Air Force Civil Engineer Center

FINAL

Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites

Eielson Air Force Base,
Fairbanks North Star Borough, Alaska

June 2021

Contract Number: FA8903-16-D-0041
Delivery Order: FA8903-20-F-1108
CDRLs A007 and A008

Prepared For:

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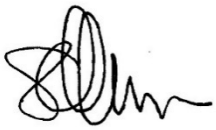
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List of Acronyms and Abbreviations

%	percent
+/-	Plus or minus
ºC	Degrees Celsius
≤	Less than or equal to
≥	Greater than or equal to
>	Greater than
<	Less than
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
%R	Percent recovery
3D	three-dimensional
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AEC	Anion exchange capacity
AES	atomic emission spectroscopy
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
ADNR	Alaska Department of Natural Resources
AFFF	aqueous film-forming foam
Ahtna	Ahtna Engineering Services, LLC
AK-CESCL	Alaska Certified Erosion and Sediment Control Lead
amsl	Above mean sea level
APP	Accident Prevention Plan
Arcadis	Arcadis U.S., Inc.
ARP	Alaska Department of Fish and Game Aquatic Research Permit
ASD	Assistant Secretary of Defense
ASTM	American Society for Testing and Materials
BAA	Broad Agency Announcement
BEM	BEM Systems, Inc.
BEM Team	BEM and Teaming Partner Arcadis
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
Bristol	Bristol Site Contractors, LLC
BTEX	Benzene, toluene, ethylbenzene, and xylenes
B.A.	Bachelor of Arts
B.S.	Bachelor of Science
CA	corrective action
CAS	Chemical Abstracts Service

CCV	Continuing Calibration Verification
CDRL	Contract Data Requirements List
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Civil Engineering Squadron
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHG	Certified Hydrogeologist
CH2M Hill	CH2M Hill, Inc.
cm/s	centimeter per second
COC	constituent of concern
CoC	Chain-of-custody
CPR	cardiopulmonary resuscitation
CQM	Construction Quality Management
CSM	conceptual site model
DI	deionized
DoD	Department of Defense
DoE	Department of Energy
DOT	Department of Transportation
DPT	direct push technology
DPW	Directorate of Public Works
DQI	data quality indicator
DQO	data quality objective
EA	EA Engineering, Science, Technology, Inc., PBC
EAFB	Eielson Air Force Base
EB	equipment blank
ECC	Environmental Compliance Consultants
EDD	electronic data deliverable
EIS	Extracted Internal Standard
ELAP	Environmental Laboratory Accreditation Program
ELLE	Eurofins Lancaster Laboratories Environmental
ERPIMS	Environmental Resources Program Info Management System
ESTCP	Environmental Security Technology Certification Program
FB	field blank
FCF	Field Change Form
FD	field duplicate
FEMA	Federal Emergency Management Agency
FFA	Federal Facilities Agreement
foc	fraction of organic carbon
FTA	Fire Training Area

ft/ft	foot/foot
GAC	Granulated Activated Carbon
GIS	Geographic information system
gpm	gallons per minute
GPS	global positioning system
GSI	groundwater - surface water interaction
GW	groundwater
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HPT	Hydraulic profiling tool
IATA	International Air Transport Association
IBC	Industrial bulk container
IC	Institutional Controls
ICAL	Initial Calibration
ICB	Initial calibration blank
ICV	Initial Calibration Verification
ICP	Inductively Coupled Plasma Atomic Emission Spectrometry
IDW	investigation-derived waste
installation	U.S. Air Force installation
ISC	Instrument Sensitivity Check
ITRC	Interstate Technology & Regulatory Council
Jacobs	Jacobs Engineering Group, Inc.
LC-MS/ MS	liquid chromatography-mass spectrometry
LCS	laboratory control sample
LCSD	laboratory control sample
LHA	Lifetime Health Advisory
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligram per kilogram
mg/L	Milligrams per liter
ml	milliliter
M.S.	Master of Science
MS	matrix spike
ms	Mass spectrometry
mS/cm	millisiemens per centimeter
MSD	matrix spike duplicate
MTGW	Migration to groundwater
N/A	not applicable
NARIS	Naval Installation Restoration Information Solution

ND	Non-detect
ng/L	nanogram per liter
NRBV	no-risk based value
NTU	nephelometric turbidity unit
OLS	ordinary least squares
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
Pace	Pace Analytical Services, LLC
PCB	Polychlorinated biphenyl
PE	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFC	perfluorinated compounds
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PG	Professional Geologist
PHA	provisional health advisory
POC	point of contact
PSL	project screening level
QA	quality assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	quality control
Q/P	Flow divided by pressure
QP	quality procedure
QSM	Quality Systems Manual
R^2	R squared
RBSL	Risked Base Screening Level
RI	Remedial Investigation
ROD	Record of Decision
RPD	Relative percent difference
RPM	Remedial Project Manager
RSL	Regional Screening Level
SB	source blank
SES	SES Construction and Fuel Services, LLC
S&H	Safety and Health
SI	site investigation
SL	Screening level
SLERA	Screening-Level Ecological Risk Assessment

SOP	standard operating procedure
SPLP	Synthetic Precipitation Leaching Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
Sundance	Sundance- EA II, LLC
SVOP	Semi-volatile organic compound
SW	surface water
Swift River	Swift River Environmental Services, LLC
Synectics	Environmental Synectics, Inc.
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TAT	Turnaround time
TBD	to be determined
TCLP	Toxicity characteristic leaching procedure
TGI	technical guidance instructions
TOC	Total organic carbon
TSS	Total suspended solids
TVSS	Total Volatile Suspended Solid
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VAP	Vertical Aquifer Profile
VOC	Volatile Organic Compound
WMP	Waste Management Plan
WWTP	Waste Water Treatment Plant
ZHE	Zero Headspace Extraction

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INTRODUCTION

BEM Systems, Inc. (BEM), along with our teaming partner Arcadis, U.S, Inc. (Arcadis) (hereinafter collectively referred to as "The BEM Team"), is under contract to the Air Force Civil Engineer Center (AFCEC) (Contract No. FA8903-16-D-0041, Task Order No. FA8903-20-F-1108) to conduct a Phase I Remedial Investigation (RI) for per- and polyfluoroalkyl substances (PFAS) at Various Sites at Eielson Air Force Base (EAFB) in Fairbanks North Star Borough, Alaska. The purpose of the RI is to characterize the nature and extent of 24 PFAS compounds, specifically perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) through the application of adaptive high-resolution site characterization and the development of a flux-based conceptual site model (CSM). The outcome of the RI will be (1) flux-based ranking of sources and mapping of migration pathway(s), and (2) delineation of soil, groundwater (GW), sediment, and surface water impacts.

The purpose of the RI investigation is to determine the vertical and lateral extent of PFAS in impacted media from U.S. Air Force (USAF) primary and secondary releases, determine their potential contribution to the Installation's PFAS groundwater plumes, and collect data needed to support a future risk assessment. The goal of this RI is to accelerate the RI process to enable AFCEC to make decisions regarding source removal or groundwater containment earlier than under a conventional RI approach, while also collecting sufficient data to support future risk assessments. This Quality Assurance Project Plan (QAPP) incorporates adaptive high-resolution site characterization and the development of a flux-based CSM that provides a flux-based ranking of sources, mapping of migration pathways, and delineation of soil, groundwater, sediment, and surface water impacts. The investigation will provide an improved understanding of how contaminant distribution and hydrogeologic structure combine to control contaminant flux. The BEM Team's approach is based on the United States Environmental Protection Agency's (USEPA's) Triad Approach (USEPA, 2001) and incorporates systematic planning, dynamic work strategies, and rapid data collection. Rapid data collection will be achieved by using a combination of standard, quick-turn, and mobile laboratory analyses to provide data to support near real-time decision making. This QAPP establishes the communication framework and frequency to support interim milestone data review to enable consensus-building and agreement among the stakeholders to ensure continuous progress during the field investigation that reduces the potential for down-time. Decision criteria and flow charts are included in this QAPP to streamline adaptive decision making related to "step-outs" to delineate extents of impacts, and "step-ins" to refine source hotspot footprints in soil and to allow precise zoom in on the occurrence and distribution of PFAS in groundwater and extent and potential discharge areas in surface water. This RI will result in a Phase I RI report described in Worksheet #17.

As part of the RI, the BEM Team will conduct a broad examination and characterization of groundwater elements (on both a base-wide and site-scale basis) including analysis of potentiometric surface and

groundwater flow, geochemical characteristics, constituent of concern (COC) chemistry, COC transport flow patterns and the relationship between groundwaters and surface water. This evaluation will account for multiple factors (e.g., seasonal variations in flow patterns and potentiometric surface contours) that can introduce uncertainties in groundwater flow, COC transport mapping, and revision of the CSM which can negatively impact future corrective action design and performance. An initial three-dimensional (3D) CSM will be developed at the planning stage to serve as a baseline for establishing the final scope and strategy of this RI.

The purpose of this site-specific Uniform Federal Policy (UFP – QAPP) is to detail the planning processes for collecting data at EAFB, and to describe the implementation of the quality assurance (QA) and quality control (QC) activities developed for the RI activities at EAFB in Fairbanks North Star Borough, Alaska. The objectives of this QAPP are to generate project data that are technically defensible and useful in meeting the AFCEC's PFAS RI project goals (**Worksheet #11, Step 2)**. Site-specific details provided in this QAPP include sampling locations, media, methodologies, and procedures.

Should site conditions warrant deviation from the prescribed procedures in this QAPP, the stakeholders, the Lead Organizations listed in **Worksheet #4** of this QAPP, will be consulted following the specific communication pathways described in **Worksheet #6** before changes to the sampling plan are made. Additionally, a non-conformance report or field change report summarizing the sampling deviations will be issued and attached as an appendix to the RI report, if necessary (i.e., if data quality objectives [DQOs] are affected and corrective action is needed). A copy of the Field Change Form (FCF) is included as **Appendix A** and described in **Worksheet #17**. Other changes that do not impact DQOs, such as adjustments to sample locations or sample collection intervals, will be documented in field notes and described in the Final RI report.

EAFB is an active U.S. Air Force installation (installation) in Fairbanks North Star Borough, Alaska (**Figure 1)**. The RI strategy for the EAFB is divided into multiple stages. This QAPP provides guidance for the sampling event for the RI, which includes data collection by conducting soil, groundwater, surface water, porewater, sediment, and fish tissue sampling at EAFB. The methods of sample collection and laboratory analysis will meet a minimum level of quality and completeness to achieve comparability across the various sites and over time. The field standard operating procedures (SOPs)/technical guidance instructions (TGIs) and protocols referred to in this QAPP are derived from and/or are in accordance with USEPA guidance documents. Copies of the applicable field SOPs/TGIs for this QAPP are provided in **Appendix B**. The QAPP consists of 37 prescriptive worksheets documenting aspects of the environmental investigation process and will be used to guide the fieldwork.

This QAPP addresses five primary elements:

- Project Management

- Measurement and Data Acquisition
- Assessment and Oversight
- Data Validation and Usability
- Field Sampling Plan (Work Plan)

The QAPP worksheet format and organization used herein follows the systematic planning process for environmental sampling and was developed via collaboration between the USEPA, Department of Defense (DoD), and the Department of Energy (DoE). In 2010, a subgroup composed of members from the participating agencies was established to review and optimize the QAPP worksheets in close coordination with USEPA's update of QA/G-5 (CIO-2106-G-05, USEPA, 2012). The optimized worksheet format is used for this QAPP. A crosswalk between the optimized QAPP worksheet numbers and titles and the CIO-2106-G-05 guidance is presented in **Table 1**.

Table 1. Crosswalk - Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) Workbook to ANSI/ASQ E-4T

Optimized UFP-QAPP Worksheets		ANSI/ASQ E-4 QAPP Guidance Section	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and Quality Assurance Project Plan Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7 & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP Elements for Evaluating Existing Data
14 & 16	Project Tasks & Schedule	2.2.4	Project Organization and Schedule
15	Reference Limits and Evaluation Tables	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field Quality Control Summary	2.3.5	Quality Control Requirements
21	SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables

Optimized UFP-QAPP Worksheets		ANSI/ASQ E-4 QAPP Guidance Section	
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records Table	2.2.8	Documentation and Records Requirements
31, 32 & 33	Assessments and Corrective Action	2.4	Assessments and Data Review
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Validation (Steps IIA and IIB) Process Table	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

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QAPP WORKSHEET #1 & #2: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)
(USEPA 2106-G-05 Section 2.2.1)

1. Project Identifying Information:
   a. Site name/project name: EAFB, Alaska / RI for PFAS at Various Sites
   b. Site location: EAFB, Fairbanks North Star Borough, Alaska
   c. Contract/work assignment number: FA8903-16-D-0041/FA8903-20-F-1108
2. Lead Organization: AFCEC
   a. AFCEC Point of Contact (POC)

_____
Kristina Smith, Remedial Project Manager (RPM), AFCEC, 354th CES Date

3. List plans and reports from previous investigations relevant to this project:

Author/Title	Date
BEM / QAPP Addendum for RI for PFAS at Various Sites - Initial Groundwater Sampling, EAFB, Fairbanks North Star Borough, Alaska	October 2020
Sundance- EA II, LLC (Sundance) / Expanded PFOA and PFOS Site Inspection, EAFB, and Moose Creek, Alaska UFP-QAPP Work Plan Field Change Forms Phase IV.	August 2020a
Ahtna Engineering Services, LLC (Ahtna) / Final Groundwater Model Summary and Quality Report, EAFB, Alaska.	June 2020
Sundance / Eielson Surface Water and Sediment Sampling – Final Addendum to Work Plan for Expanded PFOA and PFOS Site Investigation (SI), EAFB, Alaska.	April 2020b
Sundance / Expanded PFOA and PFOS Site Inspection, Eielson AFB, and Moose Creek, AK UFP-QAPP Work Plan Field Change Forms.	April 2020c
North Wind / October 2019 Groundwater Sampling Memorandum – Perfluorinated Compounds (PFC), Eielson-Moose Creak, EAFB, Alaska	March 2020
Jacobs Engineering Group, Inc. (Jacobs) / 2019 Garrison Slough Remedial Investigation/ Remedial Action, EAFB, Alaska	2020
USAF / Fifth Five-Year Review Report for EAFB, Alaska.	September 2019b
Sundance / Final UFP-QAPP Work Plan for Expanded PFOA and PFOS Site Inspection, EAFB and Moose Creek, Alaska.	September 2019

Author/Title	Date
U.S. Army Corps of Engineers (USACE) / Trip Report of PFAS Sampling at Three Groundwater Monitoring Wells in the Vicinity of the Pre-Filter Building Construction, Fuel Farm, on Eielson AFB (EIE338).	September 2019
EA Engineering, Science, Technology, Inc., PBC (EA) / Final 2018 Institutional Controls (ICs)/ Land Use Controls Annual Report, EAFB, Alaska.	July 2019
Swift River Environmental Services, LLC (Swift River) / Final RA Report for Removal Action and Monitoring at Source Areas CG517 and CS081, EAFB, Alaska.	June 2019
AFCEC / Interim Record of Decision (ROD) for Community of Moose Creek, Alaska; Long-Term-Water Supply.	June 2019
North Wind / Final PFC Eielson-Moose Creek QAPP, EAFB, Alaska	October 2018
CH2M Hill, Inc. (CH2M Hill) / Final SS035 RI/ Feasibility Study Management Plan	August 2018b
CH2M Hill / Final Site Inspection Report for Aqueous Film Forming Foam (AFFF) Areas, EAFB, Fairbanks North Star Borough, Alaska.	May 2018a
Bristol Site Contractors, LLC (Bristol) / Interim Removal Action Report, Eielson AFB Granulated Activated Carbon (GAC), EAFB, Alaska.	August 2018
AFCEC/ Action Memorandum for Time-Critical Removal Action of PFOS/ PFOA Contaminated Drinking Water, EAFB, Alaska	April 2017
USAF / 2015-2016 Field Activities Report for Four Areas: Transmitter Road, Community of Moose Creek, Western Area, Chena Floodplain at Eielson AFB, Alaska.	January 2017
CH2M Hill / Final Preliminary Assessment (PA) Report for PFS at EAFB, Alaska.	December 2015
Environmental Compliance Consultants (ECC) and Jacobs / PFC Investigation Work Plan.	April 2015
SES Construction and Fuel Services, LLC (SES) / Final SI of Fire Fighting Foam Usage at Various Air Force Bases in the United States (U.S.) for EAFB, Fairbanks North Star Borough, Alaska.	February 2015
USAF / 2013 Five-Year Review. EAFB, Alaska	February 2014
AECOM / Draft CSM, EAFB, Alaska.	May 2013
USEPA, USAF, and Alaska Department of Environmental Conservation (ADEC) / Federal Facility Agreement (FFA) Under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120 – EAFB between USEPA, ADEC, and USAF - Administrative Docket Number 1089-07-14-120.	October 1990

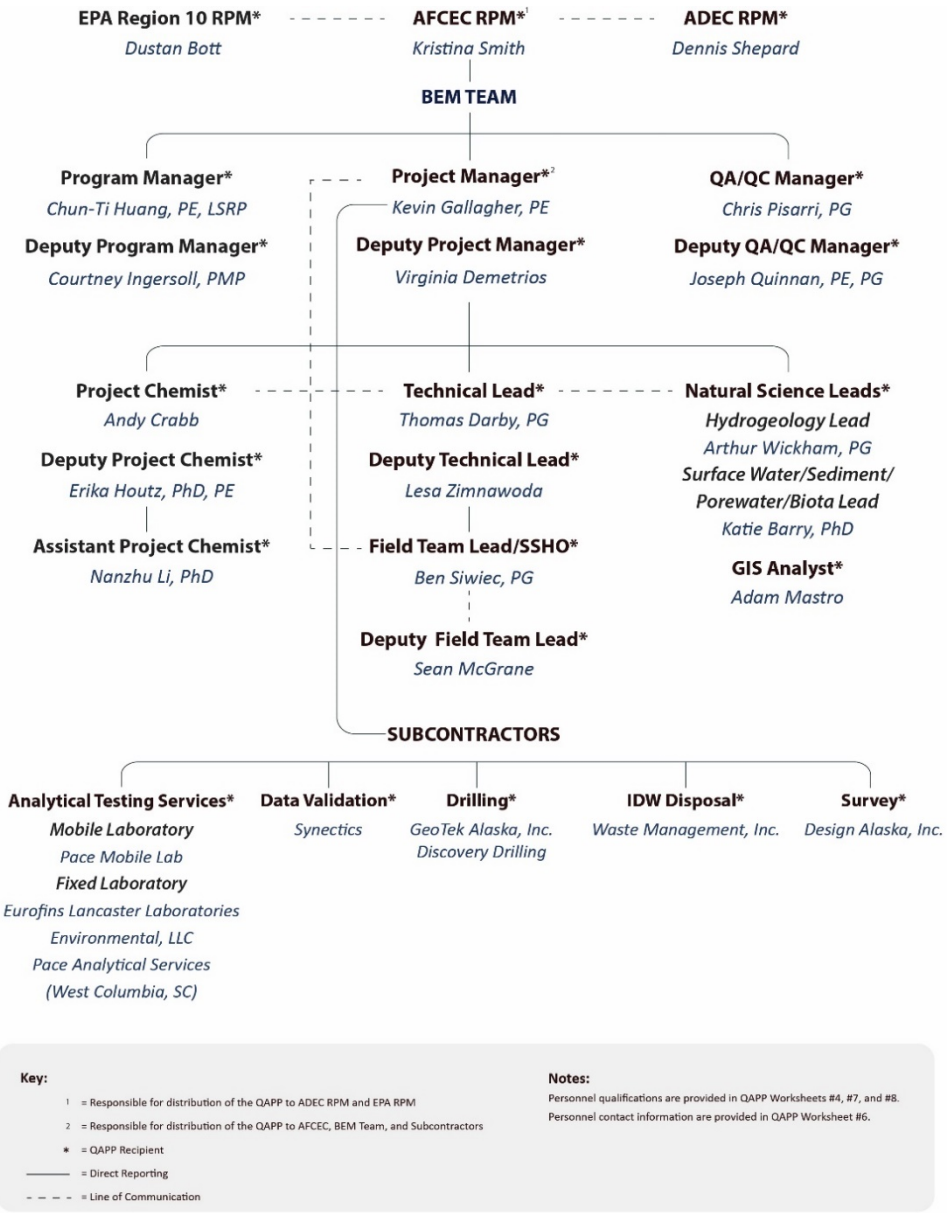
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QAPP WORKSHEET #3 & #5: PROJECT ORGANIZATION AND QAPP DISTRIBUTION

(UFP-QAPP Manual Sections 2.3 – 2.4)
(USEPA 2106-G-05 Sections 2.2.3 and 2.2.4)

Figure 2 represents the lines of authority and communication and the QAPP distribution list specific to EAFB.

Figure 2. Project Organization



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QAPP WORKSHEET #4, #7, & #8: PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(USEPA 2106-G-05 Sections 2.2.1 and 2.2.7)

This worksheet is used to identify key site-specific personnel for each organization performing tasks defined in this QAPP.

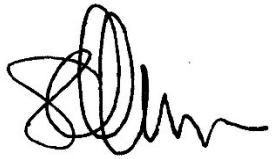
LEAD ORGANIZATIONS: AFCEC, EAFB, USEPA Region 10, and ADEC

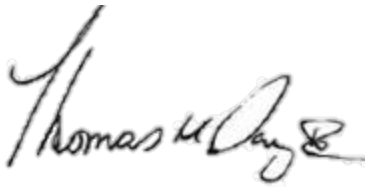
Name	Agency	Project Title/Role	Signature
Kristina Smith	AFCEC, 354th Civil Engineering Squadron (CES)	RPM	
Dennis Shepard	ADEC	RPM	
Dustan Bott	USEPA Region 10	RPM	

Note:
[1] Signature checkboxes indicate personnel have read and agree to implement this QAPP as written.
For acronym definitions, refer to List of Acronyms and Abbreviations.

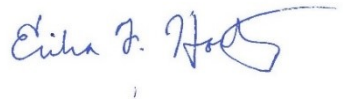
ORGANIZATION: BEM Team

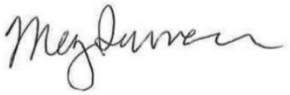
Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
Kevin Gallagher	Project Manager	B.S. and M.S. Civil Engineering, 10 years of experience conducting/ managing DoD funded projects, including construction, demolition, renovation, and repair projects that incorporated hazardous material removal, PFAS contaminated material treatment and disposal, and air quality improvement for	• PE: Alaska • Occupational Safety and Health Administration (OSHA): Initial 40-Hour Hazardous Waste Operations and Emergency Response (HAZWOPER)	

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
		USACE, Army Directorate of Public Works (DPW), and Air Force 354th CES.	• USACE Construction Quality Management (CQM) Certification	
Christopher Pisarri	QA/ QC Manager	B.A. Geology, 24 years of experience conducting/managing construction, demolition, and remediation projects, including environmental assessment, site investigations, remedial investigations, and remediation action projects for AFCEC and USACE. Project/Program Manager for four basewide RIs involving collection and analysis of samples multiple media for PFAS, has led and participated in scoping and Restoration Advisory Board meetings, including at EAFB.	• OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) and Site Supervisor • USACE CQM Certification • USEPA and American Society for Testing and Materials (ASTM) Qualified Professional for All Appropriate Inquiry Investigations • Professional Geologist (PG): New York	
Joe Quinnan	Deputy QA/QC Manager	B.S. Geological Engineering, M.S. Geological Engineering. PE, PG, 29 years' experience in environmental consulting and 8 years' experience with PFAS. Arcadis' Global Director of Site Investigation, North American Director of Emerging Contaminants, QA Manager for Army PA/SI Program, QA Manager for USAF PFAS portfolio, and principal investigator for 3 Environmental Security Technology	• PE: Wisconsin • PG: Wisconsin	

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
		Certification Program (ESTCP) projects: PFAS mobile lab and stratigraphic flux, SPAC-CMF filter for PFAS treatment, and soil washing for PFAS source zone treatment.		
Virginia "Ginna" Demetrios	Deputy Project Manager	B.A. Geography, 28 years of experience conducting/managing environmental investigations and remediation projects for various DoD clients including AFCEC and USACE. Investigations included emerging contaminants.	• OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) and Site Supervisor • Department of Transportation (DOT)/ International Air Transport Association (IATA) Hazardous Materials Transport • First Aid / Cardiopulmonary Resuscitation (CPR)	
Thomas Darby	Technical Lead	B.S. Geology, M.S. Hydrogeology, 15 years of experience. Smart Characterization Practice Area Lead under the SI Community of Practice. Technical lead for one large scale PFAS investigation involving collection and analysis of samples from soil, groundwater, surface water sediment.	• PG: South Carolina, North Carolina, Georgia, Mississippi • OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) • First Aid / CPR	
Lesa Zimnawoda	Deputy Technical Lead	B.S. Environmental Science (Biology). 13 years of experience in project management and 16 years	• Certified Environmental Specialist • OSHA 40-hour HAZWOPER	

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
		of experience in environmental investigations and remediation projects, PFAS/PFOA sample collection management, statistical analysis, and natural resource investigations. Has supported community involvement meetings for AFCEC Alaska projects.	• OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) • OSHA: 30-Hour Construction Safety and Health (S&H) • OSHA: Initial 40-hour Asbestos Abatement and 8-hour Refresher • USACE EM-385 40-hour training • USACE CQM • DOT/ IATA Hazardous Materials Transport • AK-CESL • Sustaining member of Interstate Technology & Regulatory Council (ITRC)	
Andrew Crabb	Project Chemist	B.A., Chemistry, 27 years of experience in chemistry and QC. Over 20 years as BEM's Program or Project Chemist for over 250 Task Orders issued by the DoD and over 200 projects conducted for State and commercial clients. He has conducted and reviewed audits of analytical testing laboratories for Federal and State clients and is familiar with analytical testing methods conducted for	• USEPA Region II Contract Laboratory Program Data Validation Training • USAF Environmental Resources Program Info Management System (ERPIMS) requirements	

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
		different parameters, including emerging contaminants.		
Erika Houtz	Deputy Project Chemist	BS Chemical Engineering MS Environmental Engineering PhD Environmental Engineering PFAS Analytical Lead. 13 years of experience in site characterization and remediation.	• PE: California • OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8)	
Nanzhu Li	Assistant Project Chemist	PhD Environmental Management MS Environmental Science BS Environmental Engineering 6 years of experience conducting data validation, statistical analysis and data management utilizing ERPIMS and Naval Installation Restoration Information Solution (NARIS). Assistant Project Chemist for four (4) basewide RIs involving reports review from the 3rd part data validator and submitting field and analytical data into ERPIMS.	• OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) • AFCEC ERPToolsX Training, 2016	
Arthur “Artie” Wickham	Hydrogeology Lead	B.S. Geosciences (Geology), M.S. Hydrology. 8 years of experience in project management, geology, and hydrogeology in environmental remediation. Currently managing three large-scale PFAS RIs in Colorado and South Dakota.	• PG: California and Wyoming • Certified Hydrogeologist (CHG): California • OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8)	

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature
			• First Aid / CPR • Sustaining member of ITRC	
Meg Iannacone	Hydrogeology Support	B.S. Environmental Studies, M.S. Hydrogeology, 13 years of experience in Site Remediation and Aquifer Characterization.	• PG: New York • OSHA: Initial 40-Hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8)	
Ben Siwiec	Field Team Lead and Site Safety and Health Officer (SSHO)	B.S. Geology, M.S., Geology; 16 years of experience as a professional geologist and has over 12 years of experience in environmental site and remedial investigations, including sample collection for PFAS at EAFB.	• PG: Alaska • OSHA 40-hour HAZWOPER • OSHA: HAZWOPER 8-Hour Refresher 29 CFR 1910.120€(8) • Federal Emergency Management Agency (FEMA) IS-001000 Introduction to the Incident Command System, ICS-100 • USACE EM-385 40-hour training • First Aid / CPR • EAFB Air Field Driver's Course	

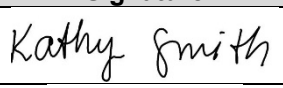
Notes:
For acronym definitions, refer to List of Acronyms and Abbreviations.

