to flow through the filter prior to sampling to ensure that the filter is thoroughly wetted and seated in the filter capsule. If required by the project-specific QAPP, include a filter blank for each lot of filters used and always record the lot number of the filters.

Because there is some evidence that PFOS may sorb onto glass fiber filters, it is preferred not to filter samples for PFAS analysis in the field or laboratory. Field filtration is generally prohibited unless specifically requested by a client. If filtering is required by client's and regulatory agency's request, it is recommended that the following be considered and discussed with the client and regulatory agency:

- Evaluate if filtered results are meaningful, and, therefore, if filtering in the field or laboratory is required;
- Consider use of low flow sampling in the field to reduce the need for sample filtering;
- Consider use of a centrifuge in the laboratory to reduce the need for sample filtering; and
- If filtering is required, determine the nature of the filters used and do not use glass fiber filters.

Field Sampling Preservation

Preserve samples immediately upon collection. Ideally, sampling containers will be pre-preserved with a known concentration and volume of preservative. Certain matrices that have alkaline pH (greater than 7) may require more preservative than is typically required. An early assessment of preservation techniques, such as the use of pH strips after initial preservation, may therefore be appropriate. Guidance for the preservation of environmental samples can be found in the U.S. EPA *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA 1982). Additional guidance can be found in other U.S. EPA documents (EPA 1992, 1996).

Field Sampling Log

A groundwater sampling log provided as Attachment 1 shall document the following:

- Identification of well;
- Well depth;
- Static water level depth and measurement technique;
- Presence of immiscible layers and detection method;
- Well yield;
- Purge volume and pumping rate;
- Time that the well was purged;
- Sample identification numbers;
- Well evacuation procedure/equipment;
- Sample withdrawal procedure/equipment;
- Date and time of collection;
- Types of sample containers used;
- Preservative(s) used;
- Parameters requested for analysis;
- Field analysis data;
- Field observations on sampling event;
- Name of sampler; and
- Weather conditions.

9.0 Quality Control and Assurance

9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific QAPP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.

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

10.0 Data and records management

10.1 Records will be maintained in accordance with SOP 3-03, Recordkeeping, Sample Labelling, and Chain-of-Custody. Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms may include:

- Sample Collection Records;
- Chain-of-custody forms; and
- Shipping labels.

10.2 Sample collection records (Attachment 1) will provide descriptive information for the purging process and the samples collected at each monitoring well.

10.3 The field logbook is kept as a general log of activities and should not be used in place of the sample collection record.

10.4 Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes.

10.5 Shipping labels are required is sample coolers are to be transported to a laboratory by a third party (courier service).

11.0 Attachments or References

Attachment 1 – Groundwater Sampling Collection Record

ASTM Standard D5088. 2020. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites.* ASTM International, West Conshohocken, PA. 2020. DOI: 10.1520/D5088-02R08. www.astm.org.

Environmental Protection Agency, United States (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater.* EPA-600/4-82-029. Cincinnati: EPA Office of Research and Development, Environmental Monitoring and Support Laboratory.

EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

EPA. 1996. *Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. Office of Solid Waste and Emergency Response. April.

EPA. 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Method (SW-846)*. 3rd ed., Final Update IIIA. Office of Solid Waste. Online updates at: http://www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

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

SOP 3-05, *IDW Management.*

SOP 3-06, *Equipment Decontamination*.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley, Environmental Scientist	Richard Purdy, Project Scientist	Rev 2 – Update & Review (June 2022)
Chris Williams Environmental Scientist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Attachment 1
Groundwater Sample Collection Record

Well ID:

Groundwater Sample Collection Record

Client: _____ Date: _____ Time: Start _____ am/pm
Project No: _____ Finish _____ am/pm
Site Location: _____
Weather Conds: _____ Collector(s): _____

1. **WATER LEVEL DATA: (measured from Top of Casing)**
   a. Total Well Length _____ c. Length of Water Column _____ (a-b)
   b. Water Table Depth _____ d. Calculated Well Volume (see back) _____
   Casing Diameter/Material _____

2. **WELL PURGEABLE DATA**
   a. Purge Method: _____
   b. Acceptance Criteria defined (see SAP or Work Plan)
   - Minimum Required Purge Volume (@ _____ well volumes) _____
   - Maximum Allowable Turbidity _____ NTUs
   - Stabilization of parameters _____ %
   c. Field Testing Equipment used: Make Model Serial Number

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

(continued on back)

   d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

   If no or N/A - Explain below.
   _____

3. **SAMPLE COLLECTION:** Method: _____

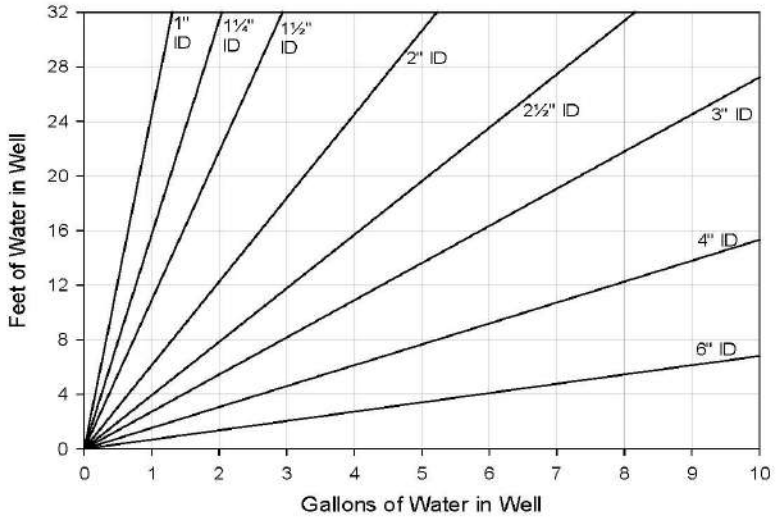
Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments _____

Signature _____ Date _____

Purge Volume Computation

Well ID:



Volume / Linear Ft. of Pipe		
ID (in)	**Gallon**	**Liter**
¼	0.0025	0.0097
3/8	0.0057	0.0217
½	0.0102	0.0386
¾	0.0229	0.0869
1	0.0408	0.1544
1¼	0.0637	0.2413
1½	0.0918	0.3475
2	0.1632	0.6178
2½	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (min)	Volume Removed (gal)	Temp. (°C)	pH s.u.	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (m)	Color/Odor/etc.

Signature _____ Date _____

Operation and Calibration of a Photoionization Detector

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-20

1.0 Purpose and Scope

1.1 Purpose and Applicability

1.1.1 This standard operating procedure (SOP) describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by Resolution Consultants personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

1.1.2 PIDs routinely used by field personnel include the Photovac Microtip, Thermoelectron 580EZ, MiniRAE 2000, and MiniRae 3000. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

1.2 Principle of Operation

1.2.1 The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having an energy from 9.5 electron volts (eV) to 11.7 eV.

1.2.2 The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in electron volts (eV) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.

1.2.3 Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive-biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

1.2.4 In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the

lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

1.3 Specifications

1.3.1 Refer to the manufacturer's instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 ppm isobutylene equivalent.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP). Work will also be conducted according to the Task Order (TO) Quality Assurance Project Plan (QAPP) and/or direction from the **Site Safety and Health Officer (SSHO)**.

2.2 Only PIDs stamped Division I Class I may be used in explosive atmospheres. Refer to the project APP/SSHP for instructions pertaining to instrument use in explosive atmospheres.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

4.2 Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.3 Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

4.4 The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 Training and Qualifications

5.1 Qualifications and Training

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

5.2 Responsibilities

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

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

5.2.3 The **Site Supervisor (SS)** is responsible for ensuring that all operation and calibration activities are conducted according to this procedure.

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

6.0 Equipment and Supplies

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated
- Regulator for calibration gas cylinder
- Approximately 6 inches of Teflon® tubing
- Tedlar bag (optional)
- Commercially-supplied zero grade air (optional)
- "Magic Marker" or “Sharpie” or other waterproof marker
- Battery charger
- Moisture traps
- Spare lamps
- Manufacturer’s instructions
- Field data sheets or logbook/pen

7.0 Procedure

7.1 Preliminary Steps

7.1.1 Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

7.2 Calibration

7.2.1 The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.

7.2.2 Calibrate the instrument according to the manufacturer’s instructions. Record the instrument model and identification number, the initial and adjusted meter readings, the calibration gas composition and concentration, and the date and the time in the field records.

7.2.3 If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Section 7.4).

7.3 Operation

7.3.1 Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.

7.3.2 Calibrate the instrument as described in Section 7.2, following the manufacturer’s instructions. Record the calibration information in the field records.

7.3.3 The instrument is now operational. Readings should be recorded in the field records.

7.3.4 When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a "bump" test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.

7.3.5 At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (Section 7.2) except that no adjustment will be made to the instrument. Record the information in the field records.

7.3.6 Recharge the battery after each use (Section 7.4).

7.3.7 When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

7.4 Routine Maintenance

7.4.1 Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

7.4.2 All routine maintenance should be performed in a non-hazardous environment.

7.5 Troubleshooting Tips

7.5.1 One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.

7.5.2 Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

7.5.3 A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

7.5.4 Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

7.5.5 A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

7.5.6 Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

7.5.7 When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or "flooded". Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

8.0 Quality Control and Assurance

8.1 The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific QAPP.

8.2 Calibration of the PID will be conducted at the frequency specified in the project plan. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling and will be checked at the end of the sampling day or whenever instrument operation is suspect. The PID will

sample a calibration gas of known concentration. The instrument must agree with the calibration gas within ±10%. If the instrument responds outside this tolerance, it must be recalibrated.

8.3 Checks of the instrument response (Section 7.5) should be conducted periodically and documented in the field records.

9.0 Records, Data Analysis, Calculations

Safety and survey monitoring with the PID will be documented in a bound field logbook, or on standardized forms, and retained in the project files. The following information is to be recorded:

- Project name and number;
- Instrument manufacturer, model, and identification number;
- Operator's signature;
- Date and time of operation;
- Calibration gas used;
- Calibration check at beginning and end of day (meter readings before adjustment);
- Span setting after calibration adjustment;
- Meter readings (monitoring data obtained);
- Instances of erratic or questionable meter readings and corrective actions taken; and
- Instrument checks and response verifications – e.g., battery check, magic marker response (Section 7.5) or similar test.

10.0 Attachments or References

United States Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). USEPA, Region 4, SESD, Enforcement and Investigations Branch, Athens, GA. November 2001.

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley, Environmental Scientist	Richard Purdy, Project Scientist	Rev 2 – Update & Review (June 2022)
David Doyle, PG Geologist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Operation and Calibration of the YSI Multi-Parameter Water Quality Monitor

Procedure 3-23

1.0 Purpose and Scope

The purpose of this standard operating procedure (SOP) is provide a framework for calibrating sondes used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen, conductivity/specific conductance, and oxidation reduction potential. Turbidity must not be measured using a portable water quality meter as EPA has not approved the collection of turbidity data from within a flow-through cell, and because the flow-through cell acts as a sediment trap. A separate meter which uses EPA Method 180.1 to measure turbidity must be used.

This SOP is written specifically for the YSI model 6-Series Sondes (which include the 600R, 600XL, 600XLM, 6820, 6920 and 6600 models), the YSI 556, the YSI Pro Plus and the YSI 650 MDS (Multi parameter Display System) handset/display/logger (note that the YSI Pro Plus uses a different handset dedicated to that model that operates in a similar fashion to the 650 MDS).

The general calibration processes discussed herein may be applicable to other manufactures sondes and displays/loggers. Consult the manufacturer's instruction manuals for specific procedures.

2.0 Health & Safety

2.1 All proper personal protection clothing and equipment is to be worn.

2.2 The standard solutions for calibrating conductivity contain iodine, potassium chloride and propanol. When using the standards, avoid inhalation, skin contact, eye contact or ingestion. If skin contact occurs, remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the Safety Data Sheets (SDS, formerly Material Safety Data Sheets or MSDSs) for prompt action, and in all cases seek medical attention immediately.

2.3 All standard solutions for calibrating pH contain the following chemicals:

2.3.1 pH 4 solutions: potassium hydrogen phthalate, formaldehyde, water

2.3.2 pH 7 solutions: sodium phosphate (dibasic), potassium phosphate (monobasic), water

2.3.4 pH 10 solutions: potassium borate (tetra), potassium carbonate, potassium hydroxide, sodium diethylenediamine tetraacetate, water

2.4 Avoid inhalation, skin contact, eye contact and ingestion. If skin contact occurs remove contaminated clothing immediately. Wash the affected areas thoroughly with large amounts of water. If inhalation, eye contact or ingestion occurs, consult the SDS for prompt action, and in all cases seek medical attention immediately.