285 **ORGANIZATION:** Eurofins Lancaster Laboratories Environmental (ELLE)

Name	Project Title/Role	Education/Experience	Signature
Stephen J Gordon	PM	B.S. Chemistry. 23 years of experience with analytical chemistry, including bench testing, data validation, six years' experience as a project manager with Eurofins Lancaster Laboratories handling DoD projects, and 4 years of PFAS project experience.	
Dorothy Love	QA Director	B.S. Environmental Health. QA Director 5+ years; QA Manager 17 years	

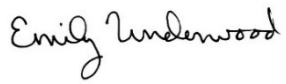
286 **Note:**
287 For acronym definitions, refer to List of Acronyms and Abbreviations.
288

289 **ORGANIZATION:** Pace Analytical Services, LLC (Pace) – Fixed Laboratory (West Columbia, South Carolina)

Name	Project Title/Role	Education/Experience	Signature
Kathy Smith	PM	B.S. Environmental Science. 20 years of environmental laboratory experience.	
Kelly Nance	QA Manager	B.S. Biology. 19 years of experience	

290 **Note:**
291 For acronym definitions, refer to List of Acronyms and Abbreviations.
292

293 **ORGANIZATION:** Environmental Synectics, Inc. (Synectics)

Name	Project Title/Role	Education/Experience	Signature
Emily Underwood	Senior Data Manager	B.S. Environmental Science. 13 years of experience.	

294 **Note:**
295 For acronym definitions, refer to List of Acronyms and Abbreviations.

296 **ORGANIZATION:** Pace Mobile Lab

Name	Project Title/Role	Education/Experience	Signature
Mike Rossi	Program Manager, Mobile Lab services	B.S. Chemistry, M.S. Environmental Engineering/25 years working for a laboratory. Manager for ESTCP mobile laboratory demonstration.	
Helmer Kerb	Lead Chemist	B.A. Chemistry. 40 years of experience in a laboratory. Lead chemist for the ESTCP mobile laboratory.	

297 **Note:**
298 For acronym definitions, refer to List of Acronyms and Abbreviations

QAPP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)
(USEPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Client agency interface	AFCEC	Kristina Smith Mike Boese Tracy Kissler	907-377-4299 kristina.smith.10@us.af.mil 907-384-3239 michael.boese.1@us.af.mil 201-478-1819 201-478-1819 tracy.kissler@us.af.mil	Primary POCs for client interface in support of the project.
Stop work because of safety issues	BEM Field Team Lead and SSHO	Ben Siwiec	907-223-8578 bsiwiec@bemsys.com	Onsite personnel will notify the BEM Team SSHO immediately who will then notify the BEM Team PMs (verbal, electronic) and BEM's Corporate Health and Safety Manager within 1 hour of the event, after determined all site personnel were safe or treated appropriately. The BEM Team PM will notify AFCEC RPM (verbal, electronic).
	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 kgallagher@bemsys.com 415-813-8030 virginia.demetrios@arcadis.com	
	Subcontractors/ Field Team	Sean McGrane Glenn Rawson	301-395-6952 907-406-5271	

Stop work because of injury to more than one worker or injury requiring treatment	BEM Field Team Lead and SSHO	Ben Siwiec	907-223-8578	Onsite personnel will immediately notify the BEM Team SSHO who will then notify the BEM Team Project Managers (verbal, electronic) and BEM's Corporate Health and Safety Manager within 1 hour of the event, after determined all site personnel were safe or treated appropriately. The BEM Team PM will immediately notify AFCEC RPM (verbal, electronic). The notification will be followed by an investigation and written report of the incident.
	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	
	Subcontractors/ Field Team	Sean McGrane Scott Vjoita	301-395-6952 907-240-8190	
Stop work because of quality issues	BEM Field Team Lead and SSHO	Ben Siwiec	907-223-8578	Onsite personnel will notify the BEM Team SSHO immediately who will then notify the BEM Team PM and the QA/QC Manager within 1 hour. The BEM Team PM will then notify AFCEC RPM (verbal, electronic) by the end of the day. AFCEC RPM will then notify and seek approval from ADEC and USEPA RPMs.
	BEM Team QA/QC Manager	Joseph Quinnan	248-789-4951	
	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	
	Subcontractors/ Field Team	Sean McGrane Scott Vojta	301-395-6952 907-240-8190	
QAPP changes before fieldwork	BEM Team, PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	BEM Team PM will notify AFCEC RPM (verbal, electronic) and obtain concurrence before proceeding. AFCEC RPM will then notify and seek approval from ADEC and USEPA RPMs.

QAPP changes during project execution	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	BEM Team PM will notify AFCEC RPM (verbal, electronic) and will issue FCF to notify the AFCEC and regulatory RPMs (USEPA and ADEC) as stated in this QAPP before proceeding. Details regarding the use of the FCF are described in Worksheet 17.
Field Corrective Actions (CAs)	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	The BEM Team PM will develop field CAs within 24 hours of notification and will communicate the CAs to the BEM Team. Field Team Lead/SSHO who will then communicate the CAs to the field team.
	BEM Field Team Lead and SSHO	Ben Siwiec	907-223-8578	
	Subcontractors/ Field Team	Sean McGrane Scott Vjoita	301-395-6952 907-240-8190	
Sample receipt variances	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	The BEM Team PM will notify the BEM Team Project Chemists within 24 hours of sample receipt.
	BEM Team Project Chemists	Andrew Crabb Erika Houtz	330-738-2081 acrabb@bemsys.com 415-432-6947 Erika.houtz@arcadis.com	

Laboratory QC variances	ELLE PM Pace PM Pace Mobile Lab PM	Stephen Gordon Kathy Smith Mike Rossi	717-556-4656 stephen.gordon@eurofinset.com 412-525-0071 Kathy.smith@pacelabs.com 802-839-0544 mike.rossi@pacelabs.com	The laboratory will report QA/QC issues with project field samples to the BEM Team PM within 2 business days of identification of the technical concern.
Analytical CAs	BEM Team Project Chemist	Andrew Crabb Erika Houtz	330-738-2081 415-432-6947	The BEM Team Project Chemist will respond to the issue reported by the laboratory with potential CAs (verbal, written, or electronic) within one week of notification. The BEM Team PM will notify AFCEC if the changes to the data impact reports/data that have already been submitted. Otherwise, a memorandum documenting CAs will be included with the validated data.
Data verification issues (incomplete records)	ELLE PM Pace PM Pace Mobile Lab PM	Stephen Gordon Kathy Smith Mike Rossi	412-525-0071 803-227-2704 802-839-0544	The laboratory will report verification issues to the BEM Team PM and the BEM Team Project Chemist via email within 24 hours of identifying the technical concern.
Data validation issues; noncompliance with procedures	Synectics	Emily Underwood	emily.underwood@synectics.net 916-737-4023	Synectics (data validator) will notify the BEM Team PM and the BEM Team Project Chemists of data validation issues within 24-

	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	hours of identification. 303
Data review of CAs	BEM Team Project Chemists	Andrew Crabb Erika Houtz	330-738-2081 415-432-6947	The BEM Team PM will communicate data review issues with the BEM Team Project Chemist who will determine the need for data review CAs. The BEM Team PM and Project Chemist will communicate necessary data review CAs with the contract laboratory within 48 hours of identifying CAs.
	BEM Team PMs	Kevin Gallagher Ginna Demetrios	907-347-8421 415-813-8030	

304 **Note:**
305 For acronym definitions, refer to List of Acronyms and Abbreviations.
306

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QAPP WORKSHEET #9: PROJECT PLANNING SESSION SUMMARY

(UFP-QAPP Manual Section 2.5.1 and Figures 8-14)
(USEPA 2106-G-05 Section 2.2.5)

The project planning session summaries presented below are specific to the RI for PFAS at Various Sites at EAFB. Meeting minutes are provided in **Appendix C**.

Participants: The key participants who have been involved in the EAFB RI for PFAS at Various Sites Kickoff Meetings are listed below.

Name	Initials	Organization	Project Title/Role	Email
Kristina Smith	KS	AFCEC	RPM	kristina.smith.10@us.af.mil
Michael Boese	MB	AFCEC	Alternative RPM	michael.boese.1@us.af.mil
Joseph Price	JP	AFCEC	POC	joseph.price.17@us.af.mil
Ted Holly	TH	EAFB	POC	ted.holly@us.af.mil
Roy Willis	RW	AFCEC/ CZOP	Chief, Environmental	roy.willis@us.af.mil
Shannon Garcia	SHG	AFCEC/ CZTE	Risk Assessment	shannon.garcia.3@us.af.mil>;
Hunter Anderson	HA	AFCEC/ CZTE	Lysimetry/ Source evaluation	richard.anderson.55@us.af.mil
Seb Gillette	SG	AFCEC/ CZTE	Chemist	john.gillette.1@us.af.mil
Dennis Shepard	DS	ADEC	RPM	dennis.shepard@alaska.gov
Dustan Bott	DB	USEPA Region 10	RPM	Bott.Dustan@epa.gov
Mark Nardolillo	MN	BEM	CEO/Corporate Sponsor	mnardolillo@bemsys.com
Chun-Ti Huang	CH	BEM	Program Manager	chuang@bemsys.com
Kevin Gallagher	KG	BEM	Project Manager	kgallagher@bemsys.com
Chris Pisarri	CP	BEM	QA/ QC	cpisarri@bemsys.com
Andrew Crabb	AC	BEM	Project Chemist	acrabb@bemsys.com
Lesa Zimnawoda	LZ	BEM	Deputy Technical Lead	lzimnawoda@bemsys.com
Adam Mastro	AM	BEM	Field Team Lead/ SSHO	amastro@bemsys.com
Artie Wickham	AW	BEM	Hydrogeologist Lead	awickham@bemsys.com

Name	Initials	Organization	Project Title/Role	Email
Meg Iannacone	MI	BEM	Hydrogeologist Support	mlannacone@bemsys.com
Courtney Ingersoll	CI	Arcadis	Deputy Program Manager	Courtney.Ingersoll@arcadis.com
Ginna Demetrios	GD	Arcadis	Deputy Project Manager	Virginia.Demetrios@arcadis.com
Joseph Quinnan	JQ	Arcadis	Deputy QA/QC Manager	Joseph.Quinnan@arcadis.com
Thomas Darby	TD	Arcadis	Technical Lead	Thomas.Darby@arcadis.com
Theresa Olechiw	TO	Arcadis	Assistant Deputy Program Manager	Theresa.Olechiw@arcadis.com
Lauren Henderson	LH	Arcadis	Staff Scientist	Lauren.Henderson@arcadis.com
Marissa McCann	MM	Arcadis	Senior Scientist	Marissa.McCann@arcadis.com
Lauren Quiq	LQ	Arcadis	Staff Engineer	Lauren.Quig@arcadis.com

Date of Planning Session: 19 August 2020
Location: Teleconference
Purpose: EAFB RI for PFAS at Various Sites at EAFB, Alaska Kickoff Meeting
Participant Initials: KS, MB, TH, SHG, HA, SG, MN, CP, AW, LZ, CI, JQ, GD, TD, LQ, LH, MM, TO, LH, MM, and LQ.
Summary of Discussion Topics: See **Appendix C**
Documented Changes since Planning Session: See **Appendix C.**

Date of Planning Session: 01 September 2020
Location: Teleconference
Purpose: EAFB RI for PFAS at Various Sites at EAFB, Alaska Regulatory Scoping Meeting
Participant Initials: KS, MB, JP, RW, SHG, HA, SG, DS, DB, MN, CP, AW, LZ, CI, JQ, GD, TD, LQ, MC, and TO.

Documented Changes since Planning Session: See **Appendix C.**
Date of Planning Session: 22 December 2020
Location: Teleconference
Purpose: EAFB RI for PFAS at Various Sites at EAFB, Alaska Triad Training Session 1
Participant Initials: KS, MB, JP, RW, SHG, DS, DB, MN, CP, AW, LZ, JQ, GD, and TD.
Documented Changes Since Planning Session: See **Appendix C.**

Documented Changes since Planning Session: See **Appendix C.**
Date of Planning Session: 21 January 2021
Location: Teleconference
Purpose: EAFB RI for PFAS at Various Sites at EAFB, Alaska Discussion on Vertical Aquifer Profile (VAP) Transects 4 and 5 Locations
Participant Initials: KS, MB, RW, CP, LZ, and TD.
Documented Changes Since Planning Session: See **Appendix C.**

Documented Changes since Planning Session: See **Appendix C.**
Date of Planning Session: 27 January 2021
Location: Teleconference
Purpose: EAFB RI for PFAS at Various Sites at EAFB, Alaska Triad Training Session 2
Participant Initials: KS, MB, RW, SG, DS, DB, MN, CP, KG, LZ, AW, JQ, GD, TD, and MM.
Documented Changes Since Planning Session: See **Appendix C.**

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QAPP WORKSHEET #10: CONCEPTUAL SITE MODEL

(UFP-QAPP Manual Section 2.5.2)
(USEPA 2106-G-05 Section 2.2.5)

The CSM for the EAFB's validated PFAS Source Areas are presented in detail in the following section. The CSM is based on the current site information and will be updated as new data becomes available. The data collected for the RI at EAFB will be used to define the nature and extent of specific PFAS compounds (24 compounds, specifically PFOS, PFOA, and PFBS) in multiple media for 13 validated PFAS source areas (and 2 subsites), as well as basewide as stated in the 23 June 2020 Statement of Work. The RI will utilize the adaptive management plan process as outlined in the USEPA Triad Process (USEPA, 2001) and will also incorporate methods previously identified in AFCEC Broad Agency Announcement (BAA) 967 and the Environmental Security Technology Certification Program (ESTCP).

Background Information & Physical Setting

EAFB is located within Fairbanks North Star Borough, approximately 25 miles southeast of Fairbanks and approximately one mile southeast of Moose Creek, Alaska **(Figure 1**). According to the 2010 census, there were 747 people and 332 households residing in Moose Creek, Alaska (U.S. Census Bureau, 2010). EAFB encompasses an area of approximately 19,700 acres and current operations include industrial areas, aircraft maintenance and operations, an active runway and associated facilities, administrative offices, and residential and recreational facilities. Approximately 3,651 acres of the base is improved or partially improved land. There are 16,139 acres of undeveloped land including forests, wetlands, lakes, and ponds. The community of Moose Creek abuts the northern boundary of EAFB and the Salcha area community lies a few miles south of the Base. EAFB is in a relatively undeveloped area. The Base is bordered on the north, east, and west by undeveloped military reservation lands. A mixture of commercial, light industrial, and residential areas, as well as recreational areas, have been developed in a narrow corridor along the Richardson Highway between the Base and Fairbanks (AECOM, 2013).

EAFB was constructed on the floodplain of the Tanana River. The floodplain is relatively flat with meandering streams and a complex network of shallow swales. Approximately 89 percent (%) of EAFB is flat alluvial floodplain with elevations ranging from 520 to 556 feet above mean sea level (amsl). The remaining 11% of the EAFB occurs in the uplands along the eastern edge of the valley. Elevations in the main industrial area surrounding the flight line range from 548 to 556 feet amsl. In the uplands at the northeast extent of the EAFB is Engineer Hill, which reaches 1,000 feet amsl. The highest elevation on EAFB is 1,125 feet amsl, which occurs on Quarry Hill in the uplands at the southeastern corner of the base (Sundance, 2019a).

Regional Geology and Hydrogeology

EAFB occupies part of a tectonic basin that is filled with alluvium, primarily shed from the Alaska Range. Along the eastern edge of the base, metamorphic bedrock (Birch Creek Schist) crops out as the Yukon-Tanana Uplands; Moose Creek Bluff, a metamorphic bedrock inselberg, rises above the floodplain 3.4 miles to the northwest of the base. Tanana River deposits fill the basin beneath EAFB and consists of unconsolidated fluvial sands and gravels with rare, interspersed lenses of silt. These deposits have been estimated to be approximately 250 to 400 feet thick. Unmodified by human activity, the uppermost 10 to 15 feet of basin-fill commonly consist of silts and sands (Swift River, 2019).

The Birch Creek Schist underlies the unconsolidated sedimentary deposits in the vicinity of EAFB. However, the unconsolidated deposits do not extend far up the hill slopes. Groundwater flows down the hill slopes within the Birch Creek Schist and within the overlying sediments of the valley fill toward the basin. Alluvial fans fine toward their distal ends. These fan deposits are typically much finer than the braided river deposits encountered at EAFB, causing the boundary effect. However, the thickness of the alluvial fans is unknown. It is likely that at least a portion of the fans have pushed out over older braided river deposits. If this is the case, the groundwater flow direction in the deep part of the aquifer could be more westerly than the shallow flow direction (Sundance, 2019b).

The Tanana Basin aquifer is composed of a heterogeneous mixture of gravelly sands and sandy gravels. Although the aquifer is generally very permeable, this heterogeneity causes local changes in groundwater flow velocity. Groundwater depths range from the ground surface in wetland areas to 10 to 15 feet below ground surface (bgs) in developed areas of EAFB, and regional groundwater flow is generally from southeast to the northwest along the axis of the Tanana River floodplain. Contaminants released in this environment tend to migrate relatively slowly through the fill material near the ground surface and very rapidly in the aquifer sediments. The plume shapes are expected to be complex because of the changes in groundwater velocity encountered in braided river sediments (Sundance, 2019b). Limited data are available to assess groundwater flow at a larger scale, including north of EAFB between EAFB and Moose Creek Dam, but groundwater flow direction varies from the north across most of EAFB to northwesterly at the northern boundary of EAFB near the community of Moose Creek (AFCEC, 2019), and more westerly north of the community of Moose Creek due to the presence of Moose Creek Bluff (Ahtna, 2020).

Recharge to the Tanana Basin aquifer is from precipitation, snowmelt, and infiltration from stream beds. Historical water-level data indicates that recharge typically increases from April through May, often beginning in late March and continuing through mid-June, indicating recharge from snowmelt and from high water levels in the rivers and streams. Water-level declines begin in July or August. The largest recharge to the aquifer is from the Tanana River during periods of high flow. There also is recharge from the Birch Creek Schist from

groundwater flowing down the hill slopes to the valley. The wetlands at the foot of the uplands, to the east of EAFB, are likely fed from this source and precipitation perched on permafrost. Therefore, the wetlands also may lose water to the Tanana Basin aquifer. The sloughs at or near EAFB are likely to be at the same elevation as the groundwater. EAFB is surrounded by wetland areas and on the eastern side of the base, these wetlands likely recharge groundwater (CH2MHill, 2018a).

Water supply wells in the underlying Birch Creek Schist, which is an inferior water-bearing formation, seldom yield more than 10 gallons per minute (gpm). Of more significance in terms of well yield are the sediment-filled valleys along the mountain slopes (CH2MHill, 2018a). These valleys are commonly underlain with sand and gravel, and wells screening within these deposits may yield 100 gpm or more (Sundance, 2019b). The sands and gravels underlying the Tanana River Valley (braided river deposits) provide large quantities of water (1,000 gpm or more) to wells. This unit has been called the Tanana Basin aquifer. Well yields of up to 3,400 gpm with minimal drawdown have been reported for this region. Recharge is predominantly from seepage into the aquifer from stream beds during periods of meltwater rather than from precipitation (CH2MHill, 2018a).

Site-Specific Background, Geology, and Hydrogeology

The developed area of EAFB is located over a shallow, unconfined aquifer with groundwater often occurring at less than 15 feet bgs. The aquifer is greater than 250 feet thick, extends to the underlying bedrock, and has a regional gradient of approximately 5 feet per mile flowing to the north-northwest. Along the flight line, the hydraulic gradient varies; over a 3,750-foot distance, a decline in the head of 4 feet has been observed, yielding a gradient of 0.0011 (Sundance, 2019b). Similarly, a horizontal hydraulic gradient averaging 0.00103 foot/foot (ft/ft) was observed from February 2018 to July 2019 data (Ahtna, 2020). Using this gradient with a hydraulic conductivity of 240 feet per day (based on a transmissivity of 800,000 gallons per day per foot), a 450-foot thickness, and a porosity of 0.3, the estimated groundwater flow velocity is approximately 320 feet per year. However, it is likely that the groundwater velocity is highly variable (Sundance, 2019b) based upon the underlying stratigraphy and occurrence of paleo-streambed channels.

Groundwater levels vary seasonally, rising during snowmelt and declining in winter. Long-term historical data shows that water levels do not greatly fluctuate from year to year. Snowmelt in the springtime leads to short periods of water level increases (a few feet). This indicates a stable flow system that is in dynamic equilibrium with seasonal recharge patterns. At most locations on EAFB, two peaks can be observed: a peak in late April/May consistent with significant snowmelt, and a second peak from July through September, consistent with increased cumulative precipitation. While the water levels fluctuate from late spring to late summer, the horizontal hydraulic gradient remains fairly stable in both magnitude and direction (Ahtna, 2020).

Generally, groundwater is encountered at or less than 10 feet bgs across EAFB, and seasonal fluctuation ranges from 1.5 to 2 feet (EA, 2008). The depth to groundwater measured during previous investigations varies from 2.20 feet bgs along Garrison Slough to 11.9 feet bgs at AFFF Area #8 - Former Fire Training Area (FTA) near the Antenna Farm (Subsite FT092). Based on water levels in five (5) well clusters (HCMW01 through HCMW04 and HCMW06), a slight upward vertical gradient (0.008 ft/ft in the southern portion of EAFB at HCMW06, 0.003–0.007 ft/ft in the center of EAFB at HCMW04, and 0.0002–0.0025 ft/ft in the northern portion of EAFB at HCMW01 through HCMW03) is present across most of EAFB. At one (1) location on the east side of the Base (HCMW05), there is a downward gradient (0.005–0.007 ft/ft), which is consistent with the downward infiltration of recharge entering the floodplain from the uplands. The dominance of horizontal flow with a slight upward gradient across most of EAFB is significant with respect to contaminant transport because it will tend to minimize the downward movement of contaminants to deeper portions of the aquifer (Ahtna, 2020).

EAFB uses the local aquifer for its drinking water and monitors groundwater quality in several onsite locations. Eight (8) groundwater drinking water wells are located at EAFB, and a ninth well provides drinking water strictly for the military working dogs. Of the eight (8) drinking water wells, five (5) are primary and supply EAFB with drinking water, a sixth is a standby/backup well to the main drinking water system, and two (2) (one at Hursey Gate and one at the Bear Lake Family Camp) supply single facilities. The wells that supply the primary drinking water distribution system range in depth from 89 to 160 feet bgs and have pumps set at between 42 and 106 feet bgs (although the installation depth of one pump is unknown) (CH2MHill, 2018a). The EAFB water supply wells can produce approximately 1,000 gpm, with the exception of one that is reportable capable of producing 2,500 gpm (Sundance, 2019b).

Several surface water bodies exist at EAFB, including Garrison Slough, Piledriver Slough, Moose Creek, French Creek, wetlands, multiple ponds, and lakes. The headwaters of Garrison Slough begin south of EAFB, east of both the Richardson Highway and Salcha, Alaska. Garrison Slough meanders north through undeveloped wetland and forest areas near the Richardson Highway and continues north near the former landfill site (LF005) before entering the airfield. From the airfield, Garrison Slough flows north toward Garrison Slough Pond (SS035). According to aerial photos, Garrison Slough was re-routed in the 1950s and channelized in its present location as it flows northward through the industrialized portion of EAFB. The slough passes near several designated contamination source areas for PFOS/PFOA along the way. Garrison Slough exits the EAFB boundary near the town of Moose Creek and ultimately drains to Moose Creek (Jacobs, 2019). Surface water levels in Garrison Slough (relative to groundwater elevations) and stable isotope data indicate the slough receives water from the aquifer along most of its length (Ahtna, 2020).

Piledriver Slough, located west of the EAFB runway, is groundwater fed south of the Base and discharges to the Tanana River near the Moose Creek Dam. Flows in Piledriver Slough have been measured between 50 and 75 cubic feet per second (cfs) in the northern part and between 2 to 8 cfs in the southern part. Moose Creek and French Creek originate to the east and southeast of EAFB, respectively, in the Yukon-Tanana Uplands. French Creek joins Moose Creek at the northeast edge of EAFB and together they discharge to Piledriver Slough northwest of Eielson AFB (Ahtna, 2020).

Permafrost

The Tanana Valley contains permafrost. Permafrost in the area is discontinuous and is generally absent on south-facing slopes and underneath large or warm surface water bodies. Where permafrost exists, the alluvial aquifer is divided into supra (above)- permafrost and sub (below)-permafrost portions. Permafrost can have a significant effect on groundwater and surface water flow. Supra-permafrost groundwater can create a shallow aquifer that is generally unconfined in the summer months. Seasonal frost may cause an unconfined supra-permafrost aquifer to become confined during the winter or it can completely freeze the supra-permafrost portion of the aquifer. The sub-permafrost portion of the aquifer is generally confined except where discontinuities, known as open taliks, connect sub- and supra-permafrost groundwater. Shallow permafrost, especially in low-lying areas, contributes to the formation of wetlands, which are prevalent in the landscape. The presence of permafrost is a controlling factor in groundwater dynamics in the Tanana River floodplain (Ahtna, 2020).

Permafrost is present along the Yukon-Tanana Uplands on the eastern side of EAFB and between Piledriver Slough and Tanana River. The occurrence of permafrost along the western side of Piledriver Slough is uncertain due to the lack of data. Limited observations indicated the occurrence of very deep and thin permafrost between the developed portion of EAFB and Piledriver Slough, but the presence of a continuous zone of permafrost at this location is uncertain (Ahtna, 2020).

The community of Moose Creek is located within an area regionally characterized by discontinuous permafrost; therefore, permafrost may be present in the subsurface. Data regarding the distribution of permafrost within the community is limited and what is available is biased to the shallow subsurface, between 40 and 100 feet bgs. Residential well logs on file at the Alaska Department of Natural Resources (ADNR) do not document the presence of permafrost in the community.

Historical PFAS Investigations

PFAS specific environmental investigations have been ongoing at EAFB since 2014. Specifically, PFOA and PFOS have been investigated in multiple media on and off base. Previous PFAS investigations have evaluated a number of potential source areas which include FTAs, Hangars, Fire Stations, Emergency Responses potentially involving the use of AFFF, AFFF spray test areas, AFFF spills, and drinking water wells. **Figures 3 through 7** depict previous investigative areas and include the sample locations and analytical results. Described below are summaries of previous PFAS investigations conducted at EAFB.

- A PA was conducted to identify locations at EAFB where PFCs may have been released and to assess possible migration pathways and receptors of potential contamination. A total of 41 sites were investigated and of the 41 sites, 23 sites (56%) were determined to have potential releases of AFFF. Also, PFOS was detected in five (5) drinking water supply wells at concentrations greater than the USEPA provisional health advisory (PHA) level of 0.2 micrograms per liter (µg/L) (CH2M Hill, 2015).

- In 2014, an SI was conducted at four (4) sites (Sites 1 through 4) at EAFB to determine whether PFCs were present at the facilities (SES, 2015). SI activities included the collection of vadose zone soil samples within the source areas, groundwater samples at existing wells or grab samples from soil borings (in the absence of wells), and surface water and sediment samples where appropriate. Surface soil samples exceeded the current PFOS and/or PFOA ADEC migration to the groundwater (MTGW) cleanup levels of 0.003 milligram per kilogram (mg/kg) and 0.0017 mg/kg, respectively, (18 Alaska Administrative Code [AAC] 75, 2018) at all four (4) sites. Subsurface soils exceeded PFOA and/or PFOS ADEC MTGW cleanup level at three (3) of the four (4) sites. Surface and/or subsurface soil exceeded the current USEPA regional screening level (RSL) of 0.126 mg/kg (Hazard Quotient [HQ]=0.1) at Site 2 and Site 3. Groundwater samples exceeded the USEPA PHA levels for PFOS (0.2 µg/L) and PFOA (0.4 µg/L) at each site. Two (2) surface water (primary and duplicate) and one (1) sediment sample were collected from Garrison Slough adjacent to Site 3 only. The surface water sample results (primary and duplicate) exceeded the USEPA PHA for PFOA and PFOS. Only PFOS was detected in the sediment sample and at concentrations below the current USEPA RSL (SES, 2015).

- Between 2015 and 2016, groundwater investigation activities were conducted at four (4) areas identified as Transmitter Road, Community of Moose Creek, Western Area, and Chena Floodplain to evaluate for the presence and distribution of PFOA/PFOS in groundwater, surface water, and/or private drinking water in the northern and western base areas and off-base in the community of Moose Creek. Groundwater sampling in the northern base area via temporary wells identified PFOA/PFOS concentrations in exceedance of the USEPA Lifetime Health Advisory (LHA) of 0.07

µg/L at depths up to 100 feet bgs. Vertical profiling identified decreasing concentrations with depth except at one location (TW-2). Surface water sampling performed in Garrison Slough and French Creek identified PFOA/PFOS concentrations in exceedance of the USEPA LHA at the Garrison Slough locations only. Private water supply well sampling identified PFOS exceedance of the USEPA LHA in 96% of the water supply samples with the most elevated concentrations directly downgradient of the northern base area, east of Garrison Slough. Multiple investigations and actions have occurred to provide clean drinking water to the residents of Moose Creek. Overall concentrations of PFOA and PFOS generally decreased to the west in the inferred direction of groundwater flow. Groundwater and surface water samples collected along the western boundary of EAFB and the Chena Floodplain (north of Moose Creek) did not identify exceedances of the USEPA LHA for PFOA and PFOS in groundwater or surface water (Piledriver Slough) (USAF, 2017).

- In 2016, SIs were conducted at 15 of the sites identified during the 2015 PA to assess for the presence or absence of PFOA and PFOS in multi-media. PFOS and/or PFOA were detected in soil and/or sediment samples at concentrations above the ADEC MTGW cleanup levels of 0.003 mg/kg and 0.0017 mg/kg, respectively, at nine (9) of the 15 AFFF areas sampled and at one site above the ADEC Human Health cleanup level (under 40-inch zone) of 1.6 mg/kg (ADEC, 2020d). Surface water samples collected from the Waste Water Treatment Plant (WWTP) and Garrison Slough exceed the USEPA LHA of 0.07 µg/L and ADEC groundwater cleanup levels of 0.40 µg/L. PFOS/ PFOA concentrations in groundwater samples exceeded the USEPA LHA and ADEC groundwater cleanup levels at all 15 sites (CH2M Hill, 2018a).

- In 2016, prior to the expansion of the WWTP located adjacent to Garrison Slough Pond, a soil investigation was conducted. PFAS was detected at concentrations above ADEC Human Health cleanup levels around the proposed GAC facility building footprint. Contaminated soil was excavated from the area and PFOA and PFOS were detected at concentrations above the ADEC MTGW cleanup levels (0.0017 mg/kg and 0.003 mg/kg, respectively) in excavation confirmation samples. Confirmation samples were not collected from the additional excavations (Bristol, 2018).

- In 2016, five (5) AFFF releases occurred at Polaris Lake, at the Combat Alert Center (Building 1300), and at the HazWaste Facility (Building 4378). To evaluate the release areas, soil samples were collected at the Polaris Lake and Combat Alert Center spill sites, and surface water samples were collected at the Polaris Lake spill site. At Polaris Lake, PFOA and PFOS were not detected in soil and PFOS was detected in surface water in exceedance of the USEPA LHA (0.07 µg/L). At

582 the Combat Alert Center, PFOS detected in soil exceeded the ADEC MTGW cleanup level (0.003
583 mg/kg). No samples were collected at the HazWaste Facility (ADEC, 2020abc).

584 • In 2019, an RI/Remedial Action was conducted to collect data for RI, a Human Health Risk
585 Assessment (HHRA), and Screening-Level Ecological Risk Assessment (SLERA)/ Baseline
586 Ecological Risk Assessment (BERA). Soil, sediment, porewater, surface water, and biota
587 (macroinvertebrates and fish) samples were collected along an 8-mile length of Garrison Slough
588 (Source Area SS062) within EAFB. PFAS compounds were detected in and near Garrison Slough
589 throughout the occupied portion of EAFB and the preliminary analytical results reported values
590 exceeding screening levels (SLs) in all media (Jacobs, 2020). Screening levels (SI) used for data
591 evaluation included the ADEC MTGW for soil (0.003 mg/kg for PFOA and 0.0017 mg/kg for PFOA),
592 1/10th ADEC human health cleanup level under 40-inch zone (0.16 mg/kg for PFOS and PFOA) for
593 sediment, 1/10th ADEC groundwater cleanup level (0.04 µg/L) for surface water and pore water. No
594 ecological based screening levels were available at the time of the reporting.

595 • In 2019, three (3) groundwater samples were collected from the EIE338 site and analyzed for PFOS
596 and PFOA. Combined PFOA/ PFOS exceeded the current USEPA LHA (0.07 µg/L) in two (2) of the
597 three (3) wells (USACE, 2019).

598 • In 2019, an Expanded PFOA and PFOS Site Inspection for EAFB and Moose Creek was initiated.
599 Seven (7) soil borings were advanced at AFFF Area 9 – Former FTAs located by the Current
600 Entomology Building (FT092 subsite), and six (6) soil borings were advanced at AFFF Area 5 – Fire
601 Station 1. Surface soil and subsurface soil samples were collected from each of the sites. At both
602 sites, PFOS and/or PFOA exceeded the ADEC MTGW cleanup levels (0.003 mg/kg and 0.0017
603 mg/kg, respectively) and/or USEPA RSL (0.126 mg/kg HQ=0.1) in surface soil and subsurface soil.
604 Additionally, 34 temporary groundwater wells were installed and sampled around the perimeter of
605 EAFB and Moose Creek. Six (6) of the temporary wells detected combined PFOS and PFOA at
606 concentrations equal to or exceeding the USEPA LHA (0.07 µg/L) (Sundance, 2020c).

607 • In 2020, under the Expanded PFOA and PFOS Site Inspection, six (6) step out soil borings were
608 completed at AFFF Area 9 – Former FTAs located by the Current Entomology Building (FT092
609 subsite), and seven (7) step out soil borings were completed at AFFF Area 5 – Fire Station 1. Surface
610 soil and subsurface soil samples were collected from each of the sites for laboratory analysis. At both
611 sites, PFOS and/or PFOA exceeded the ADEC MTGW cleanup levels (0.003 mg/kg and 0.0017
612 mg/kg, respectively) and/or USEPA RSL (0.126 mg/kg HQ=0.1) in surface soil and subsurface soil.
613 Additionally, over 50 surface water samples, 23 sediment samples, and 20 soil samples were
614 collected from various water bodies in the eastern and western boundaries of the base and

downgradient (off base) and 21 step out temporary monitoring wells were installed and sampled. The following waterbodies reported exceedances of the USEPA LHA (0.07 µg/L) for PFOA and/or PFOS in one or more surface water samples: Bear Lake, Moose Creek, Moose Lake, Piledriver Slough, and Spruce Lake. There were no exceedances of the USEPA RSL (0.126 mg/kg HQ=0.1) in the sediment or soil samples. Two (2) of the temporary wells detected combined PFOS and PFOA at concentrations equal to or exceeding the USEPA LHA (Sundance, 2020a).

Potential PFAS Source Areas

Localized contamination of the aquifer beneath EAFB from a variety of compounds consisting of fuels, solvents, metals, PFOS, and PFOA have been identified in the industrial area of EAFB and the occurrence of PFOS and PFOA extending beyond EAFB boundary has been documented in several historical studies as described above. The 2013 Five-Year Review (USAF, 2014) indicated that multiple private wells located down-gradient of EAFB were potentially impacted by the offsite occurrence of PFOS and PFOA. The community of Moose Creek is located approximately one (1) to three (3) miles downgradient of the northern end of EAFB and relies on wells installed in the shallow aquifer for drinking water. Drinking water wells in Moose Creek range from 12 to 60 feet bgs (Sundance, 2019b). During the time-critical removal action conducted in Moose Creek, 178 properties with drinking water wells were identified in the community that could have potentially been impacted by the offsite migration of PFOS/PFOA (Sundance, 2019b). From May 2015 through June 2016, 174 private water wells in the community of Moose Creek were sampled, and 170 wells contained PFOA/PFOS in exceedance of the USEPA LHA (0.07 µg/L) (USAF, 2017).

The EAFB Fire Department has responded to four (4) emergencies requiring the application of AFFF to suppress fires or in anticipation of potential landing aircraft fires (mid-1970s to 1994). These include two (2) aircraft incidents, a foaming event completed on a runway, and one (1) building fire. All four (4) incidents involved an unknown amount of AFFF discharge, but large volumes are likely to have been used. Overall, these locations are likely to have impacted media (ADEC, 2020abc).

Table 2. Site-Specific Validated Source Area Summary

Site Number	Name/ Description	Source Area Description	Maximum PFOA/PFOS Concentrations (2014 to 2020)
SS302P	AFFF Area #6, Former Adak Building Fire	AFFF was used to extinguish the Adak Building Fire that burned for approximately 10 to 12 hours, but the release volume of AFFF is unknown.	6.5 micrograms per kilogram (µg/kg) in soil 0.83 µg/L in groundwater

Site Number	Name/ Description	Source Area Description	Maximum PFOA/PFOS Concentrations (2014 to 2020)
SS303P	AFFF Area #2, Air National Guard KC-135 Hangar (Building 1176)	Building 1176 was formerly equipped with an AFFF fire suppression system. There was a reported release of foam that produced 20 vertical feet of foam that may have been pushed out the west doors to the nearby grassy areas. It is unclear if this release was AFFF or high expansion foam, which does not include PFAS.	9.9 µg/kg in soil 9.7 µg/L in groundwater
SS304P	AFFF Area #3, Corrosion Control (Building 1348)	Building 1348 is equipped with an AFFF fire suppression system including a 1,500-gallon tank of AFFF. In 2014, a valve broke and discharged AFFF into the mechanical room. The spill was contained in an oil-water separator that recovered 600 gallons of diluted AFFF. Small amounts of AFFF that has been used in cannon testing may have been pushed out of the hangar doors. It is estimated that approximately 75 to 150 gallons of AFFF used during testing over 15 years has possibly been released.	Soil not sampled 0.89 µg/L in groundwater
SS305P	AFFF Area #12, Hangar (Building 1344)	Building 1344 was formerly equipped with an AFFF system that included a 1,000-gallon AFFF storage tank. In 2000, a system failure caused a small but unknown quantity of AFFF to discharge into the mechanical room. The discharge was contained by the floor drains that connected to the WWTP system. In either 2005 or 2007, up to two larger discharges that were only partially contained occurred, and some AFFF was pushed out of the door to the north.	6.1 µg/kg in soil 0.81 µg/L in groundwater
SS306P	Site 3, Former Ball Field Spray Test Area	In the 1980s, spray pattern tests were performed in the old ball field north of Fire Station 1 (Building 1206) where a significant portion of the surface water runoff enters Garrison Slough. AFFF may have spread beyond the ball field area.	8,900 µg/kg in soil 250 µg/L in groundwater

Site Number	Name/ Description	Source Area Description	Maximum PFOA/PFOS Concentrations (2014 to 2020)
SS307P	AFFF Area #10, Fuel Pump House (Building 1246)	Building 1246 was formerly equipped with an AFFF system that included a 550-gallon storage tank and a pipeline carrying AFFF to the JP-4 tank area. The building also included fuel storage tanks. An accidental activation event occurred in 2016, which sent AFFF to the fuel tanks. In response, the pipes of the AFFF system and the fuel tanks were drained.	Soil not sampled 0.44 µg/L in groundwater
SS309P	AFFF Area #14, Thunderdome (Building 1140)	Building 1140 is equipped with an AFFF fire suppression system including a 1,500-gallon tank of AFFF. There have been two known discharges that were considered large but of unknown quantities: an intentional demonstration of a foam cannon using water, and an accidental system activation. AFFF was pushed out of the doors and drained into a French drain connected to an oil-water separator tank.	81 µg/kg in soil 4.1 µg/L in groundwater
SS310P	Site 1, South Ramp Spray Test Area	The South Ramp Spray Test Area is located at the southern end of the runway between Taxiways H and J. The paved area of the ramp has been used for spray pattern testing since the 1980s. Foam was sprayed on the tarmac to determine the density and thickness of the foam at measured distances and spray angles from the truck.	99 µg/kg in soil 9.7 µg/L in groundwater
SS311P	Site 2, KC-135 Fire	In 1989, an overheated fuel pump exploded on a KC-135 on a parking apron north of the intersection of Taxiway C and Taxiway F. An unknown quantity of AFFF was used to extinguish the fire.	140 µg/kg in soil 2,000 µg/L in groundwater
SS312P	Site 4, Foamed Runway	The North/South runway was foamed with AFFF as a precautionary measure when a KC-135 aircraft was preparing to land with potentially disabled landing gear. The aircraft, however, landed without incident. The runway is surrounded by grassy areas to the east and west along the flight line which received the spray foam drainage.	15 µg/kg in soil 0.29 µg/L in groundwater

Site Number	Name/ Description	Source Area Description	Maximum PFOA/PFOS Concentrations (2014 to 2020)
SS314P	AFFF Area #1, Air National Guard Hangar (Building 1171)	Building 1171 is equipped with an AFFF fire suppression system including an 800-gallon tank of AFFF. There was a small amount of fire suppression discharged in the mechanical room (date unknown) with possible release of AFFF beyond the mechanical room door on the eastern side of the building.	Soil not sampled 5.0 µg/L in groundwater
FT009	AFFF Area #4, Current FTA (FT009)	FT009 is a current and historical fire training exercise area that is adjacent to a former base landfill which may have also been used historically for fire training exercises. Foam tests in the lined area were performed annually on 8 emergency vehicles equipped with AFFF and used approximately 10 gallons of AFFF per vehicle, for a total of 80 gallons per annual test. Residual liquids in the lined area may have been pumped onto the ground pre-winterization. The landfill may also contain PFAS containing materials.	780 µg/kg in soil 41 µg/L in groundwater
FT092	AFFF Area #7, Former Fire Station 1	Former Fire Station 1 no longer exists, and little is known regarding its construction and operation. There are no known releases at this site.	Soil not sampled 0.90 µg/L in groundwater
	AFFF Area #8, Former FTA near the Antenna Farm (FT092)	FT092 includes locations used for fire training and an unlined area used to burn “unknown liquid wastes”. The method of extinguishing fires is unknown. Biosolids and land spreading is permitted in this area and may have occurred.	2.7 µg/kg in soil 2.0 µg/L in groundwater
	AFFF Area #9, Former FTA by the Current Entomology Building (Building 4335)	Building 4335 includes three fire training areas north of Outer Loop Road that were used from 1976 to 1981. Firefighting methods are unknown, but possibly included the use of AFFF in the late 1970s. There is drum storage, asphalt mixing, and former underground storage tanks (USTs) in the area.	16,000 µg/kg in soil 330 µg/L in groundwater

640 (CH2M Hill 2015; CH2M Hill, 2018a; Sundance, 2020ac)

Nature and Extent of Contamination

The following subsections include a summary of the extent of known PFAS impacts for soil and groundwater in each source area and site-wide groundwater, surface water, and sediment at key base and off-base areas. Data is compared to the project screening levels (PSLs), which will be used to determine and delineate the extent of impacts as part of the RI. These screening levels include:

- PFOA:
  - 0.04 µg/L in groundwater and surface water
  - 0.13 mg/kg in soil and sediment (USEPA RSL, HQ=0.1)
- PFOS:
  - 0.04 µg/L in groundwater and surface water
  - 0.13 mg/kg in soil and sediment (USEPA RSL, HQ=0.1)
- PFBS:
  - 0.6 µg/L in groundwater and surface water
  - 1.9 mg/kg in soil and sediment.

SS302P – AFFF Area #6, Former Adak Building Fire

Prior SIs have included the installation and sampling of one (1) soil boring (0 to 5 feet bgs) and groundwater sampling of one (1) upgradient and one (1) downgradient monitoring well (**Figure 5)**. Monitoring wells were installed in the shallow unconsolidated aquifer at depths up to 23 feet bgs and were abandoned in Fall 2020. Water levels at the site have been gauged from approximately 11 to 13 feet bgs with an inferred groundwater flow to the northwest. An open drainage storm sewer is located immediately east of the site. Additionally, samples from one (1) side gradient shallow monitoring well and one (1) soil boring have been collected near or within this feature. Water levels at the side gradient well have been observed shallower than near-source groundwater at 5 feet bgs.

The near-source area soil boring was completed in the northeastern portion of the site. Soil results indicate detections of PFOA and PFOS at concentrations less than the screening level (0.13 mg/kg). Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at all area wells. Maximum concentrations (0.83 µg/L PFOS) in groundwater were reported for the upgradient well; with the lowest concentrations adjacent to the drainage feature (0.22 µg/L PFOS). Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS303P – AFFF Area # 2, Air National Guard KC-135 Hangar (Building 1176)

Prior SIs have included the installation and sampling of one (1) soil boring (0 to 5 feet bgs) and groundwater sampling of one (1) upgradient and two (2) downgradient monitoring well (**Figure 5)**. Monitoring wells were

installed in the shallow unconsolidated aquifer at depths up to 23 feet bgs. Water levels at the site were gauged from approximately 8 to 12 feet bgs with an inferred groundwater flow to the northwest. The soil boring was completed adjacent to the western side of the building in the area of a reported release of AFFF or high expansion foam. Soil results indicate detections of PFOS at concentrations less than the screening level (0.13 mg/kg). Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at both wells. Maximum concentrations (9.7 µg/L PFOS) in groundwater were reported for the upgradient well. Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS304P – AFFF Area #3, Corrosion Control (Building 1348)

Prior SIs have included groundwater sampling of one (1) upgradient and one (1) downgradient monitoring well (**Figure 4**). Monitoring wells were installed in the shallow unconsolidated aquifer at depths up to 21 feet bgs. Water levels at the site were gauged from approximately 4 to 6 feet bgs with an inferred groundwater flow to the northwest. Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at both wells. Maximum concentrations (0.89 µg/L PFOA) are observed at the downgradient well. Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS305P – AFFF Area #12, Hangar (Building 1344)

Prior SIs have included the installation and sampling of one soil boring (0 to 5 feet bgs) and groundwater sampling of one (1) upgradient and one (1) downgradient monitoring well (**Figure 4)**. Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 20 feet bgs. Water levels at the site were gauged from approximately 5 to 6 feet bgs with an inferred groundwater flow to the northwest. An open drainage storm sewer is located immediately north of the site. The soil boring was completed in the northwestern portion of the site side gradient of the suspected release area. Soil results indicate detections of PFOA and PFOS at concentrations less than the screening level (0.13 mg/kg). Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at both wells. Maximum concentrations (81 µg/L PFOS) were historically observed at the downgradient well. Preliminary data from Fall 2020 indicate maximum concentrations at the upgradient well (0.49 µg/L PFOS), with order of magnitude decrease in PFOS concentrations at the downgradient well (0.41 µg/L in 2020 versus 81 µg/L in 2016). Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS306P – Site 3, Former Ball Field Spray Test Area

Prior SIs have included the installation and sampling of 18 soil borings (0 to 10 feet bgs), collection of grab groundwater samples from one (1) boring in the near-source area and one (1) source area, one (1) upgradient, one (1) source area, and three (3) downgradient monitoring wells (**Figure 5)**. Grab groundwater samples were collected at the water table which was observed at depths of 9.7 feet bgs. The upgradient, source area, and two (2) downgradient monitoring wells were installed in the shallow unconsolidated aquifer at depths up to 21 feet bgs. The other two (2) downgradient monitoring wells are installed in the intermediate aquifer at depths from 57 to 100 feet bgs. The source area and one (1) shallow downgradient monitoring wells were abandoned in Fall 2020. Water levels at the site were gauged from approximately 9 to 10 feet bgs with an inferred groundwater flow to the northwest.

The soil borings were completed within the source area utilizing two (2) step-out sampling phases to refine the extent of impact toward the west (toward SS311P/ Site 2 – KC-135 Fire). Soil results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.13 mg/kg) at the majority of locations. PFBS is detected at concentrations less than 130 mg/kg. The vertical distribution of soil concentrations is variable across the area, with maximum PFOS concentrations detected in surface soil (0 to 1 feet bgs) at 8.9 mg/kg and in subsurface soil (7 to 8 feet bgs) at 2.3 mg/kg. Maximum soil concentrations appear to be increasing toward the western portion of the site, in both surface and subsurface soil.

Groundwater results indicate PFOA and/or PFOS concentrations in exceedance of screening levels (0.04 µg/L) at each location. Maximum concentrations (250 µg/L PFOA) are observed at the shallow downgradient monitoring well. Groundwater concentrations in shallow groundwater appear to increase significantly from the source area to the downgradient perimeter (from 1.5 µg/L to 250 µg/L PFOA). Vertically, groundwater concentrations in the intermediate well are orders of magnitude less (0.095 µg/L to 0.027 µg/L PFOA [decreasing with depth]) than those results reported for the shallow wells. Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS307P – AFFF Area #10, Fuel Pump House (Building 1246)

Prior SIs have included groundwater sampling of one (1) upgradient and two (2) downgradient monitoring wells (**Figure 4**). Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 19 feet bgs. Water levels at the site were gauged from approximately 6 to 9 feet bgs with an inferred groundwater flow to the northwest. Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at all wells. Maximum concentrations (0.44 µg/L PFOS) are observed at the northwest area downgradient well. Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS309P – AFFF Area #14, Thunderdome (Building 1140)

Prior SIs have included the installation and sampling of one (1) soil boring (0 to 5 feet bgs) and groundwater sampling of one (1) upgradient, one (1) near source, and one (1) downgradient monitoring well (**Figure 5)**. The upgradient and downgradient monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 27 feet bgs. The near source monitoring well is installed in the intermediate aquifer at depth of 48 feet bgs. Water levels at the site were gauged from approximately 6 to 11 feet bgs with an inferred groundwater flow to the northwest. An open drainage storm sewer is located immediately north of the site. The soil boring was completed in the northeastern portion of the site downgradient of the suspected release area. Soil sample results indicate detections of PFOA and PFOS at concentrations less than the PSL (0.13 mg/kg). Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at both wells. Maximum concentrations (4.1 µg/L PFOS, based on preliminary Fall 2020 data) are observed at the downgradient well. PFOS concentrations (based on preliminary Fall 2020 data) are also elevated in the intermediate aquifer well with maximum concentrations of 3.7 µg/L. Additional characterization is needed to evaluate soil and to further refine the lateral and vertical extent of groundwater impacts at the site.

SS310P – Site 1, South Ramp Spray Test Area

Prior SIs have included the installation and sampling of three (3) soil borings (0 to 6 feet bgs), collection of grab groundwater samples from one (1) boring located to the south of the ramp (hydraulically upgradient) and four (4) monitoring wells located to the north of the ramp (hydraulically side gradient and downgradient) (**Figure 4)**. Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 16 feet bgs. Water levels at the site have been observed from approximately 5 to 6 feet bgs with inferred groundwater flow to the northwest. Grab groundwater samples were collected at the water table. Inferred groundwater flow is to the northwest. Garrison Slough runs parallel to the ramp area and is located to the south of the site.

The soil borings were completed along the southern and northern perimeters of the ramp in the anticipated runoff areas for suspected AFFF discharges. Soil results indicate detections of PFOA and PFOS at concentrations less than the PSLs (0.13 mg/kg) and PFBS less than 130 mg/kg at two (2) locations in the eastern portion of the area on opposing sides of the ramp in surface (0 to 0.25 feet bgs) and shallow subsurface (2 to 3 feet bgs) soil only. Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at each downgradient/ side gradient monitoring well location only. Maximum concentrations (9.7 µg/L PFOS) are observed at the eastern most downgradient well. Concentrations decrease (to 0.52 µg/L PFOS) to the northwest. Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

SS311P – Site 2, KC-135 Fire

Prior SIs have included the installation and sampling of three (3) soil borings (0 to 8 feet bgs), collection of grab groundwater samples from two (2) borings located to the south of the ramp (hydraulically side gradient), one (1) boring and two (2) monitoring wells located to the north of the ramp (hydraulically side gradient) (**Figure 5)**. Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 17 feet bgs. Water levels at the site have been observed from approximately 7 to 8 feet bgs with inferred groundwater flow to the northwest. Grab groundwater samples were collected at the water table. The soil borings were completed along the southern and northern perimeters of the ramp in the anticipated runoff areas for suspected AFFF discharges.

Soil results indicate PFOS concentrations in exceedance of the PSL (0.13 mg/kg) in surface soil (0 to 0.25 feet bgs) collected from one boring completed on the south side of the ramp. The other four (4) borings completed indicate detections of PFOA and/or PFOS at concentrations less than the PSL (0.13 mg/kg). Concentrations are observed to decrease with depth to the south of the ramp but increase with depth to the north of the ramp.

Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at each location. Maximum concentrations (2,000 µg/L PFOS) are observed at grab groundwater sample collected to the north of the ramp abutting SS306P/ Site 3 – Former Ball Field Spray Test Area and AFFF Area #5 – Fire Station 1 (Building 1206). Groundwater concentrations on the south of the ramp are observed to increase by one order of magnitude to the northwest (from 6.7 to 23 µg/L PFOS). Groundwater concentrations on the north side of the ramp are observed to decrease to the northwest (from 2,000 to 30 µg/L PFOS). Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

SS312P– Site 4, Foamed Runway

Prior SIs have included the installation and sampling of four (4) soil borings (0 to 8 feet bgs), collection of grab groundwater samples from two (2) borings located to the west of the ramp (hydraulically side gradient) and two (2) borings located to the east of the ramp (hydraulically side gradient) (**Figure 5**). Grab groundwater samples were collected at the water table which was observed at depths of 2 to 8 feet bgs. Inferred groundwater flow is to the northwest.