2.5 Standard solutions for calibrating oxidation reduction potential (ORP) contain the following chemicals:

2.5.1 • potassium ferrocyanide trihydrate

2.5.2 • potassium ferrocyanide

2.5.3 • potassium chloride

2.6 Avoid inhalation, skin contact, eye contact, and ingestion. Avoid combining with the pH buffers and with any acids since cyanide may be released. Isolate the ORP solution. Do not dispose with other calibration solutions. If skin contact occurs, wash affected areas thoroughly with large amounts of

water. Consult the Health and Safety Plan, and the MSDSs therein.

2.7 Standard solutions for calibrating dissolved oxygen contain sodium sulfite and cobalt chloride. Avoid inhalation, skin contact, eye contact, and ingestion. If skin contact occurs, wash affected areas thoroughly with large amounts of water. Consult the Health and Safety Plan, and the SDSs therein.

3.0 Interferences

3.1 Each of the parameters measured with this procedure are subject to various interferences including cross-contamination, turbidity, aeration, and temperature fluctuations. Care must be taken to ensure that the instrument remains in a stable, controlled environment throughout the calibration and monitoring process; and that the conditions under which the samples are analyzed are the same as those under which calibration is conducted.

3.2 There must be no air bubbles lodged between the probe and probe guard.

3.3 All standards should be stored according to manufacturers' instructions.

4.0 Personnel Qualifications

Prior to the implementation of this procedure, the field sampler will be instructed by a person experienced with these procedures and will demonstrate to the field team leader the proper set-up, calibration, operation, and routine maintenance of the hand-held equipment, as well as an understanding of this procedure.

5.0 Equipment and Supplies

- Copy of the instrument manual and instrument specifications
- Copy of the project Health and Safety Plan and Sampling and Analysis Plan
- Thermometer (with NIST trace)
- pH Buffers of 4, 7, and 10
- Conductivity standards (concentration dependent upon expected field conditions)
- Zobell ORP calibration standard
- Zero Dissolved Oxygen Solution
- Deionized Ultra-Filtered (DIUF) Water
- YSI Sonde with attached pH, Conductivity, Dissolved Oxygen, and ORP probes with clear flow-through cell
- YSI handset (650 MDS Multiparameter Display System or Pro Plus handset)
- Sonde communications cable
- Ring stand or similar capable of holding the sonde and flow-through cell upright during low-flow groundwater sampling
- Kim-wipes

6.0 Procedure

All instrument probes must be calibrated before they are used to measure environmental samples, and the calibration should be checked at the end of the sampling day or if any anomalous readings are obtained. All results should be recorded on the YSI Water Quality Calibration Log Sheet, presented in Attachment 1.

6.1 Set-up

6.1.1 Before performing any calibration procedure, the sonde and display/logger must warm-up for at least 15 minutes.

6.1.2 During the warm-up period, set the sonde up on a ring stand.

6.1.3 Prior to calibration, all instrument probes on the sonde must be cleaned according to the manufacturer's instructions. Failure to perform this step can lead to erratic measurements. The probes

must also be cleaned by rinsing with DIUF water before and after immersing the probe in a calibration solution. Dab probes gently with Kimwipes after rinsing to remove excess water.

6.1.4 Check the calibration solutions for expiration dates and do not use expired standards.

6.1.5 The temperature of the standards should be as close to the temperature of the samples to be measured as is practical. This can be facilitated by storing the YSI in the same place as the calibration standards.

6.1.6 For each of the calibration solutions, provide enough volume so that the probes and the temperature sensor are sufficiently covered. Refer to the manual to find the location of each sensor and the recommended volume of calibration solution for each analysis.

6.1.7 Check the display/logger to determine the battery level in the display/logger to see if new batteries are required.

6.1.8 Set up instrument display so that the following items are displayed:

1. DO (%)
2. ORP (mV)
3. DO (mg/L)
4. Cond. (µs/cm)
5. Sp. Cond. (µs/cm)
6. pH (Standard Units [S.U.])
7. Temperature (°C)

6.2 Temperature

For instrument probes that rely on the temperature sensor (pH, dissolved oxygen/specific conductance, and ORP), the sonde temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). This accuracy check should be performed at least once a year, and the date and results of the check kept with the instrument. Temperature checks will be performed by the rental company for rented units. Prior to mobilizing, obtain the date and results of the check from the equipment room manager or check the outside of the case for rental units. If the check has not been performed within the past year, do not use the instrument. Document the date, results, and company that performed the check on the calibration log sheet or in the field logbook. In the event that verification is required, the procedure is presented below:

6.2.1 Fill a container with water and adjust the water temperature to a temperature below the temperature of the samples to be measured.

6.2.2 Place a thermometer that is traceable to the NIST into the water and wait for both temperature readings to stabilize.

6.2.3 Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer within the accuracy of the sensor (+/- 0.2°C). If the measurements do not agree, the instrument may not be working correctly and the manufacturer should be contacted.

6.2.4 Repeat the procedure using a container of water that has a temperature above that anticipated for the samples to be measured.

6.3 Dissolved Oxygen

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane should be inspected for any damage and electrolyte solution should be checked for air bubbles prior to calibration. If air bubbles, nicks, or damage are present, replace the membrane and electrolyte solution according to manufacturer's directions. After changing the membrane, it is preferable to wait 12 hours before use to allow the membrane to equilibrate. If this is not possible, note in the calibration log. The DO probe be must calibrated using the calibration cup provided with the

sonde. Calibration of the DO probe requires that the current barometric pressure be input first. The YSI 650 display/logger/handset has a barometer within the unit and automatically provides this during the calibration procedure. The barometric pressure for all other onsite units should be checked for agreement between units or checked using the onsite barometer. Other display/loggers do not supply the barometric pressure, and this must be obtained from an onsite barometer. Do not use barometric pressure obtained from meteorology reports as these are usually corrected to mean sea level.

Calibration is performed using 100% saturated air and checked immediately after with a solution with zero dissolved oxygen. The calibration check at the end of the day uses both 100% saturated air and the zero dissolved oxygen solution.

6.3.1 DO Calibration

6.3.1.1 Gently dry the temperature sensor and remove any water droplets from the DO probe's sensor membrane according to the manufacturer's instructions. Note that the evaporation of moisture on the temperature sensor or DO probe may influence the readings during calibration.

6.3.1.2 Place a small amount of water (<1/8") in the bottom of the calibration cup. Do not engage the threads of the calibration cap onto the sonde so that the DO probe is readily vented to the atmosphere. Take care to avoid touching the oxygen membrane with the calibration cups and flow-cell. The DO probe and thermistor must not be in contact with the water. Keep the instrument in run mode and wait approximately 15 minutes for the air in the calibration cup to become water-saturated (100% humidity at atmospheric pressure) and the temperature to equilibrate. Set up the remaining instruments and solutions in the meantime.

6.3.1.3 When the temperature has stabilized, go to Calibrate mode - **Calibrate DO%**

6.3.1.4 Record the temperature on the calibration log. Check the barometric pressure reading on the YSI versus the barometer and other YSIs present. Enter the barometric pressure if correction is necessary. Record the barometric pressure on the calibration log. (Note: barometric pressures presented in meteorological reports are generally corrected to mean sea level. These are not useful for calibrating the sonde, which requires uncorrected barometric pressure).

6.3.1.5 When the DO% and temperature readings have stabilized for at least one minute, press **enter**. Record the number that appears on the screen. Also record the DO mg/L value.

6.3.1.6 Check the oxygen solubility at that pressure and temperature on Table 1 and record under "Std temp/pressure correction." The instrument DO reading should be comparable with the value on the table (within $\pm$0.2 mg/L). If not, recalibrate, or replace DO membrane.

6.3.1.7 Immediately after calibration, perform a zero DO check. Make up the zero DO solution by filling the calibration cap with DI water, adding approximately 1 gram of sodium sulfite to supersaturate the solution. Add a few crystals of the cobalt chloride (purple salt) and stir. There should be solids on the bottom of the cap. Screw the cap tightly onto the YSI. Water should leak out to indicate that there is no air around the probes. An open disposable sample cup may be used in place of the calibration cap. However, if check criteria are not met, the procedure must be repeated using the calibration cap as described. If the DO is $\leq$ 0.50 mg/L and $\geq$ 0.00 mg/L, record the value on the calibration log. If the number stabilizes at a value > 0.50 mg/L, or reads negative, and an open cup was used, repeat the procedure with the closed calibration cup. If an open cup was not used, change the DO membrane and repeat the calibration and check.

6.3.1.8 Remove the cap, and rinse the probes well with DI water. Blot the probes dry, carefully avoiding the DO membrane.

6.3.2 End-of-Day DO Check

6.3.2.1 Perform the calibration check using the 100% humidity-saturated standard.

6.3.2.1.1 Follow Steps 6.3.1.1 and 6.3.1.2.

6.3.2.1.2 Allow the DO% and temperature readings to stabilized for at least one minute. Record the number that appears on the screen. Record also the DO mg/L value.

6.3.2.1.3 Check the oxygen solubility at that pressure and temperature on the attached table and record under "Std temp/pressure correction." The instrument DO reading should be comparable with the value on the table (within ±0.5 mg/L).

6.3.2.2 Perform the calibration check using the zero dissolved oxygen standard.

6.3.2.2.1 Follow Step 6.3.1.7.

6.3.2.2.2 The DO should be ≤ 0.5 mg/L, but not negative. If the DO is above criteria, make up a new zero DO standard and used a closed calibration cap if an open cup was used. Repeat the calibration check. If criteria are still not met, note the failed criteria and the readings that are impacted.

6.4 pH

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate standards that will bracket the expected values at the sampling locations. A two or three-point calibration can be performed. Typically, a three-point calibration using standards pH 4, pH 7, and pH 10 will be required. A calibration check is performed immediately after calibration using the pH 7 standard and a criterion of ±0.05 S.U. A calibration check is also performed at the end of the day using the pH 7 standard and a criteria of 0.3 S.U.

6.4.1 pH Calibration

6.4.1.1 Allow the buffered samples to equilibrate to the ambient temperature.

6.4.1.2 Remove the calibration cap and clean all of the probes on the sonde with DIUF water. Begin with pH 7. Wipe away any excess DUIF with Kimwipe and immerse all the probes except the DO probe in the 7 pH solution. Place enough pH 7 solution in the calibration cup to immerse the pH probe, reference junction, and thermistor. Return to **calibration mode**.

6.4.1.3 Scroll to pH on the calibration menu. Select **3-pt calibration**.

6.4.1.4 Enter the pH value that has been corrected for the solution's temperature (Table 3) when prompted for the first value, and press **enter**. The pH value adjusted for temperature is presented on the label of the buffer solution.

6.4.1.5 When value is stable for approximately 30 seconds, press **enter**, and record the number that appears on the screen. The display will indicate that the calibration has been accepted and will prompt the analyst to enter a second pH value.

6.4.1.6 Remove probes from solution. Rinse with DI water, wipe carefully, and put all probes in solution pH 4. Make sure that there is enough pH 4 buffer to immerse the pH probe, reference junction, and thermistor.

6.4.1.7 Enter the pH value that has been corrected for the solution's temperature when prompted for the second pH solution, press **enter**.

6.4.1.8 Allow at least one minute for temperature equilibration. When value is stable for at least 30 seconds, press **enter**, and record the number that appears on the screenRemove

probes from solution. Rinse with DI water, wipe carefully, and put all probes in solution pH 10. Make sure that there is enough pH 10 buffer to immerse the pH probe, reference junction, and thermistor.

6.4.1.9 Enter the pH value that has been corrected for the solution's temperature when prompted for the second pH solution, press **enter.**

6.4.1.10 Allow at least one minute for temperature equilibration. When value is stable for at least 30 seconds, press **enter**, and record the number that appears on the screen.

6.4.1.11 Next, press **enter** or **esc** to go to calibration menu.

6.4.1.12 Go to the run mode to perform a calibration check. Rinse the probe and immerse in pH 7 solution. The reading should be within ± 0.05 pH units of the pH value that has been adjusted for temperature. If not, recalibrate. Record the reading.

6.4.2 pH End-of-Day Check

6.4.2.1 Go to the run mode to perform a calibration check of the pH 7 solution.

6.4.2.2 Rinse the probe and immerse in pH 7 solution. Record the reading. The reading should be within ± 0.3 pH units of the pH value adjusted for temperature.