The soil borings were completed along the western and eastern perimeters of the ramp in the anticipated runoff areas for suspected AFFF discharges. Soil results indicate detections of PFOA and PFOS at concentrations less than the screening level (0.13 mg/kg). The highest concentrations were detected at the two (2) locations along the western perimeter of the ramp in surface (0 to 0.25 feet bgs) and subsurface (4 to

5 feet bgs) soil. Soil concentrations increase to the northwest. Groundwater results indicate PFOS concentrations in exceedance of screening levels (0.04 µg/L) at three (3) locations. Maximum concentrations (0.29 µg/L PFOS) are observed at the northeastern most well. Concentrations slightly increase (from 0.14 to 0.29 µg/L PFOS) on the eastern side of the ramp (to the northwest). Concentrations decrease (from 0.08 to 0.059 µg/L PFOS) on the western side of the ramp (to the northwest). Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

SS314P – AFFF Area # 1, Air National Guard Hanger (Building 1171)

Prior SIs have included groundwater sampling of one (1) upgradient and one (1) downgradient monitoring well (**Figure 5**). Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 21 feet bgs. Water levels at the site have been observed from approximately 6 to 11 feet bgs with inferred groundwater flow to the northwest. Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at both wells. Maximum concentrations (5 µg/L PFOS) were historically observed at the downgradient well. Preliminary data from Fall 2020 groundwater sampling event indicate maximum concentrations at the upgradient well (3.4 µg/L PFOS), with slightly lower PFOS concentrations at the downgradient well (2 µg/L). Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

FT009 – AFFF Area #4, Current Fire Training Area (FT009)

Prior SIs have included the installation and sampling of three (3) soil borings (0 to 5 feet bgs) and groundwater sampling of two (2) source area and four (4) downgradient monitoring wells (**Figure 4)**. Monitoring wells are installed in the shallow and intermediate unconsolidated aquifer at depths up to 29 and 100 feet bgs, respectively. Water levels at the site have been observed from approximately 2 to 12 feet bgs with potential mounding observed in the central portion of the site and overall inferred groundwater flow to the northwest. This area is bound by Garrison Slough to the west.

Soil borings were installed in the suspected release areas and cross-gradient to the suspected release area. Soil results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.13 mg/kg) from borings in the central and western portion of the site. PFBS was detected at concentrations less than 130 mg/kg at one (1) location. Based on the available data, maximum concentrations of PFOA are detected in the upper 2.5 feet bgs for soil, whereas maximum concentrations of PFOS are detected in composite samples (0 to 5 feet bgs). Groundwater results indicate PFOA and PFOS concentrations in exceedance of screening levels (0.04 µg/L) at shallow wells only. Maximum concentrations (41 µg/L PFOS) are observed at source area wells. PFOA/PFOS concentrations decrease by two (2) orders of magnitude in the downgradient direction with maximum concentrations of 0.4 µg/L PFOS observed to the north, though maximum concentrations at the shallow well to the northwest across Garrison Slough have been observed at 2.6 µg/L PFOS. Additional

characterization is needed to evaluate soil and further refine the lateral extent of groundwater impacts at the site.

FT092 – AFFF Area #7, Former Fire Station 1

Prior SIs have included groundwater sampling of one (1) upgradient and one (1) downgradient monitoring well (**Figures 4)**. Monitoring wells were installed in the shallow unconsolidated aquifer at depths up to 23 feet bgs and were abandoned in Fall 2020. Water levels at the site have been observed from approximately 6 to 12 feet bgs with inferred groundwater flow to the northwest. Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at both wells. Maximum concentrations (0.9 µg/L PFOS) are observed at the upgradient well. Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

FT092 – AFFF Area #8, Former FTA near the Antenna Farm (FT092)

Prior SIs have included the installation and sampling of two (2) soil borings (0 to 5 feet bgs) and groundwater sampling of one (1) source area and one (1) downgradient monitoring well (**Figure 4)**. Monitoring wells were installed in the shallow unconsolidated aquifer at depths up to 21 feet bgs and were abandoned in Fall 2020. Water levels at the site have been observed from approximately 14 to 15 feet bgs with inferred groundwater flow to the northwest. The site is bound by the Garrison Slough to the southeast. Additionally, samples from one side gradient shallow monitoring well have been collected near or within this feature. Water levels at the side gradient well have been observed slightly shallower than near-source groundwater at 13 feet bgs.

The soil borings were completed within and downgradient of the suspected release area. Soil results indicate detections of PFOA and PFOS at concentrations less than the PSL (0.13 mg/kg). Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at all area wells. Maximum concentrations (2.0 µg/L PFOA) are observed at the source area well. The lowest concentrations are observed at the side gradient monitoring well near Garrison Slough (0.69 µg/L PFOA). Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

FT092 – AFFF Area #9, Former FTA by the Current Entomology Building (Building 4335)

Prior SIs have included the installation and sampling of 16 soil borings (0 to 8.5 feet bgs) and groundwater sampling of one (1) upgradient, two (2) source area, and two (2) downgradient monitoring wells (**Figure 4)**. Monitoring wells are installed in the shallow unconsolidated aquifer at depths up to 40 feet bgs. The site is bound by Garrison Slough to the southeast. Water levels at the area have been observed from approximately seven (7) feet bgs upgradient (near Garrison Slough) to approximately 10 to 13 feet bgs within the source area. Inferred groundwater flow is to the northwest.

The soil borings were completed within the source area with two (2) phases of step-outs performed to refine the extent of impacts to the west. Soil results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.13 mg/kg) at the majority of locations. To a lesser extent, PFBS was detected at concentrations less than the 130 mg/kg. Soil concentrations generally increase at depth with elevated concentrations (1 to 15 mg/kg) observed at 5 to 7 feet bgs. However, maximum concentrations have been detected in recent step out borings to the west, with impacts localized to surface soil at concentrations up to 16 mg/kg PFOS. Groundwater results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at all area wells. Maximum concentrations (330 µg/L PFOS) are observed at the western-most source area well with a decreasing concentration gradient observed to the north (130 µg/L) and east (5.8 µg/L). The lowest concentrations are observed at the upgradient monitoring well near Garrison Slough (0.55 µg/L PFOS). Additional characterization is needed to evaluate soil and further refine the lateral and vertical extent of groundwater impacts at the site.

Sitewide and Off-Base Groundwater

Prior SIs have included the installation and sampling of permanent and temporary monitoring wells at upgradient, base and off-base areas and periodic sampling of on-base production wells and off-base private water supply wells. The majority of prior SI activities have targeted characterization of groundwater within the upper 25 feet of the unconsolidated aquifer. For further discussion, the distribution and extent of contamination will be discussed for the following key areas: Southern Base, Northern Base, Moose Creek Community, and Chena Floodplains.

The Southern Base has been characterized by upgradient monitoring wells (up to 201 feet bgs), base area monitoring wells (up to 200 feet bgs), and periphery monitoring wells (up to 204 feet bgs) (**Figure 4**). Upgradient results indicate PFOA and PFOS concentrations below the PSL (0.04 µg/L) in shallow (less than [<] 50 feet bgs) and deep (196 to 201 feet bgs) wells with maximum combined concentrations of 0.0058 µg/L and <0.00047 µg/L, respectively. Plume area results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at shallow (<50 feet bgs) and intermediate (50 to 100 feet bgs) wells with maximum combined concentrations of 334.2 µg/L and 1.2 µg/L, respectively. Western and eastern periphery groundwater sample results indicate PFOA and PFOS concentrations below the PSL (0.04 µg/L) in shallow (<50 feet bgs) and deep (197 to 204 feet bgs) wells with maximum combined concentrations of 0.014 µg/L (shallow) / <0.00049 µg/L (deep) and 0.022 µg/L (shallow) / 0.0072 µg/L (deep), respectively.

The Northern Base area has been characterized by base area monitoring wells (up to 200 feet bgs), periphery monitoring wells (up to 203 feet bgs), and downgradient monitoring wells (up to 200 feet bgs) (**Figure 5**). Plume area results indicate PFOA and PFOS concentrations for groundwater in exceedance of the PSL (0.04 µg/L) at shallow (<50 feet bgs) and intermediate (50 to 100 feet bgs) wells with maximum combined

concentrations of 2,018 µg/L and 0.378 µg/L, respectively. Western and eastern periphery results indicate PFOA and PFOS concentrations below the PSL (0.04 µg/L) for shallow (<50 feet bgs) and deep (194 to 203 feet bgs) monitoring wells with maximum combined concentrations of 0.0088 µg/L (shallow) / 0.013 µg/L (deep) and 0.0516 µg/L (shallow) / 0.0038 (deep), respectively. Downgradient results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) at shallow (<50 feet bgs) and intermediate (50 to 100 feet bgs) wells with maximum combined concentrations of 1.74 µg/L and 2.43 µg/L, respectively. Concentrations decrease with depth except at one historical temporary well location (TW-02) where maximum concentrations were observed at depth (100 feet bgs). Excluding this outlier, maximum combined concentrations for the intermediate zone are 1.18 µg/L. Deep (140 to 198 feet bgs) downgradient monitoring well results are below screening levels (0.04 µg/L) for PFOA and PFOS.

Impact to the Moose Creek area has been characterized by sampling private water supply wells (estimated depth up to 60 feet bgs) and periphery monitoring wells (up to 25 feet bgs) (**Figure 6**). Private water supply well results for PFOS (which exceed the PSL for 96% of samples) have historically ranged from 2.09 µg/L in the southeast (near the base boundary) to 0.007 µg/L in the northwest (AFCEC, 2017). Western periphery results indicate PFOA and PFOS concentrations below the USEPA LHA (0.07 µg/L) with maximum combined concentrations of 0.0121 µg/L. Eastern periphery results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) and the USEPA LHA (0.07 µg/L) with concentrations ranging from 0.37 µg/L in the southeast to 0.426 µg/L in the northwest.

The Chena Floodplain area is located northwest of Moose Creek and southeast of North Pole. This area has been characterized by shallow (<25 feet bgs) and intermediate (50 to 100 feet bgs) downgradient and cross gradient wells (**Figure 7**). Groundwater sample results indicate PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L) in shallow wells only (<25 feet bgs) with concentrations ranging from 0.0539 µg/L in the southeast (near the Moose Creek boundary) to 0.072 µg/L mid-plume (localized areas adjacent to tributaries), to 0.0139 µg/L in the west (toward the Tanana River). Based on available data, elevated concentrations are bound between tributaries to Tanana River to the north (near Old Richardson Highway) and Piledriver Slough. Groundwater impacts also appear to be contained within the upper portion of the aquifer (<25 feet bgs) with maximum combined concentrations ranging from 0.0259 µg/L to non-detect in intermediate depth wells (decreasing with depth).

Garrison Slough Surface Water and Sediment

In 2014, surface water and sediment samples were collected from Garrison Slough at the location where the drainage from SS306P (*Former Ball Field Spray Test Area)* enters (**Figure 5**). PFOS and PFOA were detected in exceedance of the PSL (0.04 µg/L) in the two (2) surface water samples (primary and field duplicate) with

928 the highest concentration of each reported as 2.7 J µg/L and 0.53 J µg/L, respectively. For the sediment
929 sample, PFOS was detected at concentrations less than the PSL (0.13 mg/kg).

930 In 2016, surface water and sediment samples were collected from two (2) locations in Garrison Slough (**Figure**
931 **6**). Additional surface water samples were collected later in 2016 from one (1) location downstream of the
932 WWTP in Garrison Slough. In Garrison Slough, the highest PFOA concentration detected in sediment from
933 the 2016 investigation was 0.028 mg/kg, which is less than the PSL (0.13 mg/kg). The highest PFOS
934 concentration detected in sediment (0.22 mg/kg) was detected in the same location adjacent to the former
935 FTA near the antenna farm and was in exceedance of the PSL (0.13 mg/kg). In surface water samples
936 collected from three (3) locations in Garrison Slough, all samples exceeded the PSL for PFOA and PFOS
937 (0.04 µg/L), with the highest concentration reported as 1.9 µg/L for PFOA and 0.79 µg/L for PFOS.

938 ***WWTP Surface Water and Sediment***

939 In 2016, surface water and sediment samples were collected from one (1) location in the channel near the
940 WWTP percolation pond (**Figure 6**). For the sediment sample, PFOA and PFOS concentrations were
941 detected at concentrations less than the PSL (0.13 mg/kg). For the surface water sample, PFOA and PFOS
942 concentrations (0.17 µg/L and 1.9 J µg/L, respectively) were detected in exceedance of the PSL (0.04 µg/L).

943 ***Transmitter Road Near the Installation Northern Boundary/Garrison Slough/French Creek Surface***
944 ***Water and Sediment***

945 In 2015, two (2) surface water samples were collected from Garrison Slough and French Creek along
946 Transmitter Road (**Figure 6**). In Garrison Slough, PFOA and PFOS concentrations (0.15 µg/L and 0.62 µg/L,
947 respectively), were detected in exceedance of the PSL (0.04 µg/L). In French Creek, PFOA and PFOS
948 concentrations (0.0043 µg/L and 0.02 µg/L, respectively), were also detected in exceedance of the PSL (0.04
949 µg/L). In 2020, French Creek was sampled in three (3) locations, and based on preliminary data all results
950 were detected less than the PSL for PFOA and PFOS (0.04 µg/L).

951 ***Piledriver Slough Surface Water and Sediment***

952 In 2015, two (2) surface water samples were collected from Piledriver Slough in the Western Area. One (1)
953 location was west of the central area of the installation, and the other was approximately 2 miles downstream.
954 PFOA and PFOS were not detected in either sample. In 2020, one (1) surface water and one (1) sediment
955 sample were collected from Piledriver Slough near the northern installation boundary. Based on preliminary
956 data, PFOA and PFOS concentrations were detected less than the PSL (0.04 µg/L) in surface water and were
957 non-detect in sediment.

Polaris Lake Surface Water and Sediment

In 2016, three (3) surface water samples were collected from different depths in Polaris Lake following an AFFF release. The highest reported concentration of PFOS was 0.249 µg/L, which is in exceedance of the PSL (0.04 µg/L).

Nine Lakes Surface Water and Sediment

In 2020, surface water and sediment samples were collected from nine (9) lakes located around the installation: Bear Lake, Grayling Lake, Hidden Lake, Moose Lake, Mullins Pit, Scout Lake, Shoe Lake, Spruce Lake, and Tar Kettle Lake. Based on preliminary data, three (3) lakes (Bear Lake, Moose Lake, and Spruce Lake) on the eastern side of the installation had at least one (1) sample with PFOA and PFOS concentrations in exceedance of the PSL (0.04 µg/L). The highest surface water concentration of combined PFOA and PFOS was 0.53 QL µg/L in Spruce Lake. In sediment, PFOA was detected at concentrations less than the PSL (0.13 mg/kg) at three (3) lakes (Bear Lake, Moose Lake, and Shoe Lake). The highest sediment concentration of PFOA was 0.0034 QL mg/kg reported for Bear Lake. PFOS was not detected above laboratory detection limits in the sediment samples.

Off-Base Surface Water and Sediment

In 2020, off-base surface water and sediment sampling was conducted northwest of the installation in surface water bodies documented as being used for fishing, boating, and/or swimming. The sampled surface water bodies were not adjacent to known PFOA/PFOS sources, so the presence of PFOA/PFOS suggests migration of contaminated groundwater to surface water and sediment. Surface water samples were collected from eight (8) locations, and sediment samples were collected from six (6) co-located locations. PFOA and PFOS surface water concentrations exceeded the PSL (0.04 µg/L) at three (3) locations (at the confluence of Moose Creek and Piledriver Slough, upgradient of that confluence in Moose Creek , and in Moose Creek Landing Pond [also known as Horvath Lake]). The highest combined concentration was 0.105 µg/L for the sample obtained at the confluence location of Moose Creek and Piledriver Slough. PFOA and PFOS concentrations in sediment were detected less than the PSL (0.13 mg/kg) at four (4) locations (one at the confluence of Moose Creek and Piledriver Slough, one upgradient of that confluence in Moose Creek, and two in Moose Creek Landing Pond [also known as Horvath Lake]). The highest concentration of combined PFOA and PFOS in sediment (0.0055 mg/kg) was obtained upstream of the confluence in Moose Creek.

Summary

Figures 8 through 13 show the proposed 2021 RI sampling locations for fish tissue, sediment, surface water, pore water, groundwater, and soil. **Figure 14** shows the proposed locations for groundwater VAP flux transects and samples at mid-base, downgradient perimeter, and off base. **Worksheet #17** of this QAPP

990 provides the rationale and sampling design for the proposed RI sampling scope of work to address the above
991 data gaps. **Worksheets #18** and **#20** of this QAPP list the planned sample identifications and required QC
992 samples for each medium.

993

QAPP WORKSHEET #11: PROJECT/DATA QUALITY OBJECTIVES

(UFP-QAPP Manual Section 2.6.1)
(USEPA 2106-G-05 Section 2.2.6)

This worksheet states the problem, identifies the goal of the study, identifies information inputs, defines boundaries of the sampling, develops the analytical approach, specifies performance or acceptance criteria, and identifies the developed plan for obtaining data in accordance with USEPA's 7-step DQO process, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006). This QAPP presents the selected investigation design and rationale in **Worksheet #17**, and the sampling summary in **Worksheet #18** and **Worksheet #20**.

DQO 001 – Assessment of PFOA, PFOS, and PFBS in Groundwater

Step 1: State the Problem
The vertical and lateral extent of previously identified PFOA, PFOS, and PFBS contamination in groundwater at 13 validated source areas and their potential contribution to Eielson AFB's PFAS groundwater plume is unknown. Also, the vertical and lateral extent of Eielson AFB's PFAS groundwater plume is unknown.
Step 2: Identify the Goals of the Study
• Determine the lateral extent of PFOA, PFOS, and PFBS in groundwater at 13 validated source areas at Eielson AFB and surrounding communities. • Determine the vertical extent of PFOA, PFOS, and PFBS in groundwater at 13 validated source areas at Eielson AFB and surrounding communities. • Determine the potential contribution of the PFOA, PFOS, and PFBS contamination at the 13 validated source areas to Eielson AFB's PFAS groundwater plume. • Update the CSM for the 13 validated source areas and a Basewide CSM. • Rank source area locations to support future remedial alternative evaluations and mitigation measures. • Collect sufficient data to support future risk assessments.
Step 3: Identify Information Inputs
• Historical groundwater sampling data collected from existing monitoring wells, temporary monitoring wells, and drinking water wells. • AFCEC contract specified comparison of analytical data against the EPA RSL groundwater screening levels for PFOA, PFOS, and PFBS (PSLs). • Historical groundwater sampling data was utilized to develop the digital CSM. The historical analytical data and digital CSM are available on the project dashboard.
Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include groundwater within, upgradient, and downgradient of 13 validated source areas and along five (5) transects (two [2] on-base and three [3] off-base). • Temporal Boundaries: Sampling will be conducted once (including up to four [4] intervals at the 50-foot VAP borings, eight [8] intervals at the 100-foot VAP borings, and 12 intervals at the 150-foot VAP borings) at each sampling location. Sampling is planned in Summer 2021 for VAP and soil boring locations and in Fall 2021 for permanent monitoring wells. • Chemical Boundaries: PFOA, PFOS, and PFBS concentrations will be compared to the PSLs.

- Practical Constraints on Data Collection: Obtaining off-site access to install VAP borings and permanent monitoring wells. Limitations to VAP borings and monitoring well placement in areas inaccessible without tree clearing or access route construction. Limitations to soil boring or VAP boring placement in areas inaccessible due to base restrictions.

Step 5: Develop the Analytical Approach

- If groundwater and soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs, then delineation is complete in that direction.
- If groundwater analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs, and soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs, then delineation is complete in that direction.
- If the downgradient VAP transects do not delineate the extent of PFOA, PFOS and PFBS to concentrations below the PSLs, then additional VAP borings will be installed as needed to complete characterization. See Worksheet #17 Table 7 for details on step-in/step-out rationale.
- If groundwater analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs and is not adequately defined, then additional soil borings will be completed to refine the extent of impacts. See Worksheet #17 Table 6 for details on step-in rationale.
- If groundwater analytical data collected from a VAP boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs, then lateral delineation is complete in that direction.
- If groundwater analytical data collected from a VAP boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs at depth, then vertical delineation is complete.
- If groundwater analytical data collected from a VAP boring indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs, then additional VAP borings will be completed to refine the lateral extent of impacts. See Worksheet #17 Table 7 for details on step-in/step-out rationale.
- If groundwater analytical data collected from a VAP boring indicate the PFOA, PFOS, and PFBS concentration exceed the PSLs at depth, then additional VAP samples will be completed below the target depth to refine the vertical extent of impacts. See Worksheet #17 Table 7 for details sampling rationale.
- If the nature and extent of PFOA, PFOS, and PFBS impacts at each validated source area and base groundwater are defined, then permanent monitoring wells will be installed and sampled to provide definitive data for groundwater plume delineation, provide a location to monitor groundwater quality over time and to support remediation decisions.

Step 6: Specify Performance or Acceptance Criteria

- Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19 & 30, #20, #23, #24, #25, #31 through #37.
- Controls on precision, reporting, and accuracy are provided in Worksheets #12-1 and #28.
- Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.

Step 7: Develop the Plan for Obtaining Data

- The prescriptive phase of the investigation will include pre-determined locations for the validated source area borings, source area VAP borings (**Figures 9 through13**) and transect VAP borings (**Figure 14**). These locations were selected based on a review of data from previous Investigation Reports, the anticipated groundwater flow direction, and data regarding contaminate flow. The lateral spacing between borings should be adequate to indicate the general distribution of PFOA, PFOS, and PFBS concentrations within the study area. Specifically, the scope includes:
    - Up to 114 soil borings (installed to a depth up to 10 feet below the groundwater table interface) will be installed to determine the lateral extent of PFOA, PFOS, and PFBS contamination in shallow groundwater at the 13 validated source areas. These borings include collection of a shallow groundwater sample and co-located grain size sample to evaluate water quality and permeability beneath the source zone.

  - Up to 46 VAP borings (installed to a depth up to 50 feet bgs) will be installed to determine the lateral and vertical extent of PFOA, PFOS, and PFBS contamination in shallow groundwater at the 13 validated source areas.
  - Up to 55 VAP borings (including up to thirty 100 feet bgs VAP borings and twenty-five 150 feet bgs VAP borings) installed across five (5) transects will be installed to determine the lateral and vertical extent of PFOA, PFOS, and PFBS contamination in groundwater on base and in the surrounding communities.
- The results from the prescriptive phase will be incorporated in to the digital CSM and be presented to the project stakeholders to gain concurrence on the proposed adaptive locations needed to complete delineation of the validated source zones. Following coordination with stakeholders, 1) additional validated source area VAP borings and soil borings will be installed to refine the lateral extent of impacts for each validated source area (**Worksheet #17 Table 6**), 2) additional VAP borings will be installed upgradient and/or cross-gradient of locations where PSLs are exceeded to refine or delineate impacts (**Worksheet #17 Tables 6 and 7**), and 3) additional VAP samples will be collected where PSLs are exceeded at depth to delineate the vertical extent of impacts (**Worksheet #17 Table 7**).
- Based on data collected at validated source area soil borings and VAP borings, permanent monitoring well locations will be selected with stakeholder input (Worksheet 17 Table 8). Permanent monitoring well locations will include up to 20 shallow monitoring wells installed to 25-feet bgs and up to 20 well clusters installed across the water table (approximately 20-feet), 50-feet, 100-feet, and 150-feet bgs to determine the PFOA, PFOS, and PFBS concentrations for long term groundwater monitoring.
- Borings and monitoring wells will be completed in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs P-06, P-07, P-12, and P-14 (Appendix B).
- Groundwater samples will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs P-10 and P-11 (Appendix B).
- Groundwater samples collected from soil borings and VAP borings will be analyzed using a combination of an onsite mobile lab and fixed laboratory (screening data[1]). Mobile lab samples will be analyzed for PFOA, PFOS, and PFBS by Pace Mobile Lab via an analytical screening level method that was demonstrated in ESTCP ER-B-19-5203. Fixed laboratory samples will be analyzed for 24 PFAS compounds specified in the AFCEC contract by ELLE and/ or Pace for PFAS via DoD Quality Systems Manual (QSM) 5.3 Table B-15 (DoD, 2019a).
- Groundwater samples collected from monitoring wells will be analyzed using for 24 select PFAS compounds via the fixed laboratory (definitive data) by ELLE and/ or Pace for PFAS via DoD QSM 5.3 Table B-15 (DoD, 2019a).

[1] Screening data refers to samples analyzed via the onsite mobile laboratory or offsite fixed laboratory for PFOA, PFOS, and PFBS only. Screening data will be used for intermediate decision making to optimize placement of adaptive phase borings and samples.

DQO 002 – Assessment of PFOA, PFOS, and PFBS in Soil

Step 1: State the Problem
The vertical and lateral extent of PFOA, PFOS, and PFBS contamination in vadose zone soil at 13 validated source areas is unknown. The area below the water table will be characterized by sampling shallow groundwater (see DQO 001).
Step 2: Identify the Goals of the Study
• Determine the lateral extent of PFOA, PFOS, and PFBS in vadose zone soil at 13 validated source areas at Eielson AFB. • Determine the vertical extent of PFOA, PFOS, and PFBS in vadose zone soil at 13 validated source areas at Eielson AFB. • Update the CSM for the 13 validated source areas and a Basewide CSM. • Rank source area locations to support future remedial alternative evaluations and mitigation measures. • Collect sufficient data to support future risk assessments.

Step 3: Identify Information Inputs
• Records of potential or known AFFF use areas and potential or known spills. • Historical soil sampling data collected from prior investigation activities. • AFCEC contract specified comparison of analytical data against the EPA soil RSLs for PFOA, PFOS, and PFBS (PSLs). • Historical groundwater sampling data was utilized to develop the digital CSM. The historical analytical data and digital CSM are available on the project dashboard. •
Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include soil within, upgradient, and downgradient of validated source areas. • Temporal Boundaries: Sampling will be conducted once (at up to three [3] intervals) at each sampling location. Sampling is planned in Summer 2021. • Chemical Boundaries: PFOA, PFOS, and PFBS concentrations will be compared to the PSLs. • Practical Constraints on Data Collection: Limitations to soil boring placement in areas inaccessible due to base restrictions.
Step 5: Develop the Analytical Approach
• If soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs, then delineation is complete in that direction. • If soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs, then additional soil borings will be completed to refine the extent of impacts. See **Worksheet #17 Table 6** for details on step-in/step-out rationale. • If soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs and is not adequately defined, then additional soil borings will be completed to refine the extent of impacts. See **Worksheet #17 Table 6** for details on step-in rationale.
Step 6: Specify Performance or Acceptance Criteria
• Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19 & 30, #20, #23, #24, #25, #31 through #37. • Controls on precision, reporting, and accuracy are provided in Worksheets #12-2 and #28. • Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.
Step 7: Develop the Plan for Obtaining Data
• Up to 114 prescriptive soil borings (installed to a depth up to 10 feet below the groundwater table interface) will be installed to determine the lateral and vertical extent of PFOA, PFOS, and PFBS contamination in vadose zone soil in each validated source area. A total of three (3) discrete soil samples will be collected for PFAS from each boring to characterize the vadose zone and include surface soil (0 to 0.5 feet bgs), midpoint of the vadose (approximately 3 feet bgs), and above the water table. Locations of the validated source area soil borings (**Figures 9 through13**) were selected based on a review of potential source area information and data from previous Investigation Reports. The lateral spacing between borings should be adequate to indicate the general distribution of PFOA, PFOS, and PFBS concentrations within the study area. • The results from the prescriptive phase will be incorporated in to the digital CSM and be presented to the project stakeholders to gain concurrence on the proposed adaptive locations needed to complete delineation of the validated source zones. Following coordination with stakeholders, additional validated source area soil borings will be installed as an adaptive phase to refine or delineate the lateral extent of impacts (**Worksheet 17 Table 6**). • Based on data collected at validated source area soil borings, a source strength evaluation will be completed (see DQO 004).

- Soil Borings will be completed, and soil samples collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-06, P-10, and P-12 (Appendix B).
- All surface soil samples and a representative set of subsurface soil samples (8 to 10 per validated source area, laterally spaced to represent the extent of the source area) will be analyzed for 24 select PFAS compounds via the fixed laboratory (definitive data) by ELLE and/ or Pace for PFAS via DoD QSM 5.3 Table B-15 (DoD, 2019a). The definitive data collected throughout this investigation will be used to confirm delineation and support future risk assessment activities.
- Select subsurface soil samples collected from soil borings will be analyzed using a combination of an onsite mobile lab and fixed laboratory (screening data[1]). Mobile lab samples will be analyzed for PFOA, PFOS, and PFBS by Pace Mobile Lab via an analytical screening level method that was demonstrated in ESTCP ER-B-19-5203. Fixed laboratory samples will be analyzed for 24 PFAS compounds specified in the AFCEC contract by ELLE and/ or Pace for PFAS via DoD QSM 5.3 Table B-15 (DoD, 2019a).

[1] Screening data refers to samples analyzed via the onsite mobile laboratory or offsite fixed laboratory for PFOA, PFOS, and PFBS only. Screening data will be used for intermediate decision making to optimize placement of adaptive phase borings and samples.

DQO 003 – Assessment of PFOA, PFOS, and PFBS in Surface Water, Sediment, and Porewater

Step 1: State the Problem
The extent of PFOA, PFOS, and PFBS contamination in surface water and sediment at drainages and surface water bodies at Eielson AFB and in the surrounding communities requires refinement. The temporal variability of PFOA, PFOS, and PFBS discharges to surface water bodies at Eielson AFB and in the surrounding communities requires evaluation. Potential transport pathways of PFOA, PFOS, and PFBS contamination from validated source areas to drainages and surface water bodies at Eielson AFB and in the surrounding communities is unknown.
Step 2: Identify the Goals of the Study
• Determine the lateral extent of PFOA, PFOS, and PFBS in drainages and surface water bodies at Eielson AFB and in the surrounding communities. • Determine the temporal variability of PFOA, PFOS, and PFBS discharges to surface water bodies at Eielson AFB and in the surrounding communities. • Determine the potential transport pathways of PFOA, PFOS, and PFBS from validated source areas to drainages and surface water bodies Eielson AFB and in the surrounding communities. • Update the CSM for the 13 validated source areas and a Basewide CSM.
Step 3: Identify Information Inputs
• Historical surface water and sediment data collected from prior investigations. • AFCEC contract specified comparison of surface water and porewater analytical data against the EPA RSL groundwater screening levels for PFOA, PFOS, and PFBS (PSLs). • AFCEC contract specified comparison of sediment analytical data against the EPA RSL soil screening levels for PFOA, PFOS, and PFBS (PSLs). •
Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include drainages and surface water bodies within, upgradient, and downgradient of validated source areas and the surrounding communities. • Temporal Boundaries: Sampling will be conducted twice, once during the wet season and once during the dry season at each sampling location. Sampling is planned in May 2021 (wet season) and July 2021 (dry season). • Chemical Boundaries: PFOA, PFOS, and PFBS concentrations will be compared to the PSLs.

• Practical Constraints on Data Collection: Limitations to surface water, sediment, or porewater sample placement in areas inaccessible due to water levels, ground conditions during the spring break up, and short field season when the surface water is ice-free.
Step 5: Develop the Analytical Approach
• If co-located surface water, porewater, or sediment analytical data collected indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs during the wet season, then no further sampling is required during the dry season in that direction. • If co-located surface water, porewater, or sediment analytical data indicate the PFOA, PFOS, and PFBS concentrations exceed the PSLs during the wet season, then additional co-located surface water and sediment samples will be completed in the dry season to refine the extent of impacts. The additional sample locations would only be completed during the dry season. See Worksheet #17 “Surface Water and Sediment Sampling” for details on step-in/step-out rationale.
Step 6: Specify Performance or Acceptance Criteria
• Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19 & 30, #20, #23, #24, #25, #31 through #37. • Controls on precision, reporting, and accuracy are provided in Worksheets #12-1, #12-2, #12-3, #12-4, and #28. • Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.
Step 7: Develop the Plan for Obtaining Data
• Up to 80 co-located surface water and sediment samples and 15 porewater samples (co-located with surface water and sediment locations) will be collected to determine the nature and extent of PFOA, PFOS, and PFBS contamination at drainages and surface water bodies at Eielson AFB and in the surrounding communities. Locations of the co-located surface water, sediment, and porewater samples (Figure 8) were selected based on a review of data from previous investigation reports, proximity to validated source areas, surface water flow direction, and potential contaminant discharge pathways. The lateral spacing between samples should be adequate to indicate the general distribution of PFOA, PFOS, and PFBS concentrations within the study area. • Following coordination with stakeholders, additional co-located surface water and sediment samples will be collected in the dry season to refine the extent of impacts (Worksheet 17 “Surface Water and Sediment Sampling”). • The data collected for surface water, sediment, and porewater will be used to support future risk assessment activities and support the CSM updates (see DQO 006). • Surface water and sediment samples will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-10 and P-15 (Appendix B). • Porewater samples will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-10 and P-19 (Appendix B). • Surface water, sediment, and porewater samples will be collected and submitted to the fixed laboratory as definitive data for all 24 PFAS compounds by ELLE and/ or Pace for PFAS via DoD QSM 5.3 Table B-15 (DoD, 2019a). • Surface water samples will be collected and submitted to the fixed laboratory as definitive data by ELLE and/ or Pace for Total suspended solids (TSS) via SM 2540D and Total organic carbon (TOC) via SW846 9060A. • Sediment samples will be collected and submitted to the fixed laboratory as definitive data by ELLE and/ or Pace for TOC via SW846 9060A and grain size via ASTM D422-63.

1013 **DQO 004 – Source Strength Evaluation**

Step 1: State the Problem
The contribution of PFAS contamination in soil as an ongoing source of PFAS contamination in groundwater is unknown.
Step 2: Identify the Goals of the Study
• Determine the soil to groundwater concentration ratio to evaluate leachability of PFAS at the 13 validated source areas at Eielson AFB. • Determine the relationship between validated source area groundwater quality compared to upgradient and downgradient groundwater quality to determine contribution from a validated source area. • Rank and prioritize the validated source zones to aid in future decision making on remedial strategy.
Step 3: Identify Information Inputs
• Source area soil, source area groundwater including immediately up and downgradient groundwater, Synthetic Precipitation Leaching Procedure (SPLP) data, cation exchange capacity (CEC) data, anion exchange capacity (AEC), total organic carbon (TOC), and hydrogeological information collected during previous investigations. • SPLP, AEC, TOC, and CEC samples will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-06 and P-12 (Appendix B). • Soil samples will be analyzed for 24 select PFAS compounds via the fixed laboratory by ELLE and/ or Pace for SPLP PFAS via USEPA 1312 and also CEC via USEPA 9081/6010/6020.
Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include soil within the 13 validated source areas and groundwater within and immediately upgradient and downgradient of the 13 validated source areas. • Temporal Boundaries: SPLP, CEC, AEC, and TOC sampling will be conducted once at each sampling location. Sampling is planned in Summer 2021. • Chemical Boundaries: Soil PFAS data, SPLP PFAS, CEC, AEC, and TOC data and shallow groundwater data will be used to calculate the soil to water ratio for PFAS.
Step 5: Develop the Analytical Approach
• If soil data collected during the prescriptive phase or adaptive phase is less than PSLs, then no SPLP, CEC, AEC, or TOC sampling will be completed. • If soil data collected during the prescriptive and adaptive phase exceeds PSLs, then up to three (3) soil samples will be collected for SPLP PFAS, CEC, AEC, and TOC analysis at the locations with the highest concentrations within the validated source area.
Step 6: Specify Performance or Acceptance Criteria
• Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19 & 30, #20, #23, #24, #25, #31 through #37. • Controls on precision, reporting, and accuracy are provided in Worksheets #12-2, 12-3, and #28. • Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.

Step 7: Develop the Plan for Obtaining Data
• SPLP sample locations will be completed during the adaptive phase of the RI. • Following coordination with stakeholders, up to 45 SPLP, CEC, AEC, and TOC samples will be collected from the 13 validated source areas (up to three [3] locations per area) where the highest concentrations of contaminants are identified to determine the leachability of PFAS contamination in soil to shallow groundwater. • Sampling locations will include split samples analyzed for 24 select PFAS compounds for both soil PFAS, SPLP, CEC, AEC, and TOC.

1014 **DQO 005 – Stratigraphic Flux Evaluation from Validated Source Areas**

Step 1: State the Problem
A quantitative, flux-based CSM founded in sequence stratigraphy and high-resolution hydraulic conductivity and contaminant distribution measurements has not been developed.
Step 2: Identify the Goals of the Study
• Determine contaminant transport pathways and plume maturity using a hydrofacies classification system that quantifies transport potential in aquifers using hydraulic conductivity and relative mass flux as the primary metrics.
Step 3: Identify Information Inputs
• Hydrogeological and hydrostratigraphy data collected during SI and RI activities. • Groundwater and permeability data (i.e., grain size analysis) from validated source area soil borings collected during RI activities. • Groundwater and permeability data (i.e., Hydraulic profiling tool (HPT), grain size analysis, point permeability testing) from VAP borings collected during RI activities. • HPT borings, VAP borings and point permeability testing will be completed in accordance with P-12, P-14, and P-20 (Appendix B). • Soil samples for grain size analysis will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-06 and P-12 (Appendix B). • Soil samples will be analyzed for grain size analysis via the fixed laboratory by ELLE and/ or Pace via ASTM D422-63.
Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include groundwater and permeability data within, upgradient, and downgradient of the 13 validated source areas and VAP transects. • Temporal Boundaries: Grain size sampling and point permeability testing will be conducted at select VAP borings. Sampling is planned in Summer 2021. • Practical Constraints on Data Collection: Obtaining off-site access to install borings. Limitations to boring placement in areas inaccessible without tree clearing or access route construction. Limitations to boring placement in areas inaccessible due to base restrictions.
Step 5: Develop the Analytical Approach
• If HPT is determined to be a viable option to measure hydraulic conductivity at the 50-foot and 100-foot VAP boring locations, then HPT will be completed in advance of the VAP borings to provide a continuous profile of hydraulic conductivity to determine groundwater sample collection intervals at those borings. • If hydraulic conductivity estimates are too high to resolve with the HPT tool at the 50-foot and 100-foot VAP boring locations, then continuous soil core logging, collection of discrete soil samples for grain size analysis, or point permeability testing will be performed at each groundwater sample interval to characterize the hydraulic

conductivity of the aquifer at these locations. Groundwater sampling will be biased to the higher permeability zones, as determined through the visual logging of soil cores.
Step 6: Specify Performance or Acceptance Criteria
• Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19, #20, #23, #24, #25, #30 through #37. • Controls on precision, reporting, and accuracy are provided in Worksheets #12-3 and #28. • Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.
Step 7: Develop the Plan for Obtaining Data
• The permeability data (i.e., grain size) collected from up to 114 soil borings collected from the 13 validated source areas will be combined with the source area groundwater data to evaluate the stratigraphic flux at the source areas. • The permeability data collected from the 76 HPT borings (co-located with the 46 50-feet bgs and 30, 100-feet bgs VAP borings) and the grain size data or point permeability data collected from the 150-foot VAP borings will be combined with the groundwater data to evaluate the stratigraphic flux at the VAP transects. • Based on the results of the prescriptive phase of investigation, up to 50 additional adaptive co-located HPT and VAP borings (up to 75 feet bgs or refusal) will be completed as needed to characterize groundwater quality and evaluate the stratigraphic flux along the VAP transects. HPT will be performed at a subset of the adaptive VAP boring locations depicted in DQO 001 Step 5. • Based on the results of the prescriptive phase of investigation, up to 50 additional adaptive 150-foot VAP borings with grain size data or point permeability testing will be completed to characterize groundwater quality and evaluate the stratigraphic flux along the VAP transects.

1015 **DQO 006 – Risk Assessment**

Step 1: State the Problem
The potential risk from exposure to PFAS contaminated soil, groundwater, surface water, sediment, and fish tissue to potential human and ecological receptors is unknown.
Step 2: Identify the Goals of the Study
• Determine the extent of PFAS contamination in fish tissue collected from surface water bodies at Eielson AFB and upstream (background) locations. • Determine the potential exposure for receptors to PFAS contamination in soil, groundwater, surface water, sediment, and fish tissue.
Step 3: Identify Information Inputs
• Historical surface and subsurface soil data, groundwater data from monitoring wells and fish tissue data collected during SI activities. • Groundwater data from monitoring wells, surface water, sediment, fish tissue, surface soil, and select subsurface soil data (from 0 to 10 feet bgs) collected during RI activities. • Fish tissue samples will be collected in accordance with ADEC Field Sampling Guidance (ADEC, 2019) and SOPs# P-10, P-17, and P-18 (Appendix B). • Fish tissue samples will be analyzed for 24 select PFAS compounds via the fixed laboratory by ELLE and/ or Pace for PFAS via DoD QSM 5.3 Table B-15.

Step 4: Define the Boundaries of the Study
• Spatial Boundaries: The study boundaries include groundwater, surface water, sediment, fish tissue, and soil data within, upgradient, and downgradient of the 13 validated source areas and surrounding communities. • Temporal Boundaries: Fish tissue sampling will be conducted once at each sampling location, during the dry season. Sampling is planned in Summer 2021. • Practical Constraints on Data Collection: Limitations due to the aquatic resources permit requirements. Limitations to fish tissue sampling in areas inaccessible due to water levels prevent access or force fish to leave the area. Limitations due to the availability of sufficient fish to complete the required sample sizes and target tissue mass.
Step 5: Develop the Analytical Approach
• If there is insufficient volume of water for sampling, then the location will be aborted. • If there is insufficient quantity of fish for sampling, then the area for sample collection will be expanded to include adequate quantity or select a new location and communicate the new location via the FCF.
Step 6: Specify Performance or Acceptance Criteria
• Analytical data will meet QA and QC requirements as defined in QAPP Worksheets #15, #19, #20, #23, #24, #25, #30 through #37. • Controls on precision, reporting, and accuracy are provided in Worksheets #12-2 and #28. • Field monitoring and detection equipment will be routinely calibrated, as detailed in Worksheet #22, to confirm that the equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results.
Step 7: Develop the Plan for Obtaining Data
• Up to four (4) fish tissue samples (filet and whole body) collected from up to 20 locations will be collected for PFAS analysis to evaluate potential transport of PFAS into fish tissue and the potential risks to human and wildlife receptors that may consume fish. Locations of the fish tissue samples (Figure 8) were selected based on a review of data from previous SI Reports, proximity to validated source areas, co-location with surface water and sediment sampling locations, and potential for human or ecological usage. Sample locations were selected to cover background, and locations within, cross-gradient and downgradient of validated source areas at Eielson AFB and the surrounding communities. • If sufficient numbers of fish are not collected during the sampling event, alternate locations for collection efforts will be selected during the field season following discussion and coordination with stakeholders.

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QAPP WORKSHEET #12-1: MEASUREMENT PERFORMANCE CRITERIA – PFAS IN GROUNDWATER AND SURFACE WATER

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Matrix	Groundwater/Surface Water/SPLP Leachate
Analytical Group	PFAS per DoD QSM 5.3 Table B-15
Concentration Level	Low

Data Quality Indicator (DQI)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	Relative percent difference (RPD) less than or equal to (≤) 30%
Accuracy/Bias (contamination)	Reagent or Equipment Blanks as appropriate	No target analyte concentrations greater than or equal to (≥) ½ limit of quantitation (LOQ) or greater than (>) $^{1}/_{10th}$ the amount measured in an associated sample
Analytical Accuracy/Bias (laboratory)	Laboratory control sample (LCS)	Percent recoveries (%R), See Table C-44 of DoD QSM 5.3
Analytical Accuracy/Bias (matrix interference)	Matrix Spike (MS) and Matrix Spile Duplicate (MSD)	%R, See Table C-44 of DoD QSM 5.3
Analytical Precision (laboratory)	Laboratory control sample duplicate (LCSD) and MSD	RPD ≤ 30%
Sensitivity Check	LOQ Verification Sample (spiked at LOQ)	Recovery within plus or minus (±) 30% of true value
Analytical Accuracy	Extracted Internal Standards (EIS)	50-150%
Bias/Holding Time	Reported Sample Data	≤7 days (no preservative for Fixed or Mobile Lab) or 14 days (Trizma preserved) to extraction/≤28 days to analysis

Note: The above table complies with the requirements of DoD QSM 5.3 (DoD, 2019a).

QAPP WORKSHEET #12-2: MEASUREMENT PERFORMANCE CRITERIA – PFAS IN SOIL/SEDIMENT/FISH TISSUE

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Matrix	Soil/Sediment/ Fish Tissue
Analytical Group	PFAS per DoD QSM 5.3 Table B-15
Concentration Level	Low

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD ≤ 50%
Accuracy/Bias (contamination)	Reagent or Equipment Blanks as appropriate	No target analyte concentrations ≥ LOQ or > $^{1}/_{10th}$ the amount measured in an associated sample.
Analytical Accuracy/Bias (laboratory)	LCS	%R, See Table C-45 of DoD QSM 5.3.
Analytical Accuracy/Bias (matrix interference)	MS and MSD	%R, See Table C-45 of DoD QSM 5.3.
Analytical Precision (laboratory)	LCSD and MSD	RPD ≤ 30%
Instrument Sensitivity Check	LOQ Verification Sample (spiked at LOQ)	Recovery within ±30% of true value
Analytical Accuracy	EIS	50-150%
Bias/Holding Time	Reported Sample Data	≤28 days or 14 days (Mobile lab) to extraction/≤28 days to analysis

Note: The above table complies with the requirements of DoD QSM 5.3 (DoD, 2019a).

QAPP WORKSHEET #12-3: MEASUREMENT PERFORMANCE CRITERIA – PFAS IN SOIL/SEDIMENT/FISH TISSUE

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Matrix	Groundwater/Surface Water/Soil/Sediment
Analytical Group	PFAS per Pace Accelerated PFAS Method. SOP-ENV-MAD1-0101
Concentration Level	Low

Data Quality Indicator (DQI)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD ≤ 30%
Accuracy/Bias (contamination)	Reagent or Equipment Blanks as appropriate	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in an associated sample.
Analytical Accuracy/Bias (laboratory)	LCS	%R, In-house LCS limits. 70-130%.
Analytical Accuracy/Bias (matrix interference)	MS and MSD	%R, 60-140%
Analytical Precision (laboratory)	LCSD and MSD	RPD ≤ 30% for water and 50% for soil
Instrument Sensitivity Check (ISC)	LOQ Verification Sample (spiked at LOQ)	Recovery within ± 50% of true value
Bias/Holding Time	Reported Sample Data	≤7 days (no preservative for Mobile Lab)

Note: The above table complies with the requirements of DoD QSM 5.3 (DoD, 2019a).

QAPP WORKSHEET #12-4: MEASUREMENT PERFORMANCE CRITERIA – SECONDARY ANALYSIS IN SOIL AND SEDIMENT

(UFP-QAPP MANUAL SECTION 2.6.2)

(USEPA 2106-G-05 Section 2.2.6)

Matrix	Soil
Analytical Group	Secondary Analyses
Concentration Level	Low

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD ≤ 50%
Accuracy/Bias (contamination)	Method, Reagent and/or Equipment Blanks as appropriate	No concentrations ≥ ½ LOQ
Analytical Accuracy/Bias (laboratory)	LCS and LCSD	%R 80-120%
Analytical Accuracy/Bias (matrix interference)	Matrix Spike and MSD	%R 75-125%
Analytical Precision (laboratory)	LCSD and/or MSD	RPD ≤ 35%
Sensitivity	LOQ Verification Sample (spiked at LOQ)	Recovery within ±30% of true value

Note: Secondary Analysis include TOC 9060A, Grain Size ASTM D-422, pH 9045C/D, CEC 9081/6010/6020, and AEC p-fixation.

QAPP WORKSHEET #12-5: MEASUREMENT PERFORMANCE CRITERIA – TSS IN SURFACE WATER

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Matrix	Water
Analytical Group	**TSS /SM 2540D, TOC/SW846 9060A**
Concentration Level	**Low**

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	RPD ≤ 30%
Accuracy/Bias (contamination)	Method and Equipment Blanks, as appropriate	No TSS concentration ≥ LOQ
Analytical Accuracy/Bias (laboratory)	LCS and LCSD	%R 80-120%
Analytical Precision (laboratory)	LCSD and/or Laboratory Duplicate	RPD ≤ 20%

QAPP WORKSHEET #12-6: MEASUREMENT PERFORMANCE CRITERIA – VOC IN SOIL, WATER AND WASTE CHARACTERIZATION

(UFP-QAPP Manual Section 2.6.2)

(USEPA 2106-G-05 Section 2.2.6)

Matrix	Soil/Water/ Toxicity characteristic leaching procedure (TCLP) Leachate
Analytical Group	Volatile Organic Compound (VOC) /SW846 8260
Concentration Level	Low

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Accuracy	Surrogate Spike	%R, See Table C-23/C-24 of DoD QSM 5.3.
Accuracy/Bias/Precision	LCS/LCSD/MS/MSD	%R, See Table C-23/C-24 of DoD QSM 5.3.
Accuracy/Laboratory Contamination	Method Blank	No analytes detected > 1/2 LOQ or >1/10th the amount measured in any associated sample or 1/10 the regulatory limit, whichever is greater
Precision	Field Duplicate	RPD ≤ 50% for soil, ≤ 30% for water
Accuracy/Field Contamination	Field Blank	No detected target compounds
Accuracy/Transport Contamination	Trip Blank	No detected target compounds
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	14 days to leaching; ≤ 14 days to analysis
Sensitivity	Detection limits	Detection limits ≤ to PSLs

QAPP WORKSHEET #12-7: MEASUREMENT PERFORMANCE CRITERIA – SVOC IN SOIL, WATER AND WASTE CHARACTERIZATION

(UFP-QAPP Manual Section 2.6.2)
(USEPA 2106-G-05 Section 2.2.6)

Matrix	Soil/Water/TCLP Leachate
Analytical Group	Semi-volatile organic compound (SVOC) /SW846 8270
Concentration Level	Low

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Accuracy	Surrogate Spike	%R, See Table C-25/C-26 of DoD QSM 5.3.
Accuracy/Bias/Precision	LCS/LCSD/MS/MSD	%R, See Table C-25/C-26 of DoD QSM 5.3.
Accuracy/Laboratory Contamination	Method Blank	No analytes detected > 1/2 LOQ or >1/10th the amount measured in an associated sample or 1/10th the regulatory limit, whichever is greater
Precision	Field Duplicate	RPD ≤ 50% for soil, ≤ 30% for water
Accuracy/Field Contamination	Field Blank	No detected target compounds
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	≤14 days to leaching; ≤7 days from leaching to extraction/ ≤40 days to analysis
Sensitivity	Detection limits	Detection limits ≤ to PSLs

QAPP WORKSHEET #12-8: MEASUREMENT PERFORMANCE CRITERIA – METALS IN SOIL, WATER AND WASTE CHARACTERIZATION

(UFP-QAPP Manual Section 2.6.2)

(USEPA 2106-G-05 Section 2.2.6)

Matrix	Soil/Water/TCLP Leachate
Analytical Group	Metals /SW846 6010C/D, 7470A/7471B
Concentration Level	Low

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Accuracy/Bias/Precision	Laboratory Control Spike/Matrix Spike and their Duplicates	Recovery limits per QSM 5.3. ±25% for elements not in QSM 5.3.; RPD ≤20%
Accuracy/Laboratory Contamination	Method Blank	No analytes detected > 1/2 reporting limit (RL) or >1/20th the amount measured in any sample
Precision	Lab Duplicate	RPD ≤20%
Precision	Field Duplicate	RPD as set by project
Accuracy/Field Contamination	Field Blank	No detected target compounds
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	≤ 6 months, ≤ 28 days for Hg
Sensitivity	Detection limits	Detection limits ≤ to PSL

QAPP WORKSHEET #12-9: MEASUREMENT PERFORMANCE CRITERIA – CHLORIDE AND SULFATE IN WATER

(UFP-QAPP Manual Section 2.6.2)

(USEPA 2106-G-05 Section 2.2.6)

Matrix	Water
Analytical Group	**Chloride and Sulfate / EPA 300.0**
Concentration Level	**Low**

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Accuracy/Bias/Precision	Laboratory Control Spike/Matrix Spike	Laboratory statistical limits
Accuracy/Laboratory Contamination	Method Blank	No analytes detected > 1/2 LOQ or >1/10th the amount measured in an associated sample
Precision	Lab duplicate	Laboratory limits
Precision	Field Duplicate	RPD ≤ 30% for water
Accuracy/Field Contamination	Field Blank	No detected target compounds
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	SO4, Br, Cl, F ≤28 days, NO3, NO2 ≤48 hrs
Sensitivity	Detection limits	Detection limits ≤ to PSLs

QAPP WORKSHEET #12-10: MEASUREMENT PERFORMANCE CRITERIA – NITRITE AND NITRATE NITROGEN IN WATER

(UFP-QAPP Manual Section 2.6.2)

(USEPA 2106-G-05 Section 2.2.6)

Matrix	Water
Analytical Group	**Nitrite/Nitrate-Nitrogen/ EPA 353.2**
Concentration Level	**Low**

DQI	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Accuracy/Bias	Laboratory Control Spike/Matrix Spike	Method windows
Accuracy/Laboratory Contamination	Method Blank	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater
Precision	Lab Duplicate	Laboratory statistical RPD
Precision	Field Duplicate	RPD ≤ 30% for water
Accuracy/Field Contamination	Field Blank	No detected target compounds
Completeness	Reported Sample Data	As determined by the project
Bias/Holding Time	Reported Sample Data	48 hours/≤ 28 days
Sensitivity	Detection limits	Detection limits ≤ to PSLs

QAPP WORKSHEET #13: SECONDARY DATA USES AND LIMITATIONS

(UFP-QAPP Manual Section 2.7)

(USEPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

This worksheet identifies sources of secondary data not generated for the specific purpose of this project, or data generated under a separate QAPP, and summarizes their uses for this project. A complete list of references reviewed to complete the EAFB RI for PFAS at Various sites will be provided in the RI Report and are also listed in **QAPP Worksheet #1 & #2**.

Data type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
Meteorological	National Weather Service and Western Regional Climate Center	Average temperatures, daylight hours, average snowfall.	Published data are available for the past 74 years. It is necessary to schedule the 2021 field activities when the ground surface and surface water are thawed to allow for collection of surface soil, subsurface soil, groundwater, surface water, pore water, and sediment samples. It is also necessary to verify dry and wet seasons to collect the surface water/sediment samples during both seasons.
Topographic	United States Geological Survey (USGS)/local observations	Changes in landform, surface drainage.	Changes in landform will impact the potential migration of PFAS through surface drainage, surface water, and subsurface.
Hydrogeologic setting, geology, permafrost, and Groundwater Flow System	Final Groundwater Model Summary and Quality Report (Ahtna, 2020).	Assist in development of the CSM and placement of 2021 sample locations. Also attempts to identify locations of permafrost and potential contaminant transport as the result of the discontinuous permafrost layers at EAFB and the surrounding areas within the study.	Model development incorporated data and analyses from available site-specific data within EAFB; other available data in the vicinity of EAFB; and new data from additional investigations. The model is generally not very sensitive to change in hydraulic properties or boundary conditions.