6.4.2.3 If the value is not within ± 0.3 pH units of the pH value adjusted for temperature, make a note next to the value on the YSI calibration sheet that the pH calibration check criterion was not met.

6.5 Conductivity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. Note that the pH buffers are highly conductive and will adversely impact calibration of conductivity. Thoroughly rinse the probes after performing pH calibration, and then pre-rinse the probe with the conductivity solution to be used.

EPA recommends that conductivity be calibrated using standards that bracket the range of concentrations expected. Conductivities in groundwater frequently range below 1,000 µS/cm; however YSI does not recommend calibration with standards below 1,000 µS/cm because interference with the instrument from outside electrical noise (RF) may be a factor. Since the calibration for conductivity is a 1-point calibration, and expected conductivities will generally be less than 1,000 µS/cm, calibrate with the 1,000 µS/cm standard, and perform a check with a lower conductivity solution to bracket the range (e.g. 100 µS/cm). If an alternative check concentration is required to bracket the expected concentrations of site samples, the alternative concentration will be specified in the site-specific QAPP.

6.5.1 **Conductivity Calibration**Allow the calibration standards to equilibrate to the ambient temperature.

6.5.1.2 Carefully rinse the probes in DIUF, then in the first conductivity solution to be used.

6.5.1.3 Immerse all probes except the DO probe completely in the conductivity calibration solution. Make sure that the thermistor is immersed, and the conductivity cell is immersed past the vent hole. Gently tap the side of the calibration cup to dislodge any air bubbles trapped inside the cell.

6.5.1.4 Scroll to **conductivity** on the screen, then select **specific conductance**. Select calibrate to **µS/cm**. Enter the conductivity value for the standard at 25ºC in µS/cm, which is the same as the specific conductance for the standard

6.5.1.5 Press **enter** and wait for the readings to stabilize. Press **enter**. Record the readings for

specific conductivity in the calibration log. Do not exit conductivity. **Note: Do not** indicate "accept" when the calibration indicates "Out of Range." Possible causes are incorrect entry, low level of solution, bubbles, or a bad probe. Attempt to recalibrate. If the problem persists, use another instrument. Return the instrument to the vendor or equipment room.

6.5.1.6 Perform a check of the calibration. Remove the probes from the solution. Rinse with the next conductivity solution. Immerse all probes except DO in the conductivity calibration solution. Allow the number to stabilize and record the values for specific conductivity in the calibration log. If the specific conductivity result is not within 5% of the value on the bottle, recalibrate. Remove probes from solution and rinse with DI water. Wipe dry.

6.5.2 **Conductivity End-of-Day Check**

6.5.2.1 Rinse the probes with the 1,000 µS/cm conductivity solution. Immerse all the probes except the DO probes in the conductivity calibration solution.

6.5.2.2 Once the numbers have stabilized, record the values for conductivity and specific conductivity in the calibration log. If the specific conductivity result is not within 5% of the value on the bottle, make a note next to the value on the YSI calibration sheet that the conductivity calibration check criterion was not met.

6.5.2.3 Remove the probes from solution and rinse with DI water. Wipe dry.

6.6 Oxidation Reduction Potential

ORP will be checked for accuracy and will only be field calibrated if the calibration check fails criteria.

6.6.1 **ORP Calibration**

Go to Calibration mode. Scroll to ORP and press **enter**. Enter ORP value (see Table 2 for temperature-corrected values) and press **enter**. When the number is stable for 20 seconds, press **enter** and record the number. If instrument says "Out of Range," do not accept the value: Use a different instrument. If a different instrument is not available, record the number and note that it is not within limits.

6.6.2 **ORP End-of-Day Check**

6.6.2.1 Switch to **run mode**.

6.6.2.2 Gently mix the ORP solution and open the packet. Put all but the DO probe in the ORP solution.

6.6.2.3 Allow to stabilize and record reading. If reading is not within ±10mV of the actual value corrected for temperature (see Table 2), make a note next to the value on the YSI calibration sheet that the ORP calibration check criterion was not met.

6.7 Close up Instrument (After calibration and prior to mobilizing to the sampling location)

6.7.1 Replace clean cap over probes.

6.7.2 Select MDS Menu mode. Reset the parameters to display the following field sampling parameters:

- Time (24hr) – correct as needed
- pH (S.U.)
- specific conductivity (µs/cm)
- ORP (mV)
- Temperature (°C)
- DO (mg/L)

6.7.3 Shut off computer, and return to case

7.0 Data and Records Management

7.1 Calibration log sheets shall be used to document the details of instrument calibration and calibration checks. An example of such a logsheet has been included herein as an attachment.

7.2 The site logbook should be used to note when instrument calibration and instrument calibration checks were conducted and should reference the calibration logsheets for details.

8.0 Quality Control and Assurance

8.1 Quality Control Criteria are summarized in Table 4.

8.2 If a parameter is measured that lies outside of the range bracketed by the instrument calibration standards, the instrument must either be recalibrated using standards that bracket the value or a calibration check using a standard that brackets the value must be performed. If the standards are not available to bracket the result, the data must be qualified. Readings measured by instruments that are subsequently found to be outside of criteria during the calibration check shall be documented on the sampling worksheet used to document the sample collection.

9.0 Pollution Prevention

9.1 Containers used to calibrate the probes shall be sized to use the smallest amount of standard possible but still accommodate all probes which need to be in the calibration solution such that they are adequately covered.

9.2 Conductivity and pH calibration solutions may be reused at the end of the day with caution if properly stored. However, a calibration check that reuses standard but does not meet criteria should be re-checked with fresh standard, and calibration should be conducted with fresh standards.

10.0 Waste Management

Unused calibration standards should be returned to the equipment room manager for proper disposal. Do not combine ORP standards with other standards since cyanide could be released.

11.0 References

U.S. Environmental Protection Agency Region I (U.S. EPA-NE). 2017. *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductivity, oxidation/reduction potential [ORP], and turbidity), Revision Number 3*. March 23.

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http://usenvironmental.com/download/quick-guides/YSI%20-%20Pro%20Plus%20Quick%20Start%20Guide.pdf

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Author	Reviewer	Revisions (Technical or Editorial)
Joel C. Meunier Field Team Leader	Constance Lapite Lead Chemist	Rev 0 – Initial Issue (October 2017)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 1 – Update & Review (July 2022)

TABLE 1: Oxygen Solubility at Indicated Pressure (Source: 2010 EPA SOP for Calibration of Field Instruments)

TABLE 2: ORP Check Standard Readings (Source: YSI 3682 Zobell Solution Instructions)

Temperature, °C	231 mV Standard Solution
-5	270.0
0	263.5
1	262.2
2	260.9
3	259.6
4	258.3
5	257.0
6	255.7
7	254.4
8	253.1
9	251.8
10	250.5
11	249.2
12	247.99
13	246.6
14	245.3
15	244.0
16	242.7
17	242.4
18	240.1
19	238.8
20	237.5
21	236.2
22	234.9
23	233.6
24	232.3
25	**231.0**
30	224.5

TABLE 3: pH Values Adjusted for Temperature For Use Only with
pH4 -- Fisher #SB-101-500
pH7 – Fisher #SB-107-500
pH10 – Fisher #SB-115-500

(Source: Fisher Scientific Standard Labels)

Temperature (° C)	pH 4 (S.U.)	pH 7 (S.U.)	pH 10 (S.U.)
0	4.01	7.13	10.34
5	3.99	7.10	10.26
10	4.00	7.07	10.19
15	3.99	7.05	10.12
20	4.00	7.02	10.06
25	4.00	7.00	10.00
30	4.01	6.99	9.94
35	4.02	6.98	9.90

Table 4: Quality Control Criteria

	Beginning of Activities				End-of-Day			
	Calibration		Calibration Check		Calibration Check			
Parameter	**Standard**	**Criteria**	**Standard**	**Criteria**	**1st Standard**	**Criteria**	**2nd Standard**	**Criteria**
Temperature	NIST Thermometer	± 0.2 °C	NA	NA	NA	NA	NA	NA
Dissolved Oxygen	100 % Saturated	± 0.2 mg/L	0.0 mg/L	≤ 0.5 mg/L, but ≥ 0.0	100% Sat	± 0.5 mg/L	0.0 mg/L	≤ 0.5 mg/L, but ≥ 0.0
pH	Bracket anticipated (pH 7, 4, 10)	NA	pH 7 Temp. adjusted value	± 0.05 pH	pH 7 Temp. adjusted value	± 0.3 pH	NA	NA
Specific Conductance	Bracket anticipated (≤ 1,000 µS/cm)	NA	Bracket anticipated	± 5%	Same as for calibration	± 5%	NA	NA
Oxidation-Reduction Potential	Only if check fails: 231 mV Zobell solution	NA	231 mV Zobell solution	± 10mV	231 mV Zobell solution	± 10mV	NA	NA

Attachment: YSI Water Quality Calibration Log

Water Quality Parameter Testing

NOTE: If sampling for per- and polyfluoroalkyl substances (PFAS), please reference the Resolution Consultants PFAS SOP (RC 3-41) and the project-specific SAP for PFAS-related sampling methods and requirements.

Procedure 3-24

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) for use water quality parameter testing for groundwater or surface water sampling. This SOP describes the equipment, field procedures, materials, and documentation procedures necessary to complete this task. Specific information regarding coring locations can be found in the associated Quality Assurance Project Plan (QAPP).

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

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific QAPP.

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

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling the first surface water sampling location. All **field sampling personnel** responsible for sampling activities must review the project-specific Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP), paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific APP/SSHP. Suggested minimum protection during well sampling activities includes protective eyewear, powder-free nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on anticipated contaminants and their concentrations.

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

2.4 The health and safety considerations for the work associated with surface water sampling include:

- Proper selection of personal protective equipment for work around water bodies (e.g., personal flotation devices [PFDs]), as specified in the project-specific APP/SSHP.
- Appropriate health and safety protocols for working in a boat (if applicable), as specified in the project-specific APP/SSHP.
- Proper lifting techniques when retrieving surface water samplers, large muscles of the legs should be used, not the back.
- Stay clear of all moving equipment and avoid wearing loose fitting clothing.
- To avoid slip/trip/fall hazards as a result of working on wet surfaces, wear work boots/work boot covers with textured soles.
- To avoid heat/cold stress as a result of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended), and in cases of extreme cold, wear fitted insulated clothing

3.0 Terms and Definitions

3.1 **Barometric Pressure (BP)**: The density of the atmosphere, which varies according to altitude and weather conditions.

3.2 **Conductivity/Specific Conductance**: A measure of the ability of water to pass electrical current, which increases with the amount of dissolved ionic substances (i.e., salts). Conductivity is inversely related to the resistance of a solution and is measured in units of mhos per centimeter (mhos/cm) (inverse ohms/cm, Siemens/cm). The conductivity of water increases with increasing temperature. Specific Conductance is corrected for 25 degrees Celsius (°C); for this reason, it is best to record Specific Conductance. If Conductivity is recorded, the temperature of the sample MUST recorded.

3.3 **Dissolved Oxygen (DO):** The amount of oxygen present in water and available for respiration. DO is typically measured in milligrams per liter (mg/L). Oxygen is less soluble in warm and salty waters, so the instrument compensates the apparent percent saturation for changes in temperature and conductivity. Most probes measure the current resulting from the electrochemical reduction of oxygen (at a gold cathode) diffusing through a selective membrane. Because oxygen is being removed from the sample to perform the measurement, sample flow is required to prevent false low readings due to depletion of oxygen in the solution in front of the probe. Optical DO probes do not remove oxygen from the sample and are less affected by salts. The common range of DO in groundwater is 0.0 to 3.0 mg/L. Measurements outside of this range suggest that the meter may not be operating correctly.

3.4 **Nephelometric Turbidity Unit (NTU):** The measurement of light passing through a sample based on the scattering of light caused by suspended particles.

3.5 **Potential of Hydrogen (pH):** A measure of acidity and alkalinity of a solution using a logarithmic scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers are increasingly basic.

3.6 **Oxidation-Reduction Potential (ORP):** Also known as redox or eH, ORP is a measurement of the potential for a reaction to occur, which generally indicates the oxygen status of a sample. The probe consists of a platinum electrode, the potential of which is measured with respect to a reference electrode that rapidly equilibrates with the potential of the sample solution. A positive value indicates that oxygen is present. A negative value indicates an anaerobic environment or reducing condition. For this reason, negative ORP readings should be associated with DO readings of less than 0.5 mg/l; with negative ORP readings the water may exhibit a sulfur odor or gray color. Positive ORP readings should be associated with DO readings greater than 0.5 mg/L and lack of sulfur odors. Because of the complex relationship between ORP and temperature, no compensation is attempted; it is thus best to report both the ORP and temperature of a water sample.

3.7 **Total Dissolved Solids:** A measure of the quantity of materials in water that are either dissolved or too small to be filtered.

3.8 **Turbidity:** Measure of the clarity of water in NTUs. Potable water typically has NTU values between 0.0 and 0.3 NTUs, depending on the state or regulatory program.

4.0 Interferences

4.1 During field testing, water quality data that is documented from field testing equipment may be influenced by certain outside factors that are unrelated to the actual site water quality. Such parameters and equipment include the following:

4.2 **pH Meters:** Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use isopropyl alcohol very sparingly so that the electronic surface is not damaged.

Poorly buffered solutions with low specific conductance (less than 200 microsiemens per centimeter) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

4.3 **Dissolved Oxygen**: Dissolved gases (e.g., hydrogen sulfide, halogens, sulfur dioxide) are a factor with the performance of DO probes. The effect is less pronounced on optical DO meters. Meter type and potential interferences should be considered based on potential sulfate/sulfide or nitrate/nitrite reducing environments.

Exposure of the sample to the atmosphere will cause elevated DO measurements.

4.4 **Turbidity Meter**: If the weather is warm and humidity is high, condensation may collect on the cuvet.

To avoid this, allow the sample to warm and dry the outside of the cuvet before making the measurement. One method used to accomplish this is to place the cuvet against one's body (armpits work well).

4.5 **Temperature**: Sample temperature will change rapidly when there are significant differences between the sample and ambient air.

5.0 Training and Qualifications

5.1 Qualifications and Training

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

5.2 **Responsibilities**

5.2.1 The TO Manager is responsible for ensuring that field activities comply with this procedure. The TO Manager or designee shall review all surface water sampling forms on a minimum monthly basis. The TO Manager is responsible for ensuring that all field sampling personnel involved in water quality parameter testing shall have the appropriate education, experience, and training to perform their assigned tasks.

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

5.2.3 The Field Manager is responsible for ensuring that all field sampling personnel follow these procedures.

5.2.4 Field sampling personnel are responsible for the implementation of this procedure. Minimum qualifications for field sampling personnel require that one individual on the field team shall have a minimum of 6 months of experience with water quality parameter testing.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the surface water sampling procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected during sampling. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the Program Quality Manager and then documented in the field logbook and associated report or equivalent document.

6.0 Equipment and Supplies

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

- QAPP;
- Maps/Plot plan;
- Logbook;
- Site description forms;
- Pump (Peristaltic, Portable Bladder, Submersible);
- Polyethylene bladders (for portable bladder pumps);
- Bladder pump controller (for portable bladder pumps);
- Air compressor (for portable bladder pumps);
- Nitrogen cylinders (for portable bladder pumps);
- 12-volt power source;
- Polyethylene inlet and discharge tubing;
- Silicone tubing appropriate for peristaltic pump head;
- HDPE bailer appropriately sized for well;
- Disposable bailer string (polypropylene);
- Individual or multi-parameter water quality meter(s) with flow-through cell to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and/or turbidity;
- Turbidity meter;
- Teflon-free water level meter; and
- Oil/water interface probe.

6.2 **Equipment/Apparatus**: Field personnel shall consult the site QAPP to review the equipment requirements for the sampling procedures to be followed during the sampling effort. The specific apparatus and materials required will depend on the water quality parameters being monitored. **Table 1** shows the common equipment used in water quality parameter testing.

Table 1
Water Quality Parameter Testing — Common Equipment

Water quality Parameter Instrument	Calibration Standards Required	Other Equipment
pH Meter	Yes - 2- or 3-Point Standards depending on groundwater range. Calibration must cover the range to be measured. If samples are above or below typical buffer standards (4, 7 and 10), special order buffers that fall outside groundwater pH range.	Container or flow thru cell for holding sample
Specific Conductance	Yes	Container or flow thru cell for holding sample
ORP Meter	Yes	Container or flow thru cell for holding sample
Turbidity Meter	Yes	Container or flow thru cell for holding sample
DO	No	Container or flow thru cell for holding sample
Thermometer	No	Container or flow thru cell for holding sample
Flow Rate	No	Container or flow thru cell for holding sample

Notes:
ORP = Oxidation Reduction Potential
DO = Dissolved Oxygen

7.0 Calibration or Standardization

7.1 Instrument or Method Calibration

Most monitoring instruments require calibration before use, and this calibration must be conducted in the field under the ambient climatic conditions that will be present during field sampling. Calibration of monitoring instruments shall be performed in accordance with the manufacturer's specifications and recorded in the provided form in Attachment 1. Site-specific instrument calibration requirements should be specified in the QAPP. The following minimum calibration requirements apply to the various types of meters used to gather water quality measurements.

Initial Calibration (IC): Before use, the instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., DO saturation) or a known value of a calibration standard. An IC is performed in preparation for the first use of an instrument or if a calibration verification does not meet acceptance criteria.

Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following IC by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

Continuing Calibration Verification (CCV): After use, the instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter.

7.2 Calibration Checks

Calibration checks are conducted by measuring a known standard. They must be completed after calibration and should be performed at least one other time (i.e., after lunch) and anytime suspect measurements are encountered. Table 2 provides general acceptance ranges to be used during calibration checks. If a meter is found to be outside of the acceptance range, the meter must be recalibrated. If the meter remains out of range, the project manager and/or the supplier of the meter should be contacted to determine alternative measures.

Table 2
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:
Mg/L = milligrams per liter
Mv = millivolts
NTU = nephelometric turbidity units

7.3 Possible and Suspected Ranges

The concentration for each parameter range should be known so that concentrations outside of the range can be noted. Table 3 presents the maximum range of the parameter in groundwater. The table also presents the suspected range. Measurements outside of the maximum/minimum range should be considered in error and the measurement method should be checked. Concentrations outside the normal range should be treated as suspect but may be the result of contaminant impact. For example, a pH of 2.0 would be out of the normally suspected range for groundwater but not at a site impacted with an acid.

Table 3
Minimum and Maximum Result Ranges

Parameter	Units	PossibleMin	Possible Max	Normal Min	Normal Max	Notes
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	The colder the sample, the higher the DO reading. DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
pH	SU	0	14	5	9	pH values exceeding 10 could indicate grout contamination

Parameter	Units	Possible Min	Possible Max	Normal Min	Normal Max	Notes
ORP	mv					DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
Specific Conductance	µS/cm			varies	varies	
Temperature	°C	0	100	5	30	
Turbidity	NTU	0	Greater than 1,000	0	Greater than 1,000	50 NTU or greater suggests cloudiness.

Notes:
mg/L = milligrams per liter
°C = degrees Celsius
DO = dissolved oxygen
SU = standard units
ORP = oxidation reduction potential
Mv = millivolts
mS/cm =micro Siemens per cm
NTU = nephelometric turbidity units

7.4 Field Instruments and Calibration Criteria

The calibration acceptance criteria for each instrument are summarized in Table 4 along with special considerations related to each field instrument.

Table 4
Calibration check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature.
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:
Mg/L = milligrams per liter
mv = millivolts
NTU = nephelometric turbidity units

7.4.1 pH Meters

For the most accurate of pH measurements, pH meters should receive a three-point calibration. However, if a two-point calibration will bracket the groundwater pH of the site, a two-point calibration is acceptable. Three-point calibrations typically include calibrating to solutions of pH 7.00, 4.00, and 10.00. If groundwater pH is outside the calibration range of the solution standards, special buffers must be ordered to bracket the pH. Some meters will report the slope of the calibration and this may be used in checking the meter calibration (refer to the meter's manual). When performing an ICV, the result must be within +/- 0.2 pH units of the stated buffer value.

pH meters should be calibrated across the range of values to be measured. The maximum and minimum calibration solutions shall be outside the range of anticipated values. For example, if the expected range is between 7.50 and 9.00, the 7.00 and the 10.00 standard should be used for calibration. Perform the IC using at least two buffers, and always use the pH 7.00 buffer first. A reading that is above the maximum (or below the minimum) calibration standard is an estimate only and is not valid. This condition requires obtaining a new standard that is above (or below) the reported value, depending on the measurement.

A percent slope of less than 90 percent indicates a bad electrode that must be changed or repaired. If percent slope cannot be determined, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

7.4.2 Specific Conductivity Meters

For IC, when the sample measurements are expected to be 00 microsiemens per centimeter (µS/cm) or greater, use two standard potassium chloride (KCl) solutions that bracket the range of expected sample conductivities. Calibrate the instrument with the first standard. Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values.

If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values.

When the sample measurements are expected to be less than 100 µS/cm, a lower bracket is not required, but one standard (KCl) solution that is within the range of expected measurements must be used for the IC and the ICV.

Accept the calibration if the meter reads within +/- 5 percent of the value of any calibration standard used to verify the calibration.

Most field instruments read conductivity directly. Record all readings and calculations in the calibration records.

For CCV, check the meter with at least one KCl standard with a specific conductance in the range of conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5 percent of the standard value.

If new environmental samples are encountered outside the range of the IC, verify the instrument calibration with two standards bracketing the range of sample values. If these calibration verifications fail, recalibrate the instrument.

7.5 Dissolved Oxygen Meters

Before calibrating, check the probe membrane for bubbles, tears, or wrinkles. These conditions require replacement of the membrane in accordance with the manufacturer's directions.

If the meter provides readings that are off-scale, will not calibrate, or drift, check the leads, contacts, etc., for corrosion and/or short circuits. These conditions require replacement maintenance in accordance with the manufacturer's directions.

Most DO meters must be calibrated based on an environment of 100 percent humidity and a known elevation and barometric pressure (BP).

For 100 percent humidity, place the probe in the calibration container with a moist towel and allow the probe to remain, undisturbed, for 10 to 20 minutes.

The IC is an air calibration at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument. Allow an appropriate warm up period before IC. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into

the chamber (this ensures 100 percent humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine from the DO versus temperature table (see Attachment 2) what DO should measure. The acceptance criterion for DO ICV is +/- 0.3 mg/L.

Use the same procedure as above for CCV.

7.6 ORP Meters

Verify electrode response before use in the field.

Equilibrate the standard solution to the temperature of the sample. The standard solution is based on a 25°C temperature; however, the calibration solution standard's value will require adjustment based on the temperature.

Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell).

Turn the meter on, placing the function switch in the millivolt (mv) mode.

Let the electrode equilibrate and record the reading to the nearest millivolt. The reading must be within ±10 mv from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.

Record the mv reading and temperature in the field notebook or in form. Rinse the electrode with distilled water and proceed with the sample measurement, unless using a flow cell. If a flow cell is used, rinse between sample locations.

7.7 Turbidity Meters

Perform an initial calibration using at least two primary standards.

If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard.

Perform an ICV by reading at least one primary standard as a sample. The acceptance criterion for the ICV depends on the range of turbidity of the standard value:

1. Standard Value = 0.1 to 10 NTU: the response must be within 10 percent of the standard;
2. Standard Value = 11 to 40 NTU: the response must be within 8 percent of the standard;
3. Standard Value = 41 to 100 NTU: the response must be within 6.5 percent of the standard; and
4. Standard Value greater than 100 NTU: the response must be within 5 percent of the standard.

Determining the Values of Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards may be used for CCVs.

To initially determine the value of a secondary standard, assign the value that is determined immediately after an ICV or verification with primary standards. This is done by reading the secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and +/- 10 percent of the assigned standard value. If the +/- 10 percent criterion is not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

CCV: Perform a CCV using at least one primary or secondary standard. The calibration acceptance criteria are the same as those for an ICV.

8.0 Procedures

8.1 Purpose

The procedures will vary depending on parameters being measured, method of sampling, and the method of measurement used. The information here is a general guidance and the site-specific documents and manufacturer manuals supersede these procedures.

8.2 Cautions

Improper use of water quality testing equipment could result in equipment damage or compromised sampling results. Personnel should be trained to operate the test equipment being used for a field operation and should be trained in the proper techniques for collecting and logging water quality parameters. Personnel should also be able to recognize problems with test equipment and have someone available for basic troubleshooting and repair.

8.3 Direct Measurements

Direct measurements with meters are the most common methods and can be accomplished by placing a sample in a container with the probe or by allowing the water to flow past the probe in a flow cell. The use of a flow-through cell improves measurement quality by allowing the constant flow of water over the probes and reduces interaction of the sample with the atmosphere. Sample cups should be avoided. The quantity of samples, timing, and methodology should be described in the project QAPP.