Data type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
Location description, maps, operational history, mission, climate, land use, and physical setting	Draft CSM, EAFB, Alaska (AECOM, 2013)	Assist in development of the CSM and EAFB operational history.	The CSM was completed in 2013 and was not finalized. Some of the data may be dated.
Permafrost	Quantifying Permafrost Extent, Condition, and Degradation at EAFB (Labedz, 2019)	Provide background information on the presence of discontinuous permafrost present at EAFB.	The investigation was conducted to better understand the effect of construction activities on permafrost and does not provide detailed information on where permafrost is located.
Historical Analytical Results and Past Site Uses.	References listed in QAPP Worksheet #1 & #2.	Analytical data from previous assessments.	PFAS assessments and investigations have occurred at EAFB since 2014 and data was used to develop the CSM and determine the location of 2021 prescriptive sample locations. Analytical data from the earlier investigations may not have followed the same protocols as currently in place to minimize cross-contamination. Analytical data from 2020 investigations are preliminary and have not been finalized.
Eielson AFB Background and identifies known contaminated areas on base	Eielson Environmental Restoration Program Atlas (July 2020)	Provides location information on monitoring wells and also identifies area of contamination to determine the type of waste characterization samples required to dispose of investigation-derived waste (IDW).	None

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QAPP WORKSHEET #14 & #16: PROJECT TASKS & SCHEDULE

(UFP-QAPP Manual Section 2.8.2)
(USEPA 2106-G-05 Section 2.2.4)

The project schedule is presented below for sampling and other activities planned at EAFB as part of the PFAS RI.

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s) (Contract Data Requirements List [CDRL] #)	Deliverable Due Date
Project Kickoff Meeting	BEM	04 August 2020	31 August 2020	Agenda (B008) Presentation Materials (B007) Meeting Minutes (B009)	Complete
Regulatory Scoping Meeting	BEM	19 August 2020	14 September 2020	Agenda (B008) Presentation Materials (B007) Meeting Minutes (B009)	Complete
QAPP Addendum for Fall 2020 Groundwater Sampling and Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP)	BEM	04 August 2020	05 October 2020	Pre-Draft, Draft, Draft Final, and Final QAPP Addendum (A007 and A008)	Complete
Fall 2020 Groundwater Sampling Event	BEM	19 October 2020	28 October 2020	Analytical data incorporated into CSM (A012)	Complete
Pre-Draft QAPP (WMP provided as **Appendix E**)	BEM	05 October 2020	01 December 2020	Pre-Draft QAPP (A007)	01 December 2020

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s) (Contract Data Requirements List [CDRL] #)	Deliverable Due Date
Pre-Draft APP/SSHP; provided as **Appendix F**, under separate cover	BEM	05 October 2020	01 December 2020	Pre-Draft APP and SSHP (A008)	01 December 2020
TRIAD/Dynamic Work Plan Training and Scoping Meeting (meeting held over 2 days on 22 December 2020 and 27 January 2021)	BEM	05 October 2020	22 December 2020 and 27 January 2021	Agenda (B008) Presentation Materials (B007) Meeting Minutes (B009)	08 January 2021 and 08 February 2021 for Meeting Minutes
Draft QAPP (WMP provided as **Appendix E**)	BEM	25 January 2021	31 January 2021	Draft QAPP (A007)	31 January 2021
Draft APP/SSHP; provided as **Appendix F**, under separate cover	BEM	To Be Determined (TBD)	TBD	Draft APP and SSHP (A008)	TBD
Draft Final QAPP (WMP provided as **Appendix E**)	BEM	31 March 2021	13 April 2021	Draft Final QAPP (A007)	13 April 2021
Draft Final APP/SSHP; provided as **Appendix F** under separate cover	BEM	TBD	TBD	Draft-Final APP and SSHP (A008)	TBD
Final QAPP (WMP provided as **Appendix E**)	BEM	10 June 2021	10 June 2021	Final QAPP (A007)	10 June 2021
Final APP/SSHP provided as **Appendix F**	BEM	10 June 2021	10 June 2021	Final APP and SSHP (A008)	10 June 2021
Coordinating/permitting	BEM	05 October 2020	23 March 2021	Site Permits, Rights of Entry	23 March 2021

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s) (Contract Data Requirements List [CDRL] #)	Deliverable Due Date
Mobilization and set up	BEM	17 May 2021	18 May 2021	Field notes (included in RI Report [A001])	Submitted in RI Report
Sample Collection, monitoring well installation, and monitoring well development	BEM	14 June 2021	27 September 2021	Field notes and measurements (included in RI Report [A001])	Submitted in RI Report
Sample Analysis	ELLE and Pace	20 October 2020	28 September 2021	Analytical data package (A012) and electronic data deliverable (EDD) (Environmental Resources Program Info Management System [ERPIMS] Upload [B006]]	Submitted in RI Report
	Pace	14 June 2021	11 September 2021		
Demobilization of field team	BEM	28 September 2021	28 September 2021	Field notes (included in Report [A001])	Submitted in RI Report
IDW Management and Disposal	BEM	20 October 2020	27 September 2021	Field notes (included in RI Report [A001])	Submitted in RI Report
Data Validation	BEM / Synectics	12 November 2020	01 November 2021	Data validation report (A012)	Submitted in RI Report

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s) (Contract Data Requirements List [CDRL] #)	Deliverable Due Date
ERPIMS Data Upload	BEM	01 December 2020	19 November 2021	ERPIMS Data Upload (B006)	19 November 2021
Pre-Draft RI Report (includes CSM Updates)	BEM	21 July 2021	19 November 2021	Pre-Draft RI Report (includes CSM Updates) (A001)	19 November 2021
Draft RI Report (includes CSM Updates) for stakeholder review	BEM	17 December 2021	28 December 2021	Draft RI Report (includes CSM Updates) (A001)	28 December 2021
Draft Final RI Report (includes CSM Updates)	BEM	25 March 2022	05 April 2022	Draft Final RI Report (includes CSM Updates) (A001)	05 April 2022
Final RI Report (includes CSM Updates)	BEM	05 May 2022	10 May 2022	Final RI Report (includes CSM Updates) (A001)	10 May 2022
Geospatial Submittal	BEM	05 November 2021	04 August 2022	Geospatial data submittal (A005)	04 August 2022

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QAPP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

(UFP-QAPP Manual Section 2.6.2.3)
(USEPA 2106-G-05 Section 2.2.6)

This worksheet provides the laboratory-specific limits for the PFAS compounds that will be analyzed, including the typical LOQ and limit of detection (LOD). The LOQs and LODs are what the laboratory can achieve and were supplied by the laboratory. The LOQ is the lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias, and the LOD is the lowest concentration for reliable reporting of a non-detection of a specific analyte in a specific medium with a specific method at 99% confidence (DoD, 2017). For the purposes of this RI scope, the PSLs are defined as the DoD screening levels (Assistant Secretary of Defense [ASD], 2019a) where available. Concentrations detected between the LOD and LOQ are estimates due to matrix interference and/or dilution of the sample, and therefore will be qualified and indicated as such on laboratory analytical reports. Laboratory analyses adhere to the ASD Memorandum for Establishing a Consistent Methodology for Analysis of PFAS (ASD, 2019b). Soil/sediment results are to be reported as dry weight.

The PSLs for 24 PFAS compounds are summarized below for groundwater/surface water followed by soil/sediment. Pace will provide mobile lab services on-site, and ELLE and Pace will provide off-site laboratory sample analysis. There are no associated PSLs for fish tissue. ADEC Table B1 Method Two MTGW cleanup levels and Table C Groundwater Cleanup Levels (ADEC, 2020d) are included for comparison purposes and will not be used for decision making purposes.

Matrix: Aqueous		**Analytical Group: PFAS (ELLE) per DoD QSM 5.1.1, 5.3 or later versions Table B-15**			
Analyte	**CAS Number**	**ADEC Table C Levels[3] (ng/L)**	**Project Screening Levels[2] (ng/L)**	**Laboratory-specific Limits[1]**	
				LOQ[3] (ng/L)	**LOD[3] (ng/L)**
4:2 Fluorotelomer sulfonic acid	75124-72-4	NA	No-risk based value (NRBV)	2.0	1.0
6:2 Fluorotelomer sulfonic acid	27619-97-2	NA	NRBV	5.0	4.0
8:2 Fluorotelomer sulfonic acid	39108-34-4	NA	NRBV	3.0	2.0
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NRBV	3.0	1.0
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NRBV	2.0	1.2
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	600	2.0	1.0
Perfluorobutanoic acid (PFBA)	375-22-4	NA	NRBV	5.0	4.0
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NRBV	2.0	1.0
Perfluorodecanoic acid (PFDA)	335-76-2	NA	NRBV	2.0	1.0
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NRBV	2.0	1.0
Perfluoroheptanoic acid (PFHpA)	374-85-9	NA	NRBV	2.0	1.0
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NRBV	2.0	1.0
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NA	NRBV	2.0	1.0
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	NRBV	2.0	1.0
Perfluorononanoic acid (PFNA)	375-95-1	NA	NRBV	2.0	1.0

Matrix: Aqueous		Analytical Group: PFAS (ELLE) per DoD QSM 5.1.1, 5.3 or later versions Table B-15			
Analyte	CAS Number	ADEC Table C Levels[3] (ng/L)	Project Screening Levels[2] (ng/L)	Laboratory-specific Limits[1]	
				LOQ[3] (ng/L)	LOD[3] (ng/L)
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NRBV	2.0	1.0
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NRBV	2.0	1.0
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	400	40	2.0	1.0
Perfluorooctanoic acid (PFOA)	335-67-1	400	40	2.0	1.0
Perfluoropentanoic acid (PFPA)	2706-90-3	NA	NRBV	2.0	1.0
Perfluoropentanesulfonic acid (PFPS)	2706-91-4	NA	NRBV	2.0	1.0
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NRBV	2.0	1.0
Perfluorotridecanoic acid (PFTriDA)	72629-94-68	NA	NRBV	2.0	1.0
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NRBV	2.0	1.0

Notes:
[1] These limits are what ELLE can achieve and were supplied by ELLE.
[2] The PSLs for PFBS, PFOS, and PFOA are set to the DoD risk SLs using the most conservative HQ of 0.1 and residential scenario (OSD, 2021).
[3] ELLE is scheduled to re-evaluate their PFAS soil and water RL/LOD/LOQs in accordance with the DoD QSM 5.3 requirements in December 2020 and finalize by January 2021. ELLE thoroughly expects the new values will be at a minimum of half of the previous values presented in this worksheet.
[3]18 AAC 75.345 ADEC Table C Groundwater Cleanup Levels (ADEC, 2020d)
CAS = Chemical Abstracts Service
NA = Not Applicable
NRBV = no-risk based value
ng/L = nanogram per liter

Matrix: Aqueous		**Analytical Group: PFAS (Pace – Fixed Lab West Columbia, SC) per DoD QSM 5.1.1, 5.3 or later versions Table B-15**			
Analyte	**CAS Number**	**ADEC Table C Levels[3] (ng/L)**	**Project Screening Levels[2] (ng/L)**	**Laboratory Specific Limits[1]**	
				LOQ (ng/L)	**LOD (ng/L)**
4:2 Fluorotelomer sulfonic acid	757124-72-4	NA	NRBV	8	4
6:2 Fluorotelomer sulfonic acid	27619-97-2	NA	NRBV	8	4
8:2 Fluorotelomer sulfonic acid	39108-34-4	NA	NRBV	8	4
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NRBV	8	4
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NRBV	8	4
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	600	4	2
Perfluorobutanoic acid (PFBA)	375-22-4	NA	NRBV	4	2
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NRBV	4	2
Perfluorodecanoic acid (PFDA)	335-76-2	NA	NRBV	4	2
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NRBV	4	2
Perfluoroheptanoic acid (PFHpA)	375-85-9	NA	NRBV	4	2
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NRBV	4	2
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NA	NRBV	4	2
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	NRBV	4	2
Perfluorononanoic acid (PFNA)	375-95-1	NA	NRBV	4	2
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NRBV	4	2
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NRBV	4	2
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	400	40	4	2
Perfluorooctanoic acid (PFOA)	335-67-1	400	40	4	2
Perfluoropentanoic acid (PFPA)	2706-90-3	NA	NRBV	4	2
Perfluoropentanesulfonic acid (PFPS)	2706-91-4	NA	NRBV	4	2
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NRBV	4	2

Matrix: Aqueous		Analytical Group: PFAS (Pace – Fixed Lab West Columbia, SC) per DoD QSM 5.1.1, 5.3 or later versions Table B-15			
Analyte	CAS Number	ADEC Table C Levels[3] (ng/L)	Project Screening Levels[2] (ng/L)	Laboratory Specific Limits[1]	
				LOQ (ng/L)	LOD (ng/L)
Perfluorotridecanoic acid (PFTriDA)	72629-94-8	NA	NRBV	4	2
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NRBV	4	2

Notes:
[1]These limits are what Pace can achieve and were supplied by Pace. Pace is scheduled to re-evaluate the PFAS soil and water RL/LOD/LOQs in accordance with the DoD QSM 5.3 requirements in December 2020 and finalize by January 2021. Once finalized, the QAPP will be revised to include new limits. If the QAPP is already finalized, a FCF will be completed.
[2] The PSLs for PFBS, PFOS, and PFOA are set to the DoD risk SLs using the most conservative HQ of 0.1 and residential scenario (OSD, 2021).
[3]18 AAC 75.345 ADEC Table C Groundwater Cleanup Levels (ADEC, 2020d)
CAS = Chemical Abstracts Service
NA = Not Applicable
NRBV = no-risk based value
ng/L = nanogram per liter

Matrix: Aqueous		Analytical Group: PFAS (Pace Mobile Lab) per Screening, Accelerated LC/MS/MS Method			
				Laboratory Specific Limits[1]	
Analyte	CAS Number	ADEC Table C Levels[3] (ng/L)	Project Screening Levels[2] (ng/L)	LOQ (ng/L)	LOD (ng/L)
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	600	10	NA
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	400	40	10	NA
Perfluorooctanoic acid (PFOA)	335-67-1	400	40	10	NA

Notes:
[1] These limits are what the Pace Mobile Lab can achieve and were supplied by Pace. Screening, Accelerated LC/MS/MS method does not report below LOQ.
[2] The PSLs for PFBS, PFOS, and PFOA are set to the DoD risk SL using the most conservative HQ of 0.1 and residential scenario (OSD, 2021). The project screening levels for the remaining PFAS compounds are set to the compound LOQ.
[3] 18 AAC 75.345 ADEC Table C Groundwater Cleanup Levels (ADEC, 2020d)
CAS = Chemical Abstracts Service
NA = Not Applicable
ng/L – nanogram per liter

Matrix: Soil/Sediment		Analytical Group: PFAS (Pace Mobile Lab) per Screening, Accelerated LC/MS/MS Method			
Analyte	CAS Number	ADEC Table B1 Levels[3] (mg/kg)	Project Screening Levels (mg/kg)[2]	Laboratory Specific Limits[1]	
				LOQ (mg/kg)	LOD (mg/kg)
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	1.9	0.0001	NA
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.0030	0.13	0.00025	NA
Perfluorooctanoic acid (PFOA)	335-67-1	0.0017	0.13	0.0005	NA

Notes:
[1] These limits are what the Pace Mobile Lab can achieve and were supplied by Pace. Screening, Accelerated LC/MS/MS method does not report below LOQ.
[2] The PSLs for PFBS, PFOS, and PFOA are set to the DoD risk SL using the most conservative HQ of 0.1 and residential scenario (OSD, 2021). The project screening levels for the remaining PFAS compounds are set to the compound LOQ.
[3]18 AAC 75.341 ADEC Table B1 Method Two – Soil Cleanup Levels Table, MTGW (ADEC, 2020d)
mg/kg – milligram per kilogram
NA = Not Applicable
CAS = Chemical Abstracts Service

Matrix: Soil/Sediment/ Fish Tissue		**Analytical Group: PFAS (ELLE) per DoD QSM 5.1.1, 5.3 or later versions Table B-15**			
Analyte	**CAS Number**	**ADEC Table B1 Levels[3] (mg/kg)**	**Project Screening Levels (mg/kg)[2]**	**Laboratory Specific Limits[1]**	
				LOQ (mg/kg)	**LOD (mg/kg)**
4:2 Fluorotelomer sulfonic acid	75124-72-4	NA	NRBV	0.0020	0.0016
6:2 Fluorotelomer sulfonic acid	27619-97-2	NA	NRBV	0.0020	0.0016
8:2 Fluorotelomer sulfonic acid	39108-34-4	NA	NRBV	0.0030	0.0016
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NRBV	0.0020	0.00040
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NRBV	0.0020	0.00040
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	1.9	0.0020	0.0016
Perfluorobutanoic acid (PFBA)	375-22-4	NA	NRBV	0.0020	0.0016
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NRBV	0.00060	0.00040
Perfluorodecanoic acid (PFDA)	335-76-2	NA	NRBV	0.00060	0.00040
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NRBV	0.00060	0.00040
Perfluoroheptanoic acid (PFHpA)	375-85-9	NA	NRBV	0.00060	0.00040
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NRBV	0.00060	0.00040
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NA	NRBV	0.00060	0.00040
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	NRBV	0.00060	0.00040
Perfluorononanoic acid (PFNA)	375-95-1	NA	NRBV	0.00060	0.00040
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NRBV	0.00060	0.00040
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NRBV	0.00060	0.00040
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.0030	0.13	0.00060	0.00040

Matrix: Soil/Sediment/ Fish Tissue		Analytical Group: PFAS (ELLE) per DoD QSM 5.1.1, 5.3 or later versions Table B-15			
Analyte	CAS Number	ADEC Table B1 Levels[3] (mg/kg)	Project Screening Levels (mg/kg)[2]	Laboratory Specific Limits[1]	
				LOQ (mg/kg)	LOD (mg/kg)
Perfluorooctanoic acid (PFOA)	335-67-1	0.0017	0.13	0.00060	0.00040
Perfluoropentanoic acid (PFPA)	2706-90-3	NA	NRBV	0.00060	0.00040
Perfluoropentanesulfonic acid (PFPS)	2706-91-4	NA	NRBV	0.0030	0.00040
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NRBV	0.00060	0.00040
Perfluorotridecanoic acid (PFTriDA)	72629-94-68	NA	NRBV	0.00060	0.00040
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NRBV	0.00060	0.00040

Notes:
[1] These limits are what ELLE can achieve and were supplied by ELLE. All results for soil and sediment to be reported in dry weight and fish tissue will be reported to wet weight.
[2] The PSLs for PFBS, PFOS, and PFOA are set to the DoD risk SLs using the most conservative HQ of 0.1 and residential scenario (OSD 2021), which apply to both soil and sediment. There are no PSLs associated with fish tissue.
[3]18 AAC 75.341 ADEC Table B1 Method Two – Soil Cleanup Levels Table, MTGW (ADEC, 2020d)
CAS = Chemical Abstracts Service
NA = Not Applicable
NRBV = no-risk based value
mg/kg - milligrams per kilogram

Matrix: Soil/Sediment/ Fish Tissue			**Analytical Group: PFAS (Pace – Fixed Lab West Columbia, SC) per DoD QSM 5.1.1, 5.3 or later versions Table B-15**		
Analyte	**CAS Number**	**ADEC Table B1 Levels[3] (mg/kg)**	**Project Screening Levels (mg/kg)[2]**	**Laboratory Specific Limits[1]**	
				LOQ (mg/kg)	**LOD (mg/kg)**
4:2 Fluorotelomer sulfonate	757124-72-4	NA	NRBV	0.002	0.001
6:2 Fluorotelomer sulfonate	27619-97-2	NA	NRBV	0.002	0.001
8:2 Fluorotelomer sulfonate	39108-34-4	NA	NRBV	0.002	0.001
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6	NA	NRBV	0.002	0.001
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9	NA	NRBV	0.002	0.001
Perfluorobutanesulfonic acid (PFBS)	375-73-5	NA	1.9	0.001	0.0005
Perfluorobutanoic acid (PFBA)	375-22-4	NA	NRBV	0.001	0.0005
Perfluorodecanesulfonic acid (PFDS)	335-77-3	NA	NRBV	0.001	0.0005
Perfluorodecanoic acid (PFDA)	335-76-2	NA	NRBV	0.001	0.0005
Perfluorododecanoic acid (PFDoA)	307-55-1	NA	NRBV	0.001	0.0005
Perfluoroheptanoic acid (PFHpA)	375-85-9	NA	NRBV	0.001	0.0005
Perfluoroheptanesulfonic acid (PFHpS)	375-92-8	NA	NRBV	0.001	0.0005
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	NA	NRBV	0.001	0.0005
Perfluorohexanoic acid (PFHxA)	307-24-4	NA	NRBV	0.001	0.0005
Perfluorononanoic acid (PFNA)	375-95-1	NA	NRBV	0.001	0.0005
Perfluorononanesulfonic acid (PFNS)	68259-12-1	NA	NRBV	0.001	0.0005
Perfluorooctanesulfonamide (PFOSA)	754-91-6	NA	NRBV	0.001	0.0005
Perfluorooctane sulfonate (PFOS)	1763-23-1	NA	0.13	0.001	0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	0.0030	0.13	0.001	0.0005
Perfluoropentanoic acid (PFPA)	2706-90-3	0.0017	NRBV	0.001	0.0005
Perfluoropentanesulfonic acid (PFPS)	2706-91-4	NA	NRBV	0.001	0.0005

Matrix: Soil/Sediment/ Fish Tissue			**Analytical Group: PFAS (Pace – Fixed Lab West Columbia, SC) per DoD QSM 5.1.1, 5.3 or later versions Table B-15**		
Analyte	**CAS Number**	**ADEC Table B1 Levels[3] (mg/kg)**	**Project Screening Levels (mg/kg)[2]**	**Laboratory Specific Limits[1]**	
				LOQ (mg/kg)	**LOD (mg/kg)**
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	NA	NRBV	0.001	0.0005
Perfluorotridecanoic acid (PFTriDA)	72629-94-68	NA	NRBV	0.001	0.0005
Perfluoroundecanoic acid (PFUnA)	2058-94-8	NA	NRBV	0.001	0.0005

Notes:
[1]The limits are what Pace can achieve and were supplied by Pace. All results for soil and sediment to be reported in dry weight and fish tissue will be reported to wet weight. Pace is scheduled to re-evaluate the PFAS soil and water RL/LOD/LOQs in accordance with the DoD QSM 5.3 requirements in December 2020 and finalize by January 2021. Once finalized, the QAPP will be revised to include new limits. If the QAPP is already finalized, a FCF will be completed.
[2]The PSLs are set to the compound LODs, which apply to both soil and sediment. There are no PSLs associated with fish tissue.
[3]18 AAC 75.341 ADEC Table B1 Method Two – Soil Cleanup Levels Table, MTGW (ADEC, 2020d)
CAS – Chemical Abstracts Service
mg/kg–milligram per kilogram
NA = Not Applicable
NRBV = no-risk based value

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QAPP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

UFP-QAPP, PFAS Sampling Activities

(UFP-QAPP Manual Section 3.1.1)
(USEPA 2106-G-05 Section 2.3.1)

The DQOs for the RI sampling are described in **Worksheet #11** of this QAPP. This worksheet provides the detailed rationale and approach for the RI sampling at EAFB. This QAPP was developed to ensure the amount, type, and quality of the data are sufficient to define the nature and extent of contamination in multiple media for validated PFAS source areas, and on- and off-base in key areas utilizing an adaptive management plan process for the RI.

To execute this scope of work, the BEM Team will utilize a prescriptive and an adaptive site characterization approach to complete delineation that meets the objectives outlined in **Worksheet #11** and is consistent with the methodologies presented in the AFCEC BAA 967 and the ESTCP-B3-5203 PFAS Mobile lab demonstration. The approach includes (1) utilization of existing data to develop a base-wide CSM and AFFF Use Area-specific CSMs (**Worksheet #10**), (2) execution of a prescriptive phase of investigation work, which includes set boring and sampling locations that are based on known PFAS extents and validated PFAS source areas, (3) analysis of the data and development of additional step-out adaptive locations, and (4) utilization of digital tools to communicate the data quickly and effectively to facilitate real-time decision making to implement the adaptive phase of work.

The adaptive site characterization approach developed for EAFB is centered around the Stratigraphic Flux concept. Stratigraphic Flux enables the development of quantitative, flux-based CSMs that are founded in sequence stratigraphy, and high-resolution hydraulic conductivity and contaminant distribution measurements. The result is a 3D graphical analysis that defines contaminant transport pathways and plume maturity using a hydrofacies classification system that quantifies transport potential in aquifers using hydraulic conductivity and relative mass flux as the primary metrics. This approach includes the systematic planning and sequencing of work that utilizes a combination of prescriptive locations (pre-determined based on known source locations) and adaptive locations, which includes “step-outs” to complete delineation of lateral and vertical impacts and “step-ins” to zoom in on source hotspots or the core of the groundwater impacts.

The adaptive approach relies on a combination of standard turnaround time (TAT) results, quick turnaround results, and mobile laboratory analyses to provide data and support the near real-time decision making as specified in this QAPP and that will be demonstrated as part of the planned TRIAD-training to be conducted in two sessions (Session 1 on December 22, 2020 and Session 2 on January 27, 2021) with the BEM Team, AFCEC, ADEC, and USEPA Region 10. Proposed samples are categorized as either “definitive” or “screening” samples. The definitive samples are generally those with potential application for human health

or ecological risk assessment purposes and will be analyzed per the DoD QSM method (DoD, 2019a) for 24 PFAS compounds as listed in **Worksheet #15**. Definitive sample media will include surface soil (0 to 1-foot bgs), surface water, sediment, pore water, monitoring well groundwater, waste characterization, and fish tissue. Definitive samples will also include 5% of subsurface soils samples, source area groundwater and VAP groundwater that will be collected to evaluate reliability of the mobile lab. Additional samples from subsurface soils, source area groundwater and VAP groundwater will be analyzed as definitive additional definitive samples to ensure sufficient data is available to support future risk assessment activities.

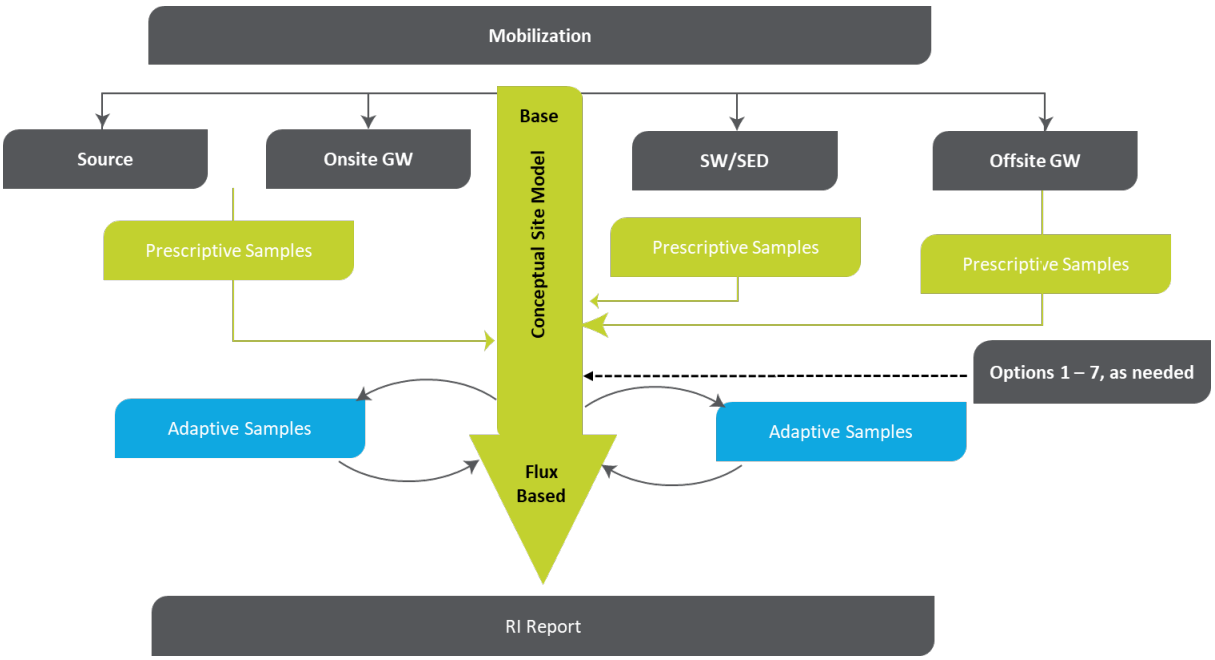
Screening samples refer to samples analyzed with the onsite mobile laboratory or fixed offsite laboratory and will include select subsurface soil (greater than 1-foot bgs), source area groundwater, and VAP groundwater. Screening samples will be analyzed for PFOS, PFOA, and PFBS as indicated in **Worksheet #15**. Other samples collected throughout the investigation (TSS, TOC, grain size analysis, AEC, and CEC) will be analyzed using standard TAT in a fixed offsite laboratory. The flow of work proposed for these site characterization activities are illustrated in the flow chart included as **Exhibit 1**.

FCFs (**Appendix A**) will be utilized to document any major changes to analytical and field methodology. Field change forms will be used for the following changes:

- Analytical methods,
- PSLs,
- Sample collection methods, and
- Prescriptive sample locations moved greater than 50 feet from the originally proposed location.

Adaptive sample locations will be discussed during meetings with AFCEC and regulators and these meetings may occur weekly or biweekly. Concurrence on the adaptive sample locations will be memorialized in meeting minutes.

Exhibit 1 – Project Workflow Chart[1]



Laboratories

Pace and ELLE will be used for this PFAS RI at EAFB, AK. PFAS analysis will be conducted in accordance with the DoD QSM 5.3, Table B-15 for the analytes listed in **Worksheet #18** and **Worksheet #15** of this QAPP, along with other testing parameters mentioned above for secondary use and for waste characterization. The BEM Team will utilize a third-party data validator (Synectics) to validate the data from the fixed laboratory in accordance with **Worksheets #34**, **#35**, and **#36** of this QAPP. A Data Usability Summary Report will be prepared in accordance with the November 2019 Final DoD General Data Validation Guidelines (DoD, 2019c) and the May 2020 Final DoD Data Validation Procedure for PFAS by QSM Table B-

[1] Options 1 through7 include:

- Option 1: Up to 50 soil borings up to 10 feet below the groundwater table interface with up to 3 soil samples and 1 grab groundwater sample per soil boring.
- Option 2: Up to 50 HPT borings to 75 feet or refusal.
- Option 3: Up to 20 soil samples collected for SPLP PFAS.
- Option 4: Up to 25 VAP borings to 50 feet with up to 4 grab groundwater samples per VAP boring.
- Option 5: Up to 50 VAP borings to 100 feet with up to 8 grab groundwater samples per VAP boring.
- Option 6: Up to 50 VAP borings to 150 feet with up to 12 grab groundwater samples per VAP boring.
- Option 7: Up to 50 co-located samples for surface water and sediment.

15 (DoD, 2020), that will review precision, accuracy, completeness, representativeness, comparability, and sensitivity of the analytical methods performed during this sampling event. In addition, an ADEC Laboratory Data Review Checklist will be completed for each data package. These data will be included in an RI Report, after completion of the subsequent investigation events. Analysis of samples at the off-site laboratory by both Pace and ELLE will include but are not limited to:

- Samples collected from monitoring wells for compliance or delineation,
- Surface soil, groundwater, surface water, and sediment samples that will be used to support future risk assessments,
- Subsurface soil, source area groundwater and VAP groundwater to provide a representative data set (8 to 10 samples per media and exposure area) that can be used to support future risk assessment activities and final delineation determinations,
- SPLP, TOC, AEC, and CEC samples to evaluate source strength and mass loading from each source area,
- Fish tissue samples,
- Waste characterization samples,
- Representative soil samples analyzed for physical and chemical properties (e.g., particle size and fraction of organic carbon),
- Split samples at the frequency of 5% of the PFAS samples analyzed with the mobile laboratory to provide a statistically significant data set for evaluating the accuracy of the mobile lab data,
- Analysis of samples by the off-base laboratory may include analysis for both rush samples and samples analyzed using standard TAT which is typically 14-business days.

Pace Mobile Lab Services, which is capable of providing screening results for PFOA, PFOS, and PFBS, as demonstrated in ESTCP ER-B19-5203, will also be used for intermediate decision making. The Pace Mobile Lab analytical method is not an accredited method. The mobile lab will be used throughout the prescriptive and adaptive phases of the characterization of soil and groundwater at the sources and to help assess extents of PFAS in groundwater, better enabling adaptive characterization. The samples analyzed by the mobile laboratory will consist primarily of subsurface soil and groundwater media using rapid turn analyses to accelerate decision-making and optimize placement of adaptive soil borings, adaptive VAP borings, and/or permanent monitoring well locations.

Prescriptive Scope of Work

Prescriptive sampling will include the collection of soil, groundwater, surface water, sediment, porewater, and fish tissue samples following the methods listed below for each media. In addition, waste characterization samples will be collected for waste disposal purposes. Key data collection objectives for each of the tools and

1282 investigation methods being used for this RI are described in **Table 3**. **Table 4** includes the detailed approach
1283 for specific sample placement based on known source locations and downgradient samples that can be
1284 determined with current site information. Additionally, **Table 4** notes where screening or definitive analysis
1285 will be used.

Table 3. RI Tools and Methods

Tool / Method	Key Objective
Source characterization borings	**Provide vertical resolution of the vadose zone and shallow groundwater to evaluate the nature and extent of the source at each validated source area. Data collected from the source characterization borings will be used in conjunction with the SPLP, AEC, CEC, and TOC data to evaluate source strength and help rank and prioritize source zones.**
HPT	**HPT will be used to provide a continuous estimate of permeability at both the 50- and 100-foot VAP borings. The HPT will be completed in advance of the VAP borings to provide a profile of that location. Data will be used to determine sample collection intervals with the VAP.**
Grain size data / point permeability testing	**Both grain size and point permeability testing are alternative methods for characterizing the hydraulic conductivity of the aquifer. These methods will be utilized at those intervals where the hydraulic conductivity is too high to resolve with the HPT tool.**
VAP borings	**VAP borings will be completed in 50-, 100- and 150-foot depths to provide a high-resolution representation of groundwater quality across the base and off-base areas. Data from the VAP transects will be combined with the permeability profiles to evaluate stratigraphic flux at 5-transects.**
SPLP sampling	**SPLP, AEC, CEC, and TOC sampling will be completed at each validated source area to evaluate leachability of PFAS across the vertical extent of the soil profile. The data collected will be used in conjunction with source characterization results and near source groundwater to evaluate source strength and mass loading of the validated source zones.**
Surface Water, Sediment and Sediment Porewater	**The data collected will be used to evaluate the quality of the surface water bodies on and off base.**
Fish Tissue Sampling	**The data collected will be used to evaluate potential uptake of PFAS in fish from the surface water bodies on and off base and evaluate potential risks to human and wildlife receptors that may consume fish.**

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Table 4. RI Prescriptive Sampling Approach

AFFF Area	Name/Description	Sampling Approach
SS302P	AFFF Area #6 - Former Adak Building Fire (**Figure 12**)	• Soil – Collection of discrete soil and grab groundwater from up to nine (9) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to four (4) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to three (3) locations (upstream, adjacent, and downstream) in Garrison Slough to evaluate transport pathways from SS302P. One (1) of these locations will also include a co-located porewater sample. Additional co-located surface water and sediment samples will be collected from up to one location along a drainage channel entering Garrison Slough from the west. (definitive data)
SS303P	AFFF Area #2 – Air National Guard KC-135 Hangar (Building 1176) (**Figure 11**)	• Soil – Collection of soil and grab groundwater from up to four (4) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to two (2) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer and evaluate and delineate groundwater impacts downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to one (1) location in the main drainage channel adjacent to Flight Line Avenue. Co-located surface water, sediment, and pore water samples will be collected from up to one (1) location in the freshwater emergent wetlands north of the building. These samples will evaluate surface water drainage pathways from SS303P. (definitive data)
SS304P	AFFF Area #3 – Corrosion Control (Building 1348) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to four (4) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data)

AFFF Area	Name/Description	Sampling Approach
		• Groundwater – Completion of up to two (2) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment – co-located surface water and sediment samples will be collected from up to two (2) locations in the drainage channel north and west of SS304P to evaluate drainage away from the building. (definitive data)
SS305P	AFFF Area #12 – Hangar (Building 1344) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to four (4) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to two (2) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment – co-located surface water and sediment samples will be collected from up to two (2) locations (upstream and adjacent) in a drainage ditch north of the building to evaluate transport pathways from the hangar. (definitive data)
SS306P	Site 3 – Former Ball Field Spray Test Area (**Figure 11**)	• Soil – Collection of soil and grab groundwater from up to seven (7) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment – co-located surface water and sediment samples will be collected from one location in a drainage channel east of SS306P to evaluate transport pathways. (definitive data)
SS307P	AFFF Area #10 – Fuel Pump House (Building 1246) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to eight (8) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data)

AFFF Area	Name/Description	Sampling Approach
		• Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to one (1) location in the freshwater pond south of the Fuel Pump House. Co-located surface water, sediment, and pore water will be collected from up to one (1) location along the drainage to Garrison Slough. These samples will be used to evaluate transport pathways from SS307P. (definitive data)
SS309P	AFFF Area #14 – Thunderdome (Building 1140) (**Figure 12**)	• Soil – Collection of soil and grab groundwater from up to four (4) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment – co-located surface water and sediment samples will be collected from up to one (1) location in a drainage channel northeast of the building to evaluate transport pathways from the Thunderdome. (definitive data)
SS310P	South Ramp Spray Test Area (**Figure 9**)	• Soil – Collection of soil and grab groundwater from up to 14 soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to four (4) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to three (3) locations (one upstream and two adjacent) in Garrison Slough and two (2) water body locations in the grassy area northeast of the South Ramp Spray Test Area. Two (2) of these locations will include co-located pore water samples. These samples will be used to evaluate transport pathways from SS310P. (definitive data)

AFFF Area	Name/Description	Sampling Approach
SS311P	Site 2 – KC-135 Fire (**Figure 11**)	• Soil – Collection of soil and grab groundwater from up to six (6) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. Surface Water/Sediment – co-located surface water and sediment samples will be collected from two (2) locations in a drainage channel east of the KC-135 historical fire location to evaluate transport pathways. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from one (1) location in a drainage channel east of the KC-135 historical fire location to evaluate transport pathways. (definitive data)
SS312P	Site 4 – Foamed Runway (**Figure 13**)	• Soil – Collection of soil and grab groundwater from up to 12 soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to four (4) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data)
SS314P	AFFF Area #1 – Air National Guard Hangar (Building 1171) (**Figure 11**)	• Soil – Collection of soil and grab groundwater from up to four (4) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to two (2) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer and evaluate and delineate groundwater impacts downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment – co-located surface water and sediment samples will be collected from up to one (1) location near the stormwater culvert adjacent to Flight Line Avenue to

AFFF Area	Name/Description	Sampling Approach
		evaluate surface water drainage pathways from SS314P. (definitive data)
FT009	AFFF Area #4 – Current Fire Training Area (FT009) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to 20 soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to six (6) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to four (4) previously-sampled locations in Garrison Slough to evaluate transport pathways from FT009 and temporal trends. One (1) of these locations will also include a co-located pore water sample. Additional co-located surface water and sediment samples will be collected from one (1) location along a drainage channel entering Garrison Slough from the west to identify additional source areas, if any. (definitive data)
FT092	AFFF Area #7 – Former Fire Station 1 (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to five (5) soil borings to characterize near-source area soil and shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water, sediment, and pore water samples will be collected from up to one (1) location where stormwater collects northwest of the building to evaluate transport pathways from the former fire station. (definitive data)
	AFFF #8 – Former FTA near the Antenna Farm (FT092) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to five (5) soil borings to characterize near-source area soil and shallow groundwater quality (combination of screening and definitive data).

AFFF Area	Name/Description	Sampling Approach
		• Groundwater – Completion of up to two (2) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to three (3) locations (upstream, adjacent, and downstream) in Garrison Slough to evaluate transport pathways from this former FTA. One of these locations will also include a co-located pore water sample (definitive data).
	AFFF #9 – Former FTA by the Current Entomology Building (Building 4335) (**Figure 10**)	• Soil – Collection of soil and grab groundwater from up to eight (8) soil borings to delineate near-source area soil and characterize shallow groundwater quality. (combination of screening and definitive data) • Groundwater – Completion of up to three (3) co-located HPT and VAP borings to evaluate permeability zones within the upper aquifer, evaluate groundwater upgradient of the source area, and evaluate and delineate groundwater downgradient of the source area. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to two (2) locations (upstream and adjacent) in Garrison Slough to evaluate transport pathways from this former FTA. One of these locations will also include a co-located pore water sample. (definitive data)
	Base wide (**Figure 8 / 14**)	• Groundwater: Completion of two (2) transects to evaluate permeability zones within the aquifer and the lateral and vertical distribution of groundwater impacts at mid-base and downgradient perimeter areas. The mid-base transect (Transect 1) includes up to 15 co-located HPT and VAP borings to 100 feet bgs. The downgradient perimeter transect (Transect 2) includes up to seven (7) co-located HPT and VAP borings to 100 feet bgs and 16 VAP borings to 150 feet bgs. (screening data with limited definitive data) • Surface Water/Sediment/Pore Water – co-located surface water and sediment samples will be collected from up to 34 additional locations within the installation boundary. Of these 34 locations, six (6) locations will also include co-located pore water samples. These samples will be used to evaluate transport pathways from known sources, identify new sources (if any), fill data gaps

AFFF Area	Name/Description	Sampling Approach
		regarding the nature and extent of contamination, and confirm historical sampling results (definitive data). • Fish Tissue – Collection of samples from 17 locations from surface water bodies within the installation boundary. These samples will be used to evaluate the nature and extent and potential transport of PFAS into fish tissue and potential human and ecological risks associated with fish ingestion (definitive data).
	Off-base (**Figure 8 / 14**)	• Groundwater: Completion of three (3) transects to evaluate permeability zones within the aquifer and the lateral and vertical distribution of groundwater impacts at downgradient off-base locations in Moose Creek and west of Moose Creek. The Moose Creek transect (Transect 3) includes up to seven (7) VAP borings to 150 feet bgs. The west of Moose Creek transect (Transect 4) includes up to one (1) co-located HPT and VAP boring to 100 feet bgs and two (2) VAP borings to 150 feet bgs. The western most transect (Transect 5) includes up to seven (7) co-located HPT and VAP borings to 100 feet bgs (screening data with limited definitive data). • Surface Water/Sediment – co-located surface water and sediment samples will be collected from up to 14 off-base locations. These samples will be used to evaluate transport pathways from known sources, identify new sources (if any), fill data gaps regarding the nature and extent of contamination, and confirm historical sampling results (definitive data). • Fish Tissue – Collection of samples from three (3) locations from surface water bodies at off-base areas. These samples will be used to evaluate the nature and extent and potential transport of PFAS into fish tissue and potential human and ecological risks associated with fish ingestion (definitive data).

Source Characterization

Source characterization activities will include a combination of soil borings and shallow groundwater sampling within the footprint of the validated PFAS source areas and VAP and HPT borings located up- and down-gradient of the source areas to evaluate the PFAS mass flux in groundwater and the mass loading from a particular source area. Details on the specific scope elements for the source borings and near-source VAP samples are summarized in the following text. Prior to using any water for RI purposes (decontamination water, drilling water, and any other use), it will be treated with the PFAS water treatment system located at

the HazWaste Facility. Water will be obtained from a source on the base. The PFAS water treatment system is designed to treat PFAS impacted water using ion exchange technology.

One (1) source blank (SB) sample will be analyzed for PFAS compounds for each batch of treated water to confirm that source water does not contain PFAS compounds at concentrations above the method detection limit (MDL) and PSLs. The SB samples will be submitted to the fixed laboratory for 24 PFAS compounds with rush analysis TAT as needed to maintain sufficient quantity of verified clean water on site. The fixed laboratory will provide definitive data prior to the use of each batch of treated water. Treated water will be stored on site until laboratory results are returned that confirm acceptable PFAS levels. If necessary, a sample may also be analyzed by the mobile laboratory while waiting for results from the fixed laboratory.

If PFAS compounds are detected in the SB at concentrations greater than the MDL using either fixed or mobile lab testing, treated water within that batch will be placed to the side to be re-treated.

Prior to treatment the water treatment system performance will be checked using a mobile laboratory test. The water will then be treated and prior to use, the water will be analyzed by the fixed laboratory as described above.

The distribution of PFAS in the validated PFAS source areas will be characterized using a combination of soil and groundwater sampling. Soil samples will be collected from the vadose zone to evaluate the extent of PFAS across the vertical profile of the vadose. Soil samples will be collected via direct push technology (DPT) drilling methods in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (P-12 in **Appendix B**) from 114 total borings distributed across the 13 AFFF Source Areas and two (2) subsites (**Figures 8 through 13**). DPT sampling will be completed using a dual-tube, top-down method. The soil profile will be logged and documented on field forms.

A total of three (3) discrete soil samples will be collected from each boring. The target depth intervals will be adjusted based on the thickness of the vadose zone and will include:

- Surface Soil: 0 to 0.5 feet bgs,
- 3 feet bgs, and
- Above the water table at the capillary fringe.

Discrete soil samples will be analyzed for PFAS using a combination of definitive and screening data, as previously described in the laboratory section.

Each soil boring will penetrate up to 10-feet below the water table. Grab groundwater samples will be collected via DPT from each of the soil borings using a screen point sampler or a 1-inch SCHD-80 polyvinyl chloride (PVC) with a 10 foot by 010-inch machine-slotted screen will be installed to evaluate the shallow groundwater quality in each source area. All shallow groundwater samples will be analyzed for PFOS, PFOA, and PFBS

using the accelerated method with the onsite mobile laboratory. Additionally, a discrete soil sample will be collected from the target screened interval of the groundwater sample and will be submitted to the offsite laboratory for grain size analysis. This grain size data will be used to estimate the hydraulic conductivity of hydrofacies and be incorporated into the overall stratigraphic flux evaluation. Shallow (first encountered) groundwater will be sampled at each of these sampling points. DPT borings will be completed in accordance with the TGI for PFAS-Specific Drilling and Monitoring Well Installation (**Appendix B**).

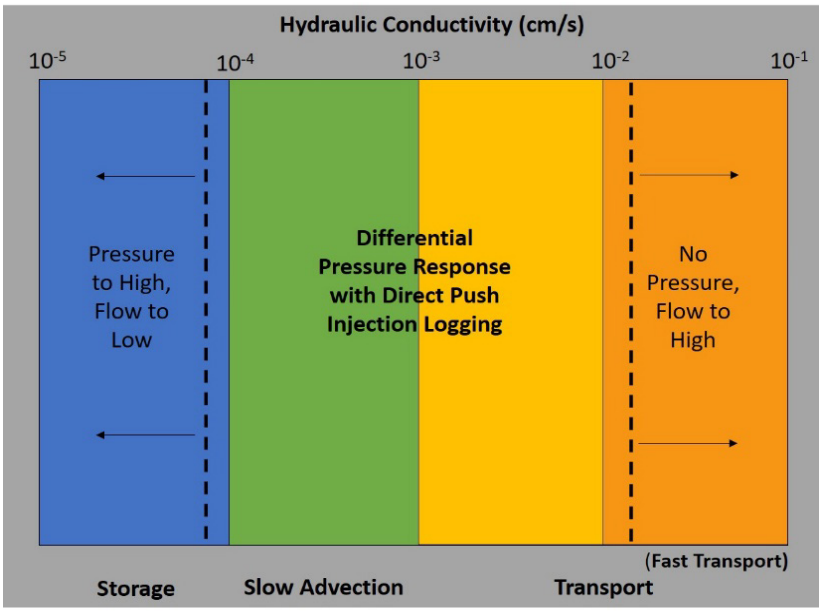
The source area characterization sampling locations shown on **Figures 8 through 13** are approximate, and final locations will be dependent on field conditions, utilities, and base access routes. Soil sampling locations will be adjusted in the field to avoid auguring through concrete or asphalt and to avoid high traffic areas, if possible. A FCF (**Appendix A**) is not anticipated when the locations are field located and moved less than 50 feet from the originally proposed locations. Coordinates for each boring location will be recorded using a handheld global positioning system (GPS).

Permeability Profiling

The Geoprobe® HPT provides a continuous profile of relative soil permeability at the centimeter scale. The HPT utilizes standard direct push drilling equipment to advance the probe into the soil. A continuous metered injection of small volumes of water (typically between 200 to 300 milliliters per minute) is completed during probe advancement while simultaneously measuring the fluid back pressure due to injection and the flow rate. The HPT pressure response maps relative changes in permeability in profile enabling a high-resolution identification of higher permeability zones within the aquifer that may correspond to preferential contaminant migration. A relative measure of hydraulic conductivity can also be obtained from the HPT data by recognizing that hydraulic conductivity is proportional (Q/P) to the flow (Q) divided by the pressure (P).

HPT data will be collected across the site and will be co-located with VAP borings. A total of 46 HPT borings will be completed to an estimated depth of 50 feet bgs, and 30 HPT borings will be completed to 100 feet bgs, or refusal. Once the data from each HPT boring are reviewed, the VAP intervals for the groundwater sample collection will be completed. HPT logging will be completed in accordance with the TGI for Geoprobe® HPT (**Appendix B**).

Exhibit 2 – Range of Hydraulic Conductivity at Standard Injection Rates



The HPT is most effective when used in aquifers with units of contrasting permeability. Sites dominated by very low hydraulic conductivity soil (clay) or very high hydraulic conductivity soil (well-sorted sand and gravel) will likely provide only a maximum or minimum undifferentiated pressure and flow response and are not well suited for the application of injection logging. For these types of environments, alternative methods of permeability profiling are required, such as sieve analysis or point permeability testing. The typical range of hydraulic conductivity that provides a distinct pressure response via HPT logging is 10^{-4} to 10^{-2} centimeters per second (cm/s). The range of responses to direct injection is shown in **Exhibit 2**. For most sites, this range is sufficient to separate storage from slow advection and transport and understand the aquifer architecture.

In the event the HPT cannot resolve the permeability, the data collection methodology will transition to use a combination of grain size analysis and point permeability testing to estimate the hydraulic conductivity. The following protocols will be considered for implementation during the RI. The final combination of data collection methodologies would be determined based on the of the initial results of the HPT.

- Point permeability testing (PPT)is an option that can be adapted to collect data through the VAP sampling apparatus and will consist of a pneumatic slug test. These tests would be completed once the PFAS groundwater sample is collected, prior to abandonment of that interval.
- Soil core logging and grain size analysis at a VAP location. These borings would be logged to characterize the different hydrofacies across the vertical extent of the boring. Discrete soil samples

will be collected from cores and would correspond to the target VAP intervals. The soil samples would be submitted for grain size analysis and would be used to estimate the hydraulic conductivity based on the grain size distribution.

If the HPT can resolve the lower permeability intervals, but the higher permeability zones exceed the range of the HPT, the HPT logs will provide a bracket of the target sampling interval with additional point permeability testing completed to determine the hydraulic conductivity of that interval. In locations where the majority of the of the HPT log exceeds the range, grain size data or point permeability testing will be used, with testing conducted at the same intervals as the VAP sampling.

Groundwater Sampling

VAP groundwater sampling will be completed to evaluate the mass flux of PFAS in groundwater migrating from the source areas, along the central portion of the base, along the downgradient boundary of the base, and off-base. The layout of the proposed VAP borings related to each source area are summarized in **Figures 8** through **13**. The on-base and off-base transects are shown on **Figures 8** and **14**. The VAP borings will be completed in transects perpendicular to groundwater flow with the VAP borings ranging in depth from 50 to 150 feet bgs with the number of samples scaled based on the depth of the VAP boring. In general, the VAP scope of work for this investigation includes:

- 46 VAP borings to 50-feet bgs with up to 4 vertical sample intervals per boring
- 30 VAP borings to 100-feet bgs with up to 8 vertical sample intervals per boring
- 25 VAP borings to 150-feet bgs with up to 12 vertical sample intervals per boring.

Specific sample intervals will be selected along the vertical section, biased to target intervals of the highest permeability, as determined by the HPT data. In the event HPT data is not available for the deeper zones or the permeability cannot be resolved by the HPT, the sample intervals will be biased to the higher permeability zones, as determined through visual logging of the soil cores at each location. VAP groundwater samples will not be collected from silt or clay intervals.

A combination of DPT and sonic drilling methods will be used to complete the VAP borings. DPT drilling will be the primary method for the 50- and 100-foot VAP borings. The 150-foot VAP borings will be completed with DPT, if possible, but sonic drilling methodologies are anticipated to achieve the depth needed for sample collection. All drilling will be completed in accordance with the drilling TGI included in **Appendix B**.

Procedures for groundwater sample collection from the VAP intervals will vary based on the drilling method used for a particular boring. The range of methods that will be utilized as part of this RI are summarized in the TGI VAP for PFAS Analysis (**Appendix B**). Groundwater samples collected from the VAP intervals will be analyzed using a combination of fixed and mobile laboratories to provide near-real-time data that can be

evaluated to determine adaptive boring locations. The combination of PFAS concentration data and permeability, described in the previous section, will provide a basis for evaluating the stratigraphic flux.

Surface Water and Sediment Sampling

Surface water and sediment samples will be collected in two seasons (wet and dry) to determine the nature and extent of PFAS impacts to ditches, creeks, tributaries, and ponds on-base and off-base and to evaluate temporal variability of PFAS discharges. The wet season sampling event will be completed in late May or early June and will depend on the thickness of the snowpack and the time of the melt. The dry season sampling will be completed in mid- to late July.

Surface water and sediment samples will be co-located and collected from 80 locations shown on **Figures 8 through 11** where they coincide with validated PFAS source areas and **Figure 8** for the remaining sitewide and offsite locations. Additionally, a total of 15 of these locations will also include a co-located porewater sampling location. Surface water samples will be collected before sediment sample collection to reduce siltation. Surface water and sediment samples will be collected from downstream to upstream to reduce siltation in sequential samples.