Following calibration of required probes, connect the bottom flow-cell port to the discharge line of the pump. Connect the top port to a discharge line directed to a bucket to collect the purge water. Allow the flow cell to completely fill. As the water flows over the probe, record the measurements. Continue to record the measurements at regular intervals, as specified in the QAPP.

When the ambient air temperatures are much higher or lower than the temperature of the water sample, it is best to keep the length of tubing between the wellhead and the flow cell as short as possible to prevent heating or cooling of the water. Tubing and flow-through cell should not be exposed to direct sunlight, particularly in the summer, if at all possible, to avoid heating of water samples.

8.4 Data Acquisitions, Calculations, and Data Reduction

8.4.1 Specific Conductivity Correction Factions

If the meter does not automatically correct for temperature (i.e., read Specific Conductivity) record Conductivity and adjust for temperature upon returning to the office. The following equation can be used to convert Conductivity to Specific Conductivity.

$$K = \frac{(Km)(C))}{1 + 0.0191(\mathrm{T} - 25)}$$

Where:

K = Conductivity in µmhos/cm at 25°C

Km = Measured conductivity in µmhos/cm at T degrees Celsius

C = Cell constant

T = Measured temperature of the sample in degrees Celsius;

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(Km)}{1 + 0.0191(\mathrm{T} - 25)}$$

8.4.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)}\ x\ 100$$

8.4.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG\ x\ 25.4$$

8.4.4 True Barometric Pressure

For Converting BP obtained from a public domain source that is expressed in BP at sea level to BP at the subject site.

$$TrueBP = (BP) - \frac{(2.5\ x\ [Local\ Altitude])}{100}$$

Where: BP is in mmHG and Local Altitude is in feet

Example: BP at Site A is 30.49 inHG and elevation is 544 feet, calculate TrueBP

Convert inHG to mmgHG:

mmHG = 30.49 inHG x 25.4 = 774.4 mmHG

Calculate TrueBP:

TrueBP = (774.4 mmHG) – [2.5*(544/100)] = 774.4-13.6 = 760.mmHG.

9.0 Quality Control and Assurance

9.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific QAPP. The goal of the QA program should be to ensure precision, accuracy, representativeness, completeness, and comparability in the project sampling program.

9.2 Quality Control (QC) requirements for sample collection are dependent on project-specific sampling objectives. The project-specific QAPP will provide requirements for sample preservation, holding times, container types, as well as various QC samples such as trip blanks, field blanks, equipment blanks, and field duplicates.

10.0 Data and Records Management

10.1 Field notes will be kept during sampling activities in accordance with *SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody*. During the completion of sampling activities, fill out the sample logbook and transmit forms to the TO Manager for storage in project files.

10.2 Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

11.0 Attachments or References

Attachment 1: Example Field Instrument Calibration Form
Attachment 2: Solubility of Oxygen at Given Temperatures
Attachment 3: Example Field Data Form

Author	Reviewer	Revisions (Technical or Editorial)
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue
Amanda Martin Engineer	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist	Rev 2 – Update & Review (June 2022)
Chris Williams Environmental Scientist	Ric Federico, CMQ/OE Sr. Technical Specialist	Rev 3 – Update & Review (September 2022)

Attachment 1
Example Field Instrument Calibration Form

EQUIPMENT CALIBRATION DAILY LOG	
Date:	Project Name:
Project Number:	Recorded By:

PID	Model:		Bulb:		Morning Calibration	Evening Check	Additional Calib./Check (if necessary)
	Equipment ID #:						
	Parameter	Standard	Exp. Date	Lot #	Time:	Time:	Time:
First Point Calibration	Vapor conc. (ppm)	0.0 (ambient air)	NA	NA	Initials:	Value:	
Second Point Calibration	Vapor conc. (ppm)	100 (isobutylene)			Initials:	Value:	

COMB. GAS/O_2 METER	Model:		Bulb:		Morning Calibration	Evening Check	Additional Calib./Check (if necessary)
	Equipment ID #:						
	Parameter	Standard	Exp. Date	Lot #	Time:	Time:	Time:
First Point Calibration	O_2 (%)	20.9%			Initials:	Value:	
	H_2S (%)	25 ppm			Initials:	Value:	
	CO (%)	50 ppm			Initials:	Value:	
	% LEL Pentane	50% (methane)			Initials:	Value:	

WATER QUALITY METER	Model:				Morning Calibration/Check	Evening Check (one point only)	Additional Calib./Check (if necessary)
	Equipment ID #:						
	Parameter	Standard	Exp. Date	Lot #	Time:	Time:	Time:
First Point Calibration (Auto)	pH	4.00			Initials:	Value:	
	Conductivity (mS/cm)	4.49				Value:	
	Turbidity (NTU)	0				Value:	
	DO (mg/L)	8.9-9.1 (ambient air)	NA	NA		Value:	
Second Point Calibration	pH	7.0			Initials:	Value:	
	Conductivity (mS/cm)					Value:	
	Turbidity (NTU)	100				Value:	
Third Point Calibration	pH	10.0			Value:	Value:	
	Conductivity (mS/cm)				Value:	Value:	
	Turbidity (NTU)				Value:	Value:	

Additional Remarks:

Attachment 2
Solubility of Oxygen at Given Temperatures

Field Measurement of Dissolved Oxygen

Solubility of Oxygen in Water at Atmospheric Pressure			
Temperature	**Oxygen Solubility**	**Temperature**	**Oxygen Solubility**
°C	**mg/L**	**°C**	**mg/L**
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

Notes:
The table provides three decimals to aid interpolation
Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water saturated
°C = degrees Celsius
mg/L = milligrams per liter

Attachment 3
Example Field Data Form

AECOM

Monitoring Well Sample Collection Form

Page 1 of ____

LOCATION	Site:	LocID:	Date:
	Project Name:	Project Number:	Recorded By: Checked By:
EQUIPMENT	Sampling Equipment - Pump:	Controller:	Compressor:
	Water Level Indicator Type/ID#:	Water Quality Meter Type: Sonde ID:	Handset ID:
	PID Type/ID#:	Equipment Decon:	
WELL & SAMPLING INFO	Description:	Screen Interval (BTOC):	Initial Depth to Water (BTOC): / Ambient PID (ppm):
	Historic Pump Settings:		Pump Inlet Depth (BTOC): / Well Head PID (ppm):
	Condition of Well/Comments:		
	NOTE:		

Date (MM/DD/YY)	Time (24 hr)	Depth to Water (BTOC)	Volume Removed (gallons)	Pumping Rate (Lpm)	Temp (°C)	Specific Conductivity (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Pump Refill/ Discharge (seconds)	Pump Pressure (PSI)	Comment

Pumping Rate: ≤ 0.5L/min; **Measurements**: every 3 - 5 minutes; **Stabilization is defined as the following for three consecutive readings**: ± 3% Temp, ± 3% Conductivity; + 10% DO; ± 0.1 pH; ± 10mV ORP; 10% Turb

Sample ID Numbers and Sample Time	Container Count, Volume & Type	Preservative	Parameter(s)

Per- and Polyfluoroalkyl Substance Field Sampling Protocol

Procedure 3-41

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) presents sampling practices to be used in the field at per- and polyfluoroalkyl substances (PFAS)-impacted sites. The protocol is intended to supplement existing Resolution Consultants SOPs for field sampling and provide guidance in the collection of PFAS samples across various environmental media as listed in **Section 7.8** without introducing cross-contaminants from personnel protective equipment (PPE), sampling equipment, or other field supplies used during sampling. This procedure applies to all qualified personnel and subcontractors who collect or otherwise handle field samples for PFAS analysis. This SOP should be reviewed by **Contract Task Order (CTO) Managers**, **Field Personnel**, and **Project Chemists** on projects where samples will be analyzed for PFAS prior to implementation of field activities, including during the planning stage, and prior to submitting a Sampling and Analysis Plan (SAP).

1.2 This procedure is the program-approved professional guidance for work performed by Resolution Consultants under the client contract.

1.3 Use of this SOP does not replace the need for pre-field mobilization planning and discussion. The **CTO Manager** and **Field Team Leader (FTL)** should use this SOP in the development of planning documents and emphasize the procedures during kick-off meetings prior to the start of field mobilization.

2.0 Safety

2.1 It is the responsibility of the **CTO Manager**, **FTL**, **Site Safety and Health Officer (SSHO)**, and **Field Personnel** to be aware of the physical, chemical, and biological hazards associated with the site. The mitigation of potential hazards will be documented in the project Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP), which will include Task Hazard Assessments (THAs) and will be incorporated into daily tailgate safety meetings. The ubiquitous nature of PFAS presents several constraints to specific types of PPE which are commonly used to mitigate health and safety concerns. As a result, certain commonly used articles of PPE should be avoided or assessed prior to use on-site. Refer to the attached **Table 1** for a summary of these items.

2.2 Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be conducted while wearing appropriate clothing that will not pose a risk for cross-contamination (see **Section 7.1** below on Field Clothing and PPE). Sampling programs that include PFAS should take these factors into consideration during the planning phase and be aware of field conditions prior to mobilization.

2.3 In addition to water resistant and waterproof clothing, chemically-treated clothing for insect resistance and UV protection should also be avoided for PFAS sampling programs unless the items have been pre-screened. This particularly poses a health and safety hazard given the prevalence of biological hazards (e.g., ticks) and risks to prolonged sun exposure. Field personnel should use tick gaiters or tuck pant legs into socks and/or boots and use duct tape and use pre-screened insect repellents to reduce the risk of being bitten by ticks. Furthermore, light-colored shirts and pants should be worn to easily identify ticks during field activities. Light-colored clothing, long sleeves, and wide-brimmed hats should also be worn to prevent sunburn, as many sunscreen products contain PFAS and should be avoided during PFAS sampling. Additional details pertaining to personal care products (e.g., sunscreen, moisturizer, make-up) are available in **Section 9.0** below.

2.4 When working on or near water, waders and personal flotation devices (PFDs) may be required. Ensure that materials that contact the media to be sampled do not have water-resistant coatings which contain PFAS. Waders made of PVC or neoprene are permissible. PFDs made of polyethylene foam and nylon shell fabric are permissible. Every effort should be made to keep samples away from the protective coatings on PFDs, as they may contain PFAS.

3.0 Terms and Definitions

3.1 Aqueous film-forming foam (AFFF): Class B firefighting foams stored and used for fire suppression, fire training, and flammable vapor suppression. Foams manufactured today may be fluorinated (i.e., contain PFAS) or fluorine free (i.e., do not contain PFAS).

3.2 Per- and polyfluoroalkyl substances (PFAS): A family of complex synthetic chemicals containing fluorine and carbon atoms, which make them extremely persistent in the environment. PFAS were developed to make various products including (but not limited to) non-stick cookware, stain and water repellents, cleaning products, food packaging, paints, and AFFF.

3.3 Perfluoroalkyl substances: A broad term for a class of synthetic fluorinated organic chemicals in which all carbon molecules are fully fluorinated.

3.4 Polyfluoroalkyl substances: A class of synthetic fluorinated organic chemicals in which some carbon molecules are not fully fluorinated (i.e., some carbons have hydrogen or other functional groups attached).

3.5 PFAS-Free Water — Deionized water that has been laboratory-certified as PFAS-free for use in decontamination and blanks.

3.6 Source Water — Municipal water from an onsite or near-site potable source which meets the requirements in **Section 7.5**. Source water may be used for decontamination or drilling water.

3.7 Source Water Blank — A blank sample collected from any potable water source used during the sampling process.

4.0 Interferences

See Resolution Consultants SOP 3-06 *Equipment Decontamination* for general information regarding cross-contamination and equipment decontamination. Due to the potential for cross-contamination, this SOP describes additional precautionary procedures to be followed when collecting PFAS samples and decontaminating sampling equipment. Decontamination procedures are presented in **Section 8.0** and appropriate decontamination materials are listed in **Table 1.**

5.0 Training and Qualifications

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP. Multiple analytical techniques for sampling PFAS are available, and the appropriate protocol will be determined by the media sampled, its uses (e.g., drinking water and non-drinking water), and will be defined in the site-specific SAP. Analytical methods may include additional requirements for each media. The individual must also have read all associated project planning documents and referenced sampling SOPs for the media being sampled (these may include U.S. EPA-, State-, or Resolution Consultants-specific SOPs).

6.0 Equipment and Supplies

Sampling equipment will change depending on the site and scope of work. Bottleware and preservatives will be specific to the method and media being sampled. Specific instructions for equipment and supplies pertaining to PFAS sampling are provided in **Section 7.3** of this SOP. Additionally, a summary of PFAS cross contamination concerns relative to equipment and materials is provided in **Table 1.**

7.0 Procedure

Given the low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFAS, specific equipment and supplies may not be permitted or used during field sampling activities. As a result, it is important that **Field Personnel** are aware of these procedures and that they act on the side of caution by strictly following these procedures in the field. Refer to **Section 7.8** for media-specific precautions and considerations. When implementing restrictions, priority shall be placed on prohibiting the use of materials that will come into direct contact with the sample media (e.g., tubing, pumps, scoops, etc.); these are referred to as first tier restrictions. Second tier restrictions are for PFAS-containing materials that are in the staging area or not in direct contact with

sample media and which pose a potential for incidental cross-contamination. Secondary sources of potential PFAS cross-contamination should be evaluated and if they cannot be removed, such as for health and safety reasons, then additional documentation and/or the need for supplemental QC samples (e.g., blanks) may be required. These first and second tier restrictions may vary when sampling different media because there may be different potential for media contact that pose a cross-contamination risk (e.g., rain gear, boots, sunscreen).

7.1 Field Clothing and PPE

A summary of the acceptable materials to use in the PFAS sampling environment is provided in **Table 1**. Additionally, personnel should complete the PFAS checklist prior to beginning field work each day (**Table 2**).

Do not wear water resistant, waterproof, or stain-treated clothing during the field program. Rain gear made from polyurethane or wax-coated materials may be used. Field clothing made either of synthetic or natural fibers are acceptable (cotton is preferred).

Field clothing should be well laundered (a minimum of 6 times from time of purchase) as new clothing may contain PFAS-related treatments. Do not use new clothing or clothing that has been treated with fabric softener and/or dryer sheets while sampling or sample handling.

Do not wear clothing or boots containing Gore-Tex™ while sampling or sample handling as they contain a PFAS membrane.

Boots and waders should be made with polyurethane, neoprene, rubber, or PVC. If PFAS-free boots or waders cannot be purchased, PFAS-free overboots or PFAS-free disposable shoe covers shall be worn. Hands must be washed after donning the overboots/shoe covers/ waders and before beginning sampling activities. Overboots/shoe covers/waders may only be removed in the staging area after sampling activities are completed. Note: if boots will not be in direct contact with sampling media (e.g., groundwater samples), then the Project Team may waive requirement for PFAS-free boots as long as appropriate precautions are taken to prevent cross-contamination of samples.

Do not wear Tyvek® suits and clothing that contains Tyvek®, as these may contain fluorinated compounds. If use of Tyvek® suits are required for safety concerns, collection of a Tyvek® suit equipment blank prior to use is recommended.

Powderless nitrile gloves must be worn at all times while collecting and handling samples. Nitrile gloves should be donned prior to the following activities at each sample location:

- Decontaminating reusable sampling equipment;
- Contacting sampling apparatus (pumps, spoons, etc.);
- Contacting sample containers (before, during, or after sample collection);
- Inserting equipment into a well (e.g., pump, tubing, bailer, etc.);
- Inserting silicone tubing into a peristaltic pump;
- Immediately prior to sample collection;
- Handling of any quality assurance/quality control (QA/QC) samples, including field blanks and equipment blanks; and
- After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.

7.2 Vehicles

- Do not place samples or sampling equipment directly on seats or seat covers since they may have been treated with a waterproofing material such as Scotchgard. Newer rental vehicles may pose a greater risk of cross-contamination.
- High-density polyethylene (HDPE) or well-washed towels should be placed on the seats to prevent potential PFAS cross-contamination onto clothing and/or equipment.

7.3 Equipment and Supplies

Sampling equipment and supplies coming into direct contact with sample media shall be constructed of PFAS-free materials, such as HDPE, polypropylene, silicone, stainless steel, nylon, polyvinyl chloride (PVC), acetate, and cotton. HDPE and medical grade silicone materials are acceptable for sampling (i.e., tubing). Do not use any bonded tubing, as the bonding material is Teflon®-based.

Do not use materials containing fluoropolymers. Examples of fluoropolymers include, but are not limited to:

- Ethylene tetrafluoro-ethylene (ETFE), including tradenames Tefzel, which can be found in wire/cable insulation and covers, liners in pipes, and cable tie wraps.
- Fluorinated ethylene propylene (FEP), including tradenames Teflon FEP and Hostaflon FEP, and may also include Neoflon, which can be found in wire/cable insulation and covers, pipe linings, and labware.
- Low-density polyethylene (LDPE), which may be found in bailers, tubing, and plastic bags and sample shipping materials.
- Polychlorotrifluoroethylene (PCTFE), including the tradename Neoflon, which may be found in valves, seals, gaskets, and food packaging.
- Polytetrafluoroethylene (PTFE), including the tradenames Teflon and Hostaflon, which may be found in check-valves on bailers, lining in hoses and tubing, wiring, gears, lubricant, and various objects with sliding parts.
- Polyvinylidene fluoride (PVDF), including the tradename Kynar, which can be found in tubing, films and coatings on aluminum, galvanized or aluminized steel, wire insulators, and lithium-ion batteries.
- Other vinylidene fluoride- (VDF-) based fluoroelastomers, such as FKM and FPM, or the tradename Viton, and other fluoroelastomers, which are designed to be more elastic and flexible than Teflon.

Note that this SOP does not include every type of fluoropolymer which may be brought to a site. When a material is identified prior to coming onsite or brought onsite, project staff should check material composition to determine if it is a fluoropolymer. Many other fluoropolymers, surfactant, and surface protection products remain on the market. **Before sampling, check pump and well construction materials (check tubing, O-rings, pipe thread material, and valves) for fluoropolymer materials. Additional evaluation of field materials may be required to document they are PFAS-free.** This may include:

- researching materials to determine if prior tests/certifications have been documented
- requesting testing/certification that materials are PFAS-free from vendors/suppliers (verify that methods/detection limits are comparable to what is being required by project sampling plans)
- collecting equipment blanks off uncertain field materials for PFAS analysis

Do not use coated bentonite pellets, shrink resistant/quick curing concrete, synthetic plumbers' grease, thread tape, etc.

During groundwater sampling, a water level meter may be used to measure depth-to-water only. Do not allow the tape to contact the water surface. Change gloves immediately after using the water level meter. Total well depth measurements should only be obtained after PFAS sample collection is complete. When gauging total depth during well installation, the measurement should be obtained prior to development. If the total well depth must be gauged prior to sampling, purge a minimum of three well volumes and allow the well to recharge for at least 24 hours prior to PFAS sampling.

Do not use waterproof field books (e.g., Rite in the Rain®) within the sampling area and during sample collection, as these may contain a plastic coating or adhesive containing PFAS. If you touch the field book, you must change gloves prior to handling samples or performing sampling activities. Field notes should be documented in untreated Composite® notebooks or on loose paper on Masonite or aluminum clipboards (i.e., plastic clipboards, binders, or spiral hard cover notebooks are not acceptable).

Post-It Notes® are not allowed on project sites. Recycled paper towels will not be used during sample collection or in the immediate sampling environment.

Sharpies® are acceptable to use in PFAS sampling programs if they are fine-tipped and used in the staging area only. Ballpoint pens should be used when documenting field activities in field notebooks or on field forms, as well as labeling sample containers and preparing chains of custody (CoCs).

Do not use chemical (blue) ice packs during the sampling program. This includes the use of ice packs for the storage of food and/or samples. Only wet ice (i.e., water ice) should be used during the sampling program. Do not use non-stick aluminum foil during sampling or sample handling.

For sampling equipment or supplies that are questionable or for which the absence of PFAS was not previously documented, equipment blanks should be collected by passing laboratory-certified, PFAS-free deionized water over and through the item in question.

7.4 Sample Containers and Handling

Samples should be collected in laboratory-provided polypropylene or HDPE bottles fitted with an unlined (i.e., no Teflon®), polypropylene or HDPE screw cap per method requirements. Teflon-lined bottleware may not be used in sample collection. Glass and LDPE containers should also be avoided due to potential analyte loss through adsorption. Potable water samples analyzed via Methods 537.1 and 533 must be collected in polypropylene bottles and preserved with Trizma and ammonium acetate, respectively. Note that different media require different containers and preservative. Work with your analytical laboratory to ensure the correct bottleware is selected. All bottles used for PFAS sampling should come from the same laboratory that will also be performing the PFAS analysis.

When bottleware have been received at a project site, the field team should confirm the appropriate materials have been provided. The sample containers should be kept covered in original packaging from the laboratory and must be kept sealed and opened only during sample collection.

The sample cap should never be placed directly on the ground during sampling. If sampling staff must set the sample bottle cap down during sample collection and a second member of the sampling crew (wearing a fresh pair of powderless nitrile gloves) is not available, the cap must be placed top down on a clean PFAS-free surface (cotton sheeting, HDPE sheeting, etc.).

7.5 Potable Source Water Evaluation

Available PFAS data will be reviewed for the facility's potable water source to determine if it is acceptable to be used as source water (i.e., decontamination water or drilling water). Analytical data collected in accordance with the Assistant Secretary of Defense *Memorandum for Sampling of Per- and Polyfluoroalkyl Substances in DoD-Owned Drinking Water Systems* (ASD 2023) or the subsequent *Memorandum: Policy for Per- and Polyfluoroalkyl Substances Monitoring and Treatment in DoD-Owned Drinking Water Systems in the United States* (ASD 2024) will be used to evaluate Navy facilities. Data from the Fifth Unregulated Contaminant Monitoring Rule will be used to evaluate off base potable supply systems. If no data is available, a source water blank sample from the potable water source must be collected and analyzed for PFAS by EPA Method 1633A prior to mobilization to confirm that it is acceptable for use during field activities. The water source is acceptable for use if the detected PFAS concentrations meet the following criteria:

- Water used for decontamination procedures must be less than the most current version of the U.S. EPA tap water RSLs (based on a target risk of 1E-6 and target HQ of 0.1) for PFAS approved for use by DoD (as specified at https://www.acq.osd.mil/eie/eer/ecc/pfas/pfas101/rsl.html).

- Water introduced into a borehole must be less than the most current version of the U.S. EPA tap water RSLs (based on a target risk of 1E-6 and target HQ of 0.1) for PFAS approved for use by DoD (as specified at https://www.acq.osd.mil/eie/eer/ecc/pfas/pfas101/rsl.html).

If a water source meeting the above criteria is not able to be identified, the decision for how to meet the above criteria will be made based on logistics and cost. Water confirmed to meet the standard can be trucked on site, or the water available on site can be treated to the appropriate standard. If on site treatment is selected, careful consideration will be given to the volume of water that can be processed before granular activated carbon breakthrough results in exceedances of the water quality standard. The options will be presented to project stakeholders prior to a final decision being made.

7.6 Sampling

- Hands should be thoroughly washed before sampling.
- Clean powderless nitrile gloves must be donned before collecting each PFAS sample, handling sample containers, and/or handling sampling equipment. Latex or powdered nitrile gloves shall not be utilized.
- Do not insert tubing into the sample container, nor let tubing or any other items or materials contact the inside of the sample container.
- Dust and fibers must be kept out of sample containers.
- If sampling for multiple analytes using PFAS-appropriate equipment, don new gloves and collect samples for PFAS analysis **first** to avoid contact with other sample containers or packing materials, which may contain PFAS.
- Collect field blank samples per the requirements of the project-specific SAP. These are collected by performing a bottle-to-bottle transfer of laboratory-certified, PFAS-free deionized water in order to assess contaminants in the blank water and/or the atmosphere surrounding the sample collection area.

7.7 Sample Labeling/Packing/Shipping

- All containers shall have a completed label affixed to it, prior to submitting to the laboratory.
- LDPE resealable zipper bags (e.g., Ziploc) may be used if the sample does not come in direct contact with them.
- When collecting samples for multiple analyses, it is recommended to segregate the sample containers for the PFAS analyses into separate coolers from the containers for the other analyses.
- Use regular wet ice in double-bagged zipper bags to maintain the sample at or below 10 degrees Celsius during the first 48 hours after collection. Ice bags must be prepared outside of sampling areas/in the staging area and not come into direct contact with samples. Gloves must be changed after preparing ice bags.
- Minimize exposure of samples to light by placing the collected samples in a cooler with ice and closing the cooler lid.

7.8 Media Specific Precautions and Procedures.

The following table discusses procedures and precautions for specific environmental media. These should be considered as a supplement to other existing Resolution Consultants SOPs.

Media	**Precaution**
Drilling	Drilling and direct push sampling technique procedures will be discussed on a project-specific basis. However, drilling scopes of work will be prepared to specifically prohibit use of PFAS containing materials, including equipment (e.g., pumps and fittings) and expendables (e.g., coated bentonite pellets, synthetic grease, shrink resistant concrete, O-rings, and thread tape). Note that drillers may not be aware that the equipment that is proposed and ultimately brought onsite may contain fluorinated materials. Project staff should review materials and double check material composition to ensure that fluorinated materials are not inadvertently used. Source water must be evaluated as described in **Section 7.5**. All down-hole drilling tools should be final rinsed with source water meeting criteria in **Section 7.5** before being advanced into the ground. Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water.

Media	Precaution
	Development pumps and other equipment to be inserted into the well should be verified by personnel to be PFAS-free prior to use.
Groundwater	Compatible materials should be evaluated for both well development and well sampling. The most inert material (e.g., stainless steel, silicone, HDPE, PVC), with respect to known or anticipated co-contaminants in wells, should be used whenever possible. Project teams should be aware that many common pumps, including bladder pumps, may include Teflon or Viton components. Most vendors offer alternative, PFAS-free options. Project teams should identify options and ask vendors for testing results to demonstrate plastic components other than the inert materials identified above (e.g., stainless steel, silicone, HDPE, PVC) are PFAS-free. Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water. For long-term investigations or monitoring with dedicated Teflon tubing and/or passive diffusion bags, monitoring wells shall be re-developed using HDPE tubing by removing three well volumes. Redeveloped wells should recover for a minimum of 24 hours prior to PFAS sampling; refer to the project-specific SAP for equilibration time requirements from development to sampling. If additional regularly scheduled sampling (e.g., long-term monitoring) is not planned, sample tubing and other equipment should be removed from the monitoring well following the completion of each sampling event. Alternatively, samples may be collected in duplicate, with and without existing dedicated equipment. If PFAS analyses show that the equipment does not affect results, the equipment may be kept and used long-term. This determination depends on project-specific requirements, however, and should only be used by a project team with full disclosure to all stakeholders. Minimize turbidity during sampling activities. Low-flow or passive sampling techniques are preferred for collection of groundwater samples for PFAS to keep the turbidity of samples and purge-water volume to a minimum. Elevated PFAS concentrations have been correlated with elevated turbidity readings. Filtering should not be performed, because filters may be a source of contamination, or PFAS may be adsorbed by the filter. Contact the project chemist to determine if additional laboratory preparation (e.g., filtering, centrifugation) is required to address suspended solids. When sampling existing monitoring wells, obtain well construction records and be mindful of PFAS impacted materials used during construction. See **Table 1** for approved materials.
Surface Water	To avoid cross-contamination from sampling materials to surface waters, the outside of the capped sample containers or sampling device (e.g., Kemmerer sampler) should be rinsed multiple times downstream of the surface water sampling location with the surface water being sampled before filling. When site conditions require, remote sampling into sample containers can be accomplished by clamping the container onto the end of a clean extension rod. The extension rod and clamping device must be made of PFAS-free material and must be decontaminated prior to use. Within the context of data quality objectives, the sample depth in the water column should consider the potential stratification of PFAS, tendency of PFAS to accumulate at the air/water interface, groundwater to surface water interface, etc. The location-specific sample depth and rationale should be documented in project-specific planning documents. When performing surface water sampling at multiple locations on a moving body of water, begin at the downstream sample location and progress upstream. Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water. PPE, such as waders and personal flotation devices, may be required. Ensure that materials that contact the media to be sampled do not have water-resistant coatings that contain PFAS (Refer to **Section 2**).
Porewater	Peristaltic pumps with silicone and HDPE tubing are typically used for porewater sample collection, along with push point samplers, porewater observation devices, drive point piezometers, or lysimeters. Push point samplers and drive point piezometers are made of

Media	Precaution
	stainless steel and shall be decontaminated between sampling locations. Tubing and porewater observation devices, consisting of slotted PVC pipe and silicone tubing, should be dedicated and not reused across a site or multiple sites. Lysimeters should be verified PFAS-free from the manufacturer. Alternatively, an equipment blank sample shall be collected on a specific lysimeter prior to installation. Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water.
Soil/Sediment	Most core and grab sampling devices are constructed of stainless steel. Some core samplers include an HDPE sleeve inserted in the core barrel to retain the sample. PPE, such as waders and personal flotation devices, may be required. Ensure that materials that contact the media to be sampled do not have water-resistant coatings that contain PFAS (Refer to **Section 2**). When collecting PFAS surface water and sediment samples from the same location, obtain the surface water sample prior to the sediment sample. Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water.
Fish and Shellfish Tissue	Clothing and PPE, such as waders and personal flotation devices, may be required. Ensure that materials that contact the media to be sampled do not have water-resistant coatings which contain PFAS (Refer to **Section 2**). Backpack or boat-based electrofishing systems, seine nets, trot lines, clam rakes, and other equipment used to collect tissue samples should be verified by personnel to be PFAS-free prior to use. When planning tissue sample collection, review packaging and preservation requirements per EPA Method 1633 with the receiving laboratory.
Potable Water	Potable water can be supplied by either municipal or private well sources, each having unique sampling procedures. Review the project-specific SAP for the potable water sampling procedures, as well as SOP 3-46 *Drinking Water Sampling for Per- and Polyfluoroalkyl Substances*. Any spigot or tap identified for sampling should be free of potential PFAS-contaminated devices such as screens, aeration devices, hoses, purification devices, Teflon tape, or swiveled faucets. Avoid collecting samples from leaking spigots or taps. Care must be taken to not flush out the Trizma or ammonium acetate preservation reagent during sampling. After sample collection, the bottle should be capped and agitated by hand until the preservative is dissolved. Field blanks should be collected in accordance with the requirements in the project-specific SAP.
Treatment System Samples	If sampling is required from a remediation system, the sampler is cautioned to: • Survey the treatment system building and identify potential sources of PFAS (e.g., maintenance equipment, plumbing supplies, etc.) • Obtain a treatment system diagram to identify the location of and potential sources of PFAS internal to the treatment system (e.g., pumps, seals, valves, etc.) • Identify (at a minimum) pre- and post-system sampling points, to differentiate the impact that PFAS-containing treatment equipment could have on samples. • The system should be documented photographically for further review of potential cross contamination points. When collecting aqueous PFAS samples from tanks, the sample location in the water column should consider the potential stratification of PFAS in solution and their tendency to accumulate at the air/water interface. Treatment system sampling techniques will be described in site-specific planning documents.
High Concentration Samples: AFFF	All AFFF product samples must be considered high concentration samples. These samples should be segregated from other samples during sampling and shipping to avoid cross contamination. These samples should be collected last, whenever feasible. Sample collection using single-use, disposable equipment is recommended. If single-use equipment is not available, take additional precautions such as implementing a greater frequency of equipment blanks and not reusing equipment to sample potentially low

Media	Precaution
	PFAS concentration samples. Samples that may contain high concentrations of PFAS shall be clearly identified on the chain-of-custody.
High Concentration Samples: Landfill Leachate	Per EPA Method 1633, leachate samples from landfills may be difficult to analyze, therefore three 100 mL aliquots are collected. As above, sample collection using single-use, disposable equipment is recommended. If single-use equipment is not available, take additional precautions such as implementing a greater frequency of equipment blanks and not reusing equipment to sample potentially low PFAS concentration samples. Samples that may contain high concentrations of PFAS shall be clearly identified on the chain-of-custody.
Other Media	Reach out to your CTO Manager and project leadership if a sampling media has been requested that does not appear in this table.

8.0 Equipment Decontamination

8.1 It is highly recommended that dedicated disposable equipment be utilized when collecting samples for PFAS analysis. However, if this is not possible, reusable field sampling equipment (e.g., oil/water interface meters, water level indicators, portable bladder pumps, stainless steel spoons, etc.) must be decontaminated between uses in accordance with Resolution Consultants SOP 3-06 *Equipment Decontamination*.

8.2 The following additional considerations should be followed when performing equipment decontamination:

- Alconox®, Liquinox®, Citranox®, and Luminox® soaps are acceptable for use. However, Decon 90 must not be used during decontamination activities.
- As discussed in **Section 7.5**, municipal water from an onsite or near-site source may be used for decontamination purposes, particularly for large equipment (e.g., drilling rigs, rods), if it has been tested prior to use and is determined to be acceptable by the Project Team.
- Any equipment expected to come into direct contact with the sample should have a final rinse with laboratory-grade certified PFAS-free water
- Equipment blanks should be collected from decontaminated equipment using laboratory-certified, PFAS-free water.

9.0 Additional Considerations

Project teams should consider the following when planning PFAS sampling events.

9.1 Personnel Hygiene

There is potential that personal hygiene products such as cosmetics, moisturizers, hand cream, or other related products may contain PFAS. Samplers shall be aware of the potential for cross-contamination at all times, and should minimize products used, except for those needed for health and safety purposes (e.g., sunscreen, bug spray). To avoid potential cross contamination, fresh gloves will be used prior to sample collection and the field personnel will avoid touching hair, face, arms, or hands during sample collection. Only apply personal hygiene products outside the sampling area and wash hands prior to resuming sampling activities. If a washroom is unavailable, rinse hands with potable water, prior to donning nitrile gloves.

Many manufactured sunblock and insect repellents contain PFAS and should not be brought or used on-site. Sunblock and insect repellents that are used on-site should consist of 100% natural ingredients. As mentioned in **Section 2**, steps can be taken to reduce the hazards associated with insects and prolonged sun exposure.

9.2 Food Considerations

Many food snack products are packaged in wrappers treated with PFAS. Therefore, hands must be thoroughly washed after handling fast food, carry-out food, or snacks. Pre-wrapped food or snacks

(e.g., candy bars, microwave popcorn, etc.) must not be in the possession of field personnel during sampling.

Food and drink will be handled and consumed only outside of the sampling environment. When sampling personnel require a break to eat or drink, they should remove their gloves and other PPE in the staging area and move to a designated area for food and beverage consumption.

9.3 Analytical Methods

Current DoD policy requires use of EPA Method 537.1 and 533 for analyzing potable water samples, and Method 1633 for analyzing all other environmental matrices. Depending upon data quality objectives at the site, other methods may be integrated in project planning documents as screening methods (e.g., ASTM D8421-22). The quality control, sampling, and sample management procedures described in this SOP also apply to collection of screening samples. Be sure that the analytical methods used are consistent with DoD policy.

9.4 Shipping

PFAS analytical methods have specific holding time and storage requirements. If specific PFAS analytes are suspected to be present, Method 1633 recommends analysis as soon as possible. Consult with the project team, project chemist, and analytical laboratory when planning sampling events and sample shipments.

10.0 References

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Author	Reviewer	Revisions (Technical or Editorial)
Ken O'Donnell, PG Geologist	Claire Mitchell, PE, PMP Senior Engineer	Rev 1 – PFAS sampling update (July 2019)
Rose Kelley Environmental Scientist	Richard Purdy Project Scientist Mark MacEwan PFAS Subject Matter Expert	Rev 2 – Update & Review (June 2022)
JV PFAS Team (Sam Bartlett, Lori Goetz)		Rev 3 – Update & Review (October 2022)
Savannah Wolfe	Megan Clark	Rev 4 – Update SOP based on 2023 RITS meetings (October 2023)
Lori Goetz	Savannah Wolfe	Rev 5 – Update & Review (March 2024)
Lori Goetz	Savannah Wolfe	Rev 6 – Update & Review (April 2024)
Savannah Wolfe	Lori Goetz	Rev 7 – Update Section 9.1 based on Navy comments (July 2024)
Savannah Wolfe	Lori Goetz	Rev 8 – Update sections to clarify the use of PFAS-free water (October 2024)
Lori Goetz	Robert Shoemaker	Rev 9 – Update sections to clarify field fluoropolymer avoidance, add section for potable source water evaluation, and overall review (June 2025)

Table 1
Field Equipment Evaluation

Material or Equipment Type	Do Not Use Or Do Not Have in the Immediate Sampling Environment	Evaluate Prior to Use at a Sampling Event	Acceptable for Use in the Sampling Environment

Teflon, other fluoropolymers and fluoroelastomers	Polytetrafluoroethylene (PTFE) items, sample containers, well construction materials, pump components, or other equipment that contains PTFE parts that will be in direct contact with sampling media, such as Teflon®; no Teflon® lined bottle caps; no Teflon-bearing plumber's tape. Do not use any other fluoropolymer (Hostaflon, Neoflon, Kynar, Tefzel, Viton, FKM/FPM, etc.). Additional fluoropolymers are identified in Section 7.3.
	
	Items or materials that contain any fluoropolymers and fluoroelastomers should not be used for well construction or sampling.
		Replace Teflon, fluoropolymers, and fluoroelastomer components with alternate materials	• High-density polyethylene (HDPE)
			• Polypropylene
			• Silicone
			• Stainless-steel
			• Nylon
			• Polyvinyl chloride (PVC)
			• Acetate
			• Cotton
			• Any items used to secure sampling bottles made from:
			  ○ Natural rubber
			  ○ Nylon (cable ties)
			  ○ Uncoated metal springs
			  ○ Polyethylene
			
			If in doubt, ask the vendor to provide analytical results demonstrating that the materials are PFAS-free.

Polyethylene	Low-density polyethylene (LDPE) items or equipment that contains LDPE parts and that will be in direct contact with the sampling media	Other plastic components (e.g., acrylonitrile butadiene styrene [ABS]) should be evaluated on a case-by-case basis. Request vendor analysis and/or perform sampling of individual components.	Items or equipment made of polypropylene (PP); high-density polyethylene (HDPE); polyurethane, polyvinyl chloride (PVC); silicon, stainless steel, nylon, acetate
Equipment Lubricants		Equipment with moving parts that may be lubricated with PFAS containing lubricants or greases Drilling fluids	Crisco® or other vegetable-based greases for lubricating parts
Well Construction Materials	Coated bentonite chips/pellets Shrink-resistant or crack-resistant concrete		Instead of shrink-resistant or crack-resistant concrete, use fiberglass shreds to add to regular concrete or uncoated bentonite chips

Table 1 Field Equipment Evaluation			
Material or Equipment Type	**Do Not Use Or Do Not Have in the Immediate Sampling Environment**	**Evaluate Prior to Use at a Sampling Event**	**Acceptable for Use in the Sampling Environment**
Washers and O-rings	Viton® O-rings, Teflon parts, other fluoropolymers, fluoroelastomers	Internal valves and equipment parts (pumps, pressure, washers, well construction components, etc.)	Natural rubber, PVC, nylon, polyethylene, silicone are examples of acceptable materials
Glass	Glass sample containers (jars) and glass fiber filters		
Decon Materials	Decon 90	Source Water used for decontamination of drilling equipment must PFAS criteria as defined in project specific documents	Alconox®, Citronex®, LIquinox®, Methanol®
Buckets/spoons/bowls	LDPE or unidentifiable plastic items		HDPE-stamped items, stainless steel
Plastic Sheeting/Tarps	LDPE sheeting		HDPE sheeting
Sample storage	Non-stick Aluminum Foil	Bulk sample containers must be evaluated (e.g., contractor bags), aluminum foil (primarily used for tissue samples	Polyethylene plastic bags (e.g., Ziploc® bags)
Towels	Recycled Paper Towels		Regular paper towels
Field Notes	Waterproof (Rite in the Rain®) field notebooks; Post-it notes®		Plain paper notebooks with unbleached, non-recycled paper
Writing Implements	Any type of markers	Non-brand name markers	Fine point Sharpie®- okay for use in the staging area only; ball point pens and pencils can be used in the immediate sampling environment; pencils can be used for pre-labeling but must be written over with pen or marker; using pre-labeled bottles can avoid labeling in the field altogether.
Sample Cooling	Blue Ice or Chemical Ice		Wet Ice
Water for Equipment Blanks			Laboratory-certified PFAS-free water

Table 1
Field Equipment Evaluation

Material or Equipment Type	Do Not Use Or Do Not Have in the Immediate Sampling Environment	Evaluate Prior to Use at a Sampling Event	Acceptable for Use in the Sampling Environment
PPE - Fabrics & Materials	Gore-Tex® or PFAS treated fabrics or clothes; new and unwashed clothing (fabric treatment may contain PFAS); no fabric softener[1]	Clothes described as waterproof, water-resistant, or stain-resistant	Neoprene, clothing made of waxed fabric, synthetic and natural fibers (preferably cotton); well laundered clothes (washed several times after purchase)
PPE- Clothing & Coveralls	Clothing that has been washed with fabric softener[1]	Tyvek® or coated Tyvek®	Well-washed (washed several times) cotton coveralls
PPE – Waders	Gore-Tex or PFAS treated[1]		Polyurethane, neoprene, rubber, PVC
PPE – Rain Gear		Plastic gazebo tent that is only touched or moved prior to and following sampling activities may be used.	Rain gear made from polyurethane, PVC, or wax-coated materials may be used.
PPE - Gloves	Powdered Nitrile or Powdered Latex Gloves		Powderless Nitrile Gloves
PPE - Boots	Gore-Tex® or PFAS treated boots (unless worn with PVC or polyurethane boot covers)[1]		Steel-toed boots with polyurethane and PVC, or polyurethane/PVC boot covers
Personnel Hygiene	Avoid cosmetics, moisturizers, hand cream, and other items placed on hands that could potentially result in cross contamination with anything touching the sample media		
PPE - Sunscreen		Any untested sunscreens should be tested and added to the approved list.	Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, and baby sunscreens that are “free” or “natural”
PPE - Insect Repellent		Any untested insect repellent should be tested and added to the approved list.	Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics, OFF Deep Woods, Sawyer Permethrin Treatment

Notes:
[1] For further information on prohibited clothing, refer to Michigan Department of Environment, Great Lakes, and Energy (EGLE) General PFAS Sampling Guide (EGLE, 2024).

Table 2 **PFAS Daily Sampling Checklist**	
Project No.:	
Project Location:	
Site/SWMU:	
Field Team Lead Signature:	
Date:	
Team Member Acknowledgement	**Description**
SOP Compliance	
☐ Yes ☐ No	Have the PFAS SOP (RC 3-41) and project planning documents (SAP/WP/SOPs) been reviewed by all team members?
	Comments:
☐ Yes ☐ No	Have sampling staff received PFAS-specific training?
	Comments:
☐ Yes ☐ No	Was briefing held for field sampling staff?
	Comments:
☐ Yes ☐ No	Have personal clothing and PPE requirements been followed by all field sampling staff?
	Comments:
☐ Yes ☐ No	Were lotion and sunscreen guidelines (outlined in RC 3-41) followed by field sampling staff?
	Comments:
Sample Collection	
☐ Yes ☐ No	Has source water been identified for decontamination that meets the project specific requirements?
	Comments:
☐ Yes ☐ No	Has the laboratory provided PFAS-free deionized water for blanks and decontaminated sampling equipment final rinses?
	Comment:
☐ Yes ☐ No	Have all sampling items, parts, and equipment been inspected and/or verified to be free of PFAS?
	Comments:
☐ Yes ☐ No	Has sampling location sequence been communicated to avoid cross-contamination?
	Comments:

☐ Yes ☐ No	Have drilling fluids been evaluated and shown to be free of PFAS?
	Comments:
☐ Yes ☐ No	Have sampling setups been reviewed to ensure minimal cross contamination (i.e., logbooks, Sharpies, etc.).
	Comments:
☐ Yes ☐ No	Have materials in close proximity to samples been validated against Table 1 requirements as being PFAS-free?
	Comments:
☐ Yes ☐ No	Have all sample shipping materials (ice, Ziplock bags, etc.) been inspected and deemed to be PFAS-free?
	Comments:
☐ Yes ☐ No	Have all blanks been collected to verify cross contamination?
	Comments:
Document Control	
☐ Yes ☐ No	Have all variances from sampling guidance been documented?
	Comments:
☐ Yes ☐ No	Have all variances from the SAP been documented?
	Comments:
Additional comments:	

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

This document contains direction developed solely to provide guidance to U.S. Environmental Protection Agency (EPA) personnel. EPA retains the discretion to adopt approaches that differ from these procedures on a case-by-case basis. The procedures set forth do not create any rights, substantive or procedural, enforceable at law by party to litigation with EPA or the United States.

Prepared by: ROBERT REINHART Digitally signed by ROBERT REINHART Date: 2017.09.19 16:15:38 -04'00' _____ _____
(Robert Reinhart, Quality Assurance Unit) Date

Approved by: JOHN SMALDONE Digitally signed by JOHN SMALDONE Date: 2017.09.20 15:11:00 -04'00' _____ _____
(John Smaldone, Quality Assurance Unit) Date

Revision Page

Date	Rev #	Summary of changes	Sections
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

Table of Contents

1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in

the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume

cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the

minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be

changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and

continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods

(e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

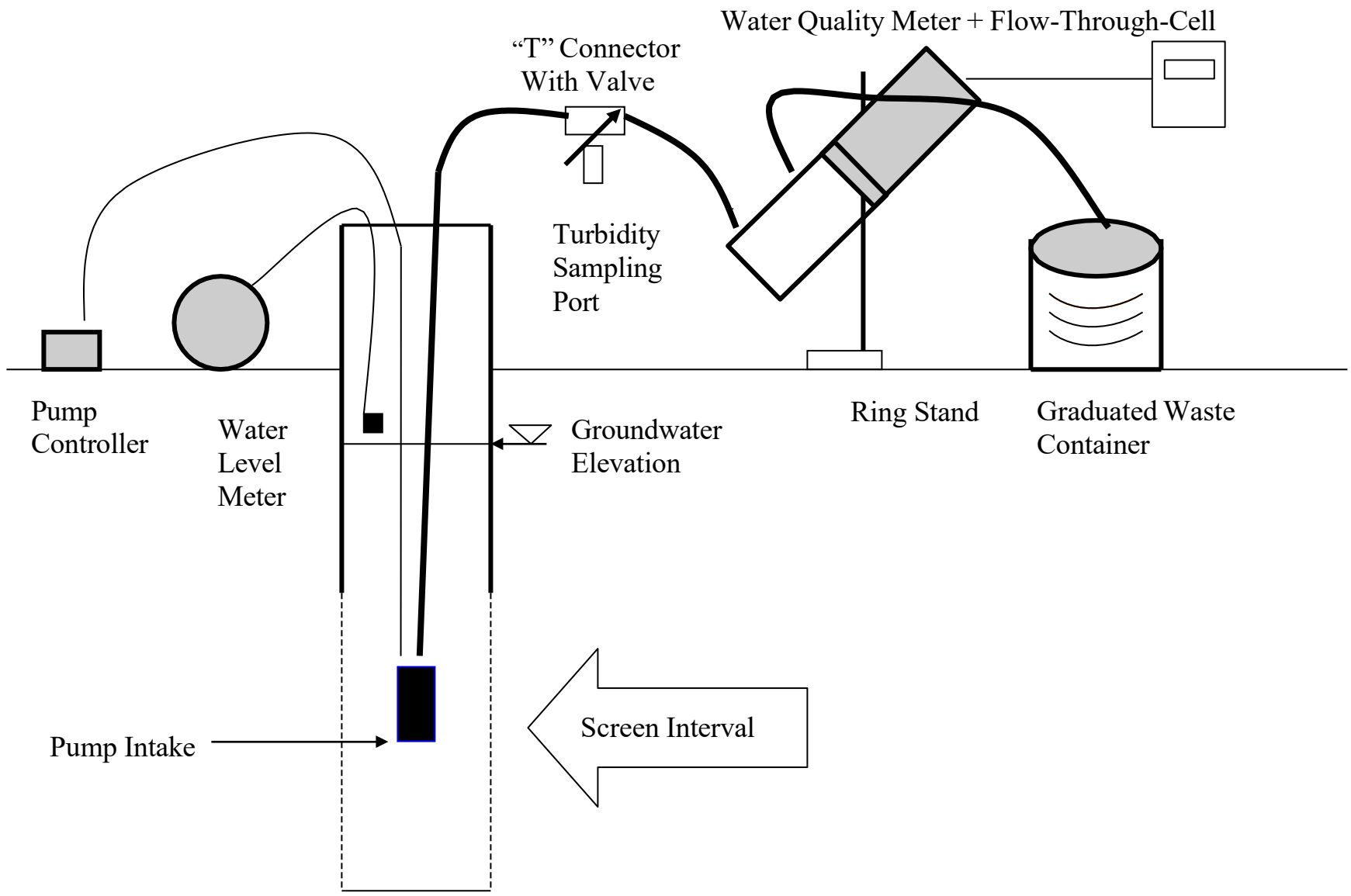
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____ Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____ Total Volume Purged _____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)