Surface water samples will be collected from the surface at 80 locations in accordance with the TGI for Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis (SOP# P-15; **Appendix B**). All surface water samples will be analyzed for PFAS, TOC, and TSS using an off-site fixed laboratory. Field parameters (temperature, pH, specific conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) will be measured during surface water sampling to potentially inform the interpretation of analytical data. Coordinates for each surface water sampling location will be recorded using a handheld GPS. **Table 4** further describes the surface water sampling points.

Sediment samples will be collected from 80 locations, co-located with the surface water samples described above. Sediment samples will be collected from the upper 0 to6 inches using dedicated Lexan™ tubes, and the sediment will be decanted before bottling for laboratory analysis PFAS, TOC, and grain size using an off-site fixed laboratory. Sediment descriptions will be documented on field forms. Coordinates for each sediment sampling location will be recorded using a handheld GPS. **Table 4** further describes the sediment sampling points.

Porewater Sampling

Porewater will be collected from 15 locations on-base in two (2) seasons (wet and dry) to determine the nature and extent of PFAS impacts to ditches, creeks, tributaries, and ponds, to evaluate temporal variability of PFAS impacts and the surface water/groundwater interaction through measurement of the head difference between the porewater sampler and the surface water body. One-inch piezometers with slotted screens will be

assembled and manually installed in accordance with the Mini-Piezometer Installation and PFAS Porewater Sampling SOP (SOP# P-19; **Appendix B**). The piezometers will be driven 1 to 2 feet into the sediments to facilitate sampling porewater on the side of the waterbody closest to the PFAS source. Coordinates for each sediment sampling location will be recorded using a handheld GPS. Samples will be collected using a PFAS-free bailer in accordance with procedures described in SOP# P-19 and will be analyzed for PFAS.

Fish Tissue Sampling

The fish tissue sampling scope of work was developed based on the current known extent of PFAS, the investigation extent proposed for the surface water and sediment sampling, and a review of previous fish tissue investigations conducted at the base. Tissue sampling will include both filet samples (for human health risk assessment) and whole-body samples (for ecological risk assessment).

Fish tissue sample locations were selected based on the following criteria:

- Likely affected by site activities;
- Potential for human or ecological usage;
- Co-location with proposed surface water and/or sediment sampling locations;
- Spatial coverage in the vicinity of the site (and background); and
- Areas previously targeted for fish tissue collection (e.g., polychlorinated biphenyl [PCB] sampling from in 1993 to 2007; PFAS sampling in 2019).

Based on this input, a total of 20 fish tissue sample locations are identified in **Figure 8**. The locations are described as follows in **Table 5**:

Table 5. Fish Tissue Sample Location Rationale

Station ID	On- or Off-Base	Description	Relationship to Validated Source Area	Co-Located SW Location	Historic PCB Location	Historic Detected PFAS Location[1]
Fish 1	Off	Northwest Pond 1	Downstream	X		
Fish 2	Off	Bathing Beauty Lake	Downstream	X		
Fish 3	On	Piledriver Slough	Downstream	X		
Fish 4	On	Moose Creek (adjacent Cathers Lake)	Downstream	X		
Fish 5	On	Bear Lake	Downstream	X		
Fish 6	On	Hidden Lake	Downstream	X		
Fish 7	On	Flightline Creek/Garrison Slough Confluence	Downstream	X	X	X
Fish 8	On	Northeast Pond	Downstream	X		
Fish 9	On	Polaris Lake	Downstream	X		
Fish 10	On	Flightline Creek	Downstream	X		
Fish 11	On	Moose Lake	Downstream	X		

Station ID	On- or Off-Base	Description	Relationship to Validated Source Area	Co-Located SW Location	Historic PCB Location	Historic Detected PFAS Location[1]
Fish 12	On	French Creek (south of Bear Lake)	Downstream	X		
Fish 13	On	Middle Garrison Slough	Downstream	X	X	X
Fish 14	On	Grayling Lake	Downstream	X		
Fish 15	On	Garrison Slough (Downstream 1)	Downstream	X		X
Fish 16	On	Garrison Slough (Artic Ave - Manchu Rd)[2]	Downstream	X		X
Fish 17	On	Garrison Slough (Downstream 2)	Downstream	X		X
Fish 18	On	Tar Kettle Lake	Downstream	X		
Fish 19	On	Mullins Pit	Upstream	X		
Fish 20	Off	South Ramp Spray Test Area	Upstream	X		

Notes:

1 Fish sampling location is within historic PFAS reach, in some instances not at an actual fish collection point.

2 Denoted as SS67 source area in 2013 5-Year Review.

During the field investigation, these locations may be adjusted based on access, availability of target species, and/or health and safety concerns.

Species Selection

Target species were selected based on potential occurrence and likelihood of consumption by human or ecological receptors, and potential for accumulation of PFAS. Review of the historic database indicates that the most frequently sampled species (for PCBs) at Eielson are artic grayling, trout, northern pike, and longnose sucker. Grayling, trout, and northern pike are frequently consumed by anglers. A study by Gewurtz et al. (2014) suggests that benthic fish (such as suckers) show greater PFAS contamination compared with pelagic fish (such as trout). This study also concluded that PFAS contamination can be independent of a fish's trophic level, and fish of higher trophic levels (such as pike) do not necessarily have higher concentrations of PFAS. PFAS tends to bioaccumulate more in larger fish than smaller fish, while there is a large variation for an individual fish species even within a narrow size range (Bhavsar et al, 2016). This information was considered when selecting fish species for analysis, but ultimately, the final decision will be made in the field based on species availability.

Sampling will target four (4) composite fish samples per location, including two (2) edible-size fish fillet samples and two (2) forage size fish whole-body samples. Similar species of similar size will be collected from each location, if available, for data comparison purposes. Alaska regulations do not have minimum size limits

for trout, northern pike, and Arctic grayling for this region. However, as a general guide, edible-size will be defined as 6-inches or larger total length for trout and grayling and 20-inches or larger total length for northern pike. Additionally, whole-body fish may include smaller individuals or different species, such as longnose sucker, with a target size of less than 6-inches total length. Each fish tissue sample will be a composite sample of five (5) fish or more, depending on the availability and size of the fish, and each composite will have similar size individuals of the same species.

Fish Collection

Fish will be collected from each of the 20 locations (**Figure 8**) using the appropriate sampling method(s) for the individual waterbody, which may include electrofishing, seining, gillnetting, trap netting (fyke/hoop nets), or angling. The work will be conducted under an Alaska Department of Fish and Game Aquatic Research Permit (ARP). State personnel (typically a conservation officer) will be notified of the sampling prior to commencing field activities as required by the permit.

Fish sampling will begin at the central portion of the proposed sampling location and will be conducted outward until the target number of fish have been collected, and the length of the sampling reach will be required in the field notes. If the length or area of adjacent sampling locations overlap, the overlap will be documented in the field notes. A reasonable level of effort will be extended at each location to attain the number of samples (approximately 4 hours). During fish collection, the target species will be retained in a live-well or clean cooler with fresh site water until sampling is complete. Upon completion of the collection activities, selected fish will be retained, measured, and counted to ensure the proper size/number were taken, and wrapped in aluminum foil and placed on wet ice. At a minimum, the label will contain the sample time, date, and capture location. The remaining fish will be released alive back into the water body. Notes will be taken on the total number of fish species observed during the sampling and their general overall relative abundance and the amount of sampling time needed to capture the required number of fish.

Fish Processing

Fish will be processed in the field using PFAS-free equipment in preparation for shipment to the analytical laboratory for PFAS analysis in edible fillets. All samples will be given a unique sample identification number that will be recorded in the field notebook, and that corresponds to the fish species, sampling date, and collection location.

Chain-of-custody (CoC) forms, custody seals, address labels, and air-bill forms will be completed. CoC forms will be initiated by the field team during sample collection. CoC forms will identify the tissue sample preparation procedure and chemical analysis. A copy of the completed CoC form and air-bill form will be retained by the sampler.

To begin field processing, sediments, soil, and other debris will be removed from the fish, as needed, by hand-picking or by rinsing with site water, PFAS-free deionized (DI) water, or potable water. Fish will be measured (total length), weighed (with an electronic balance), a photograph will be taken, and any morphological external abnormalities, fin erosion, infections, or other external abnormalities will be noted and photographed. Fish will be placed whole in aluminum foil, labeled, placed in plastic Ziploc bags and kept on wet ice and/or frozen storage prior to shipment to the analytical laboratory and filleting in a controlled environment. The sample identification number will be written on each bag with an indelible ink marker.

The detection of PFAS compounds at very low concentrations can be influenced by common PFAS-containing materials that may be present at the sampling site. Therefore, sampling protocols are to be strictly followed by the sampling personnel. To minimize the potential for cross-contamination, attention will be given to sampling materials, decontamination procedures, as well as clothing and personal care products used by sampling personnel.

Laboratory Methods and Analysis

Samples will be shipped on ice and handled with CoC documentation. All samples will be sent to ELLE for PFAS analysis. Fish tissue samples for edible-size fish (e.g., grayling, trout, pike) will be prepared as skin-on, scales-off fillets. Each fillet will be taken from behind the head to the tail and from the top of the back to the belly. During this process, the internal organs should be inspected for gross anomalies, and the gender of each fish determined by examining the reproductive organs.

Once the edible-size fillets are removed from each fish in the composite sample, the fillets will be homogenized and analyzed for the PFAS in accordance with **Worksheets #19** and **#30**. If the size or mass of fish in a single composite sample requires the sample to be divided into two (2) or more sections for homogenization, this information will be noted in the laboratory bench sheets. The lab will also note if multiple homogenized sections are recombined into a single sample for subsequent extraction and analysis, or whether the different sections are used for quality assurance purposes such as replicate analysis or a spiked sample.

As part of internal laboratory QA/QC measures, one (1) MS sample and one (1) MSD sample will be collected for every 20 fish tissue samples collected. Internal laboratory QA/QC will also consist of one (1) laboratory blank and one (1) LCS (or blank spike) per batch of samples, one (1) laboratory duplicate of fish homogenate per 20 samples, and any additional measures as indicated by the laboratory QA/QC procedures.

Adaptive Scope of Work

Following the prescriptive phase of sampling, adaptive sampling will be conducted to complete delineation of the validate source zones and groundwater. The data from the prescriptive phase will be incorporated into a digital CSM and posted on a project-specific dashboard during the investigation to facilitate discussion and

decision making with stakeholders. As boring logs, field data and laboratory analytical data becomes available, the digital CSM will be updated to provide near real-time representations of the geology, hydrogeology, and contaminant distributions and updated on the dashboard. These updates will include analytical results for soil, groundwater, surface water, sediment, pore water, and stratigraphy data from the borings. The digital CSM will be a dynamic platform that can be used throughout the data interpretation process and as a medium shared with stakeholders to provide updates and build concurrence for the adaptive scope elements. Concurrence on the adaptive scope key metrics will be memorialized using a FCF and meeting minutes, which will be submitted following update discussions with the stakeholders.

The following sections provide proposed decision logic to guide the development of the adaptive scope of work.

Source Area Characterization

Based on the results of the prescriptive phase of investigation, additional adaptive borings will be completed as needed to delineate PFAS at each source area. The borings completed during the adaptive phase will have two (2) key objectives. The primary objective will be to complete the characterization of the nature and extent of PFAS in each of the validated AFFF source areas. The second objective will be to further evaluate source strength. **Table 6** presents the decision logic for developing the adaptive scope for source area characterization.

The source strength evaluation will be completed in the adaptive phase by focusing additional discrete soil sampling in the central portion of each of the identified the source zones, as determined by the prescriptive borings. At these locations, an additional discrete soil sample will be collected from the area where the highest concentrations of contaminants are identified. The sample will be analyzed for PFAS SPLP, AEC, CEC, and TOC. The SPLP, AEC, CEC, and TOC results will be used to evaluate the source strength using leaching of vadose zone soils, which will be key data in ranking and prioritizing the source zones once the RI activities are completed.

The laboratory analysis utilized throughout the adaptive phase of the source characterization will include a combination of screening and definitive data. The screening data, which includes onsite mobile lab analysis of PFOA, PFOS, and PFBS via an analytical screening method that was demonstrated in ESTCP ER-B19-5203 and offsite fixed laboratory analysis of PFOA, PFOS, and PFBS via DoD QSM 5.3 Table B-15, will be used to verify delineation of the source zone with additional samples submitted for definitive analysis to provide final delineation data. Additionally, the SPLP, AEC, CEC, and TOC soil samples with co-located PFAS soil samples will be submitted for definitive analysis. An additional check will also be completed during the adaptive phase to ensure sufficient data to support a risk assessment in the validated source zones. If

1571 additional definitive data is needed to support risk assessment activities, those samples will be submitted.
1572

Table 6. Source Characterization Adaptive Logic

Triggering Event **(based on PFAS concentrations)**	**Contingency Action(s)**
<u>Source Delineation (soil)</u>: 1. Soil sample(s) less than screening levels (SLs) 2. Soil sample(s) between 1 to 10 times (X) the SL 3. Soil sample(s) greater than 10X the SL	1. If data at nearest location indicates additional resolution on the source is needed, step in approximately 0.5 to 1X the boring spacing, or cease source soil investigation 2. Step out 1 to 1.5X the boring spacing at representative locations 3. Step out at each location 1.5 to 2X the boring spacing
<u>Source Delineation (groundwater):</u> 1. Groundwater sample(s) less than the SLs 2. Groundwater sample(s) greater than SLs	1. If groundwater and soil results are less than SL, delineation is complete in that direction. No additional soil borings and groundwater samples. 2. If groundwater result is greater than SL and soil result is less than SL, source delineation is complete in that direction. Evaluate downgradient sample locations to confirm that VAP transects will evaluate mass flux from this location and consider installation of VAP boring as needed.

Triggering Event **(based on PFAS concentrations)**	**Contingency Action(s)**
PFAS results indicate refinement is needed: 1. Extent not defined with sufficient precision (e.g., a sample greater than 20X the SL adjacent to non-detect [ND] value) 2. Data suggests a non-continuous source or isolated source areas within a larger investigation area (e.g., ND values present within what was assumed to be a larger source area)	1. Step in between the ND and the exceedance locations to better evaluate distribution (approximately mid-point or as determined by the technical lead). 2. Step in at location(s) with highest concentrations using two to three borings to evaluate extent of the more confined source area.

VAP Borings and Groundwater Sampling

Based on the results of the prescriptive phase of investigation, additional adaptive HPT and VAP borings will be completed as needed to characterize the groundwater quality and evaluate the stratigraphic flux along the transects detailed in Figure 14. The following table presents the decision logic for developing adaptive scope for VAP Borings and GW Sampling. Table 7 presents the decision logic for VAP sampling.

The laboratory analysis utilized throughout the adaptive phase of the VAP will primarily utilize screening data analyzed with the mobile lab. The mobile lab utilizes a non-accredited method that was demonstrated in ESTCP ER-B19-5203 for PFOA, PFOS, and PFBS. Definitive data will also be used for final delineation, where appropriate. Additional definitive data will be collected once the monitoring wells are installed at the completion of the VAP sampling and will provide data on the final delineation of and can support future risk assessment activities.

Table 7. VAP Sampling Decision Logic

VAP Sampling Purpose	Scenario	Response
Background VAP locations	Background VAP boring indicates PFAS presence	Confirm groundwater flow direction and verify lack of upgradient source. Step upgradient 100 to 200 feet for VAP transect

VAP Sampling Purpose	Scenario	Response
Lateral Delineation at the end of a stratigraphic flux profile	Groundwater analytical results are below target screening levels	Boring will represent the end of the transect. Delineation would be complete in that direction.
	Groundwater analytical results are within the same order of magnitude as the target screening levels	Complete an additional VAP boring as a step-out location. The point spacing should be the same as the area-specific transect spacing of the prescriptive borings.
	Groundwater analytical results are more than an order of magnitude above the target screening levels	Complete an additional VAP boring as a step-out location. The adaptive point should be located at 2X the point spacing to provide a broader delineation. Additional adaptive borings will be located based on the results of the original adaptive boring.
Additional delineation along a stratigraphic flux profile	Permeability and or concentration data requires additional resolution to characterize the hydrostratigraphy or concentration distribution along the stratigraphic flux profile.	Complete an additional adaptive boring that is located between two completed prescriptive borings. The point spacing should be half the original spacing along the flux transect.
Vertical delineation along the stratigraphic flux profile	Groundwater analytical results are within the same order of magnitude as the target screening levels	Collect 1 additional VAP sample below the target depth and re-evaluate the concentrations
	Groundwater analytical results are more than an order of magnitude above the target screening levels	Collect 2 to 3 additional VAP samples below the target depth and re-evaluate the concentrations
	PFAS concentrations are decreasing with depth	Collect 1 additional VAP sample below the target depth and re-

VAP Sampling Purpose	Scenario	Response
		evaluate the concentrations with depth
	PFAS concentrations are increasing with depth	Collect an additional 2 to 3 VAP samples and re-evaluate trends and concentrations with depth

Monitoring Well Installation, Development, and Sampling

Once the nature and extent of the PFAS impacts at each source area and base groundwater are defined through completion of the prescriptive and adaptive phases of source characterization, permanent monitoring wells will be installed at select locations to provide monitoring points to evaluate concentration trends over time, provide data to support remediation decisions, and monitor plume stability. Proposed monitoring well locations will be recommended to stakeholders for concurrence prior to installation based on the criteria in **Table 8**. Monitoring well installation will occur after completion of the prescriptive and adaptive phases to ensure best placement in to meet DQOs.

The monitoring well installation scope will include up to 25 shallow wells to a target depth of 25 feet and up to 20 well clusters (up to 105 wells total). The well clusters will include the installation of wells to the following target depths: 20-, 50-, 100-, and 150 feet bgs but are approximate and to be determined (TBD) by field observations. The shallowest well will be screened across the groundwater table. The shallow monitoring wells (20-, 50-, and 100-foot wells) will be installed using DPT. The 150-foot wells will attempt to use DPT as well, but it is anticipated that sonic drilling methodologies may be needed to achieve the target depths. Monitoring wells will be 2-inch PVC with wire-wrapped screens. Screen slot size and filter pack sand size will be determined based on observed grain size distribution. Screen length will be nominally 5 or 10 feet, to be finalized based on observed lithologic and PFAS concentration distribution. Filter packs will be washed quartz sand, extending from 1-foot below to up to 3-feet above the well screen unless conditions dictate otherwise. Potential for bridging in the filter pack will be mitigated by performing predevelopment prior to installing bentonite and grout. Predevelopment will be performed by removing up to three (3) well volumes or 50 gallons of water, whichever is less, from the monitoring well to settle the filter pack. Additional filter pack material will then be added if needed due to filter pack settlement during predevelopment to achieve the specified filter pack thickness. Following predevelopment, three feet of hydrated bentonite will be placed above the filter pack, and bentonite cement grout will be placed by tremie pipe within the borehole from the bottom up until surface completion of the well. Each well will be completed with a surface completion appropriate for the

location of well, which will include bollards and locking caps. A combination lock will be used with a combination provided by AFCEC. The monitoring wells will be constructed and properly logged in accordance with ADEC's Monitoring Well Guidance (ADEC, 2013).

Monitoring wells shall be developed a minimum of 24 hours after installation in general accordance with ADEC's Monitoring Well Guidance (ADEC, 2013) using PFAS-free equipment. A brief description of the order of events follows:

- Measure the depth to groundwater;
- Remove sediment from the bottom of the well and well screen by surging and purging water the full length of the well screen; and
- Purge water using a pump or bailer until it becomes clearer. Monitoring wells will be considered developed after turbidity is less than 50 nephelometric turbidity units (NTU), three (3) well volumes are purged, or when purged dry.

All wells will be sampled following installation and well development, consistent with the methods described in the Groundwater Sampling section below. During sampling, the BEM Team will complete gauging of monitoring wells from the top of casing using an electronic water level meter to within 0.01 foot. A summary of the groundwater elevations will be summarized in a groundwater elevation summary table.

Groundwater Sampling

Once the monitoring well installation and development is completed, the new wells will be sampled to characterize the extent of PFAS across the network. Groundwater samples are anticipated to be collected from an estimated 105 wells. At each location, the samples will be collected from approximately the center of the saturated screened interval using low-flow sampling methods. Groundwater samples will be analyzed as definitive samples for 24 PFAS compounds as defined in **Worksheet #15** of this QAPP. Field parameters (temperature, pH, specific conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) will be measured during low flow purging and allowed to stabilize in accordance with ADEC Field Sampling Guidance (ADEC, 2019). The SOP for low-flow groundwater sampling is included in **Appendix B**.

Table 8. Monitoring Well Placement Logic

Location	Scenario	Response
Monitoring Well Placement	Source Area Wells	Locations will be identified based on the following criteria: - Target elevated concentrations downgradient of the source zone that represent the primary flux pathway - Upgradient locations that represent background or contribution from an additional source zone - Side gradient wells that help define the delineation of the source zone The source zone wells will be used to evaluate plume stability and performance of future response actions.
	Axis of the plume	Locations will be identified to target the approximate centerline of the identified PFAS impacts. Screened intervals will target zones of higher permeability that represent the transport pathways identified by the permeability profiling during the VAP data collection. The wells along the axis of the plume will be used to evaluate plume stability and performance of future response actions.
	Plume Delineation	Locations will be identified to target the portions of the hydrostratigraphy that are at or slightly below the applicable PFAS standards. Screened intervals will target zones of higher permeability that represent the transport pathways identified by the permeability profiling during the VAP data collection and will be used to evaluate plume stability over time.

Surface Water and Sediment Sampling

Based on the results of the prescriptive phase of investigation, additional surface water (including stormwater) and sediment samples will be collected as needed to characterize the nature and extent of PFAS across the surface water bodies investigated. Adaptive samples would be added to the summer dry season event and will be in addition to the 80 co-located locations described as part of the prescriptive scope of work. For results exceeding 10X PSLs (surface water results compared to groundwater PSLs), step out sampling will be performed, with step-out samples located 500 to 1,000 feet downstream of the exceedance location. The magnitude of the exceedance will dictate the specific number of samples added along a surface water reach.

Survey

Monitoring wells will be surveyed by a professional surveyor, Design Alaska, vertically and horizontally. The top of the well casing and ground surface will be surveyed for use as a reference point to determine water-level elevations and sampling depths and to evaluate groundwater flow direction. All survey data will be recorded in the field notes and submitted with the report. The location survey must achieve a horizontal accuracy of 1.0 feet, and the elevation surveys must achieve a vertical accuracy of 0.01 foot. All other sample locations will be surveyed utilizing a sub-meter accuracy handheld GPS or similar. These samples will meet accuracy requirements of less than 2 meters for horizontal and vertical. All Geographic information system (GIS) data will be submitted in WGS84 Universal Transverse Mercator (UTM) Zone 5N (meters); NAVD88 (feet) in accordance with Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) version 3.1.1 geodatabase.

Screening Data Quality Assessment

Precision, accuracy, and general reliability of the PFAS mobile laboratory data (referred to as "screening data") will be evaluated using a combination of internal laboratory QC processes and a comparison of screening results with split sample results analyzed by a fixed laboratory. Internal laboratory QC processes will evaluate precision of the laboratory methods during operation as described in Pace Mobile SOP ENV-SOP-MAD1-0101 in Worksheets 23, 24, 28, and **Appendix H**. A comparability assessment will evaluate the accuracy of the screening data by comparing the results with the split sample results to assess RPD and perform ordinary least squares (OLS) regression to compute correlation coefficient (R squared [R^2]) and regression slope. A reliability assessment will be performed to evaluate the overall ability of the screening data to accurately identify exceedances and guide intermediate decision making.

The quality assessments will be performed on subsurface soil and VAP groundwater samples. Soil samples will be homogenized prior to splitting the samples for analysis at both the mobile and fixed laboratories to improve the comparability between samples. Statistical outliers will be removed as described below. To enable early evaluation of the mobile lab accuracy and reliability, split and duplicates will be front-loaded to provide 20 soil and groundwater samples for comparison. The evaluation of the utility of the screening data will be verified using the following metrics and performance criteria at the beginning of the mobile lab deployment and at completion of the project:

Outlier Evaluation: The accuracy and reliability analyses will be performed excluding outliers. Potential outliers will be determined using the three lines of evidence described below and professional judgement:

- Visual evaluation of X-Y scatterplots of the definitive results versus the screening data. Data points that differ considerably from the majority of all data points will be considered potential outliers and evaluated further.
- Tukey test of the percent difference of the paired split sample results.
- Tukey test of the distance of the paired split sample result to the 1:1 line on X-Y scatterplots.

The Tukey outlier evaluation, also referred to as the Interquartile Range (IQR) method, is a non-parametric method for identifying potential outliers. In this evaluation, the Tukey method will be used to identify potential outliers for four iterations as described below:

- Percent difference values either greater than the 75th percentile plus 3.0 times the IQR or percent difference values less than the 25th percentile minus 3.0 times the IQR for all data pairs.
- Distance values greater than the 75th percentile plus 3.0 times the IQR for all data pairs.
- Percent difference values either greater than the 75th percentile plus 3.0 times the IQR or percent difference values less than the 25th percentile minus 3.0 times the IQR for detect pairs only.
- Distance values greater than the 75th percentile plus 3.0 times the IQR for detect pairs only.

Samples with a high number of compounds outside the Tukey 3.0 IQR cutoff values in the four iterations will be visually evaluated on the X-Y scatterplots. Samples that appear to be consistent with the majority of data points will be retained in the dataset if professional judgement indicates that they represent natural variability. Samples that are notably different than the majority of data points for most of the compounds will be considered potential outliers, likely representative of measurement error.

Relative Percent difference: Acceptable RPD for soil will be between +50% and -50% and acceptable percent difference for groundwater will be between +30% and -30%. RPD will be calculated as follows:

$$\%D = (C_1 - C_2)/[(C_1 + C_2) \div 2] \times 100\%,$$

where $\%D$ = percent difference, C_1 = concentration determined by definitive analysis and C_2 = concentration of the screening data. The performance criterion with respect to the relative percent difference is 85% after removing outliers. As such, at least 85% of the split sample results for each analyte and medium (soil or groundwater), excluding outliers, must demonstrate acceptable relative percent difference for the dataset to indicate overall acceptability by this comparison.

Ordinary least squares regression: OLS regression will be used to identify the R^2 and slope of the linear regression. The OLS regression will be performed for all sample pairs with statistical outliers excluded. Acceptable criteria will include R^2 of greater than or equal to 0.85 and a slope between 0.8 and 1.2.

Reliability assessment: Since this is not an accredited method, reliability will be determined by how often the screening data produced the same intermediate decision as the definitive data would have. To determine reliability, the split sample pairs (i.e., samples exhibiting detections or non-detects with detection limits below the PSLs) will be compared to determine whether the intermediate decision would be the same or different for each pair. The sample pairs will then be classified based on results of that comparison. Proportion analyses will then be conducted on the classification assignments. The classifications assigned to each pair will be as follows:

- **Both Action.** The definitive and screening data were both above the PSLs.
- **Both No Action.** The definitive and screening data were both below the PSLs (including non-detects below the PSLs).
- **False Positive.** The definitive result was **below** the PSL, indicating no further action, and the screening result was **above** the PSL, indicating further action.
- **False Negative.** The definitive result was **above** the PSL, and the screening data was **below** the PSL.

The decision value used for the reliability evaluation will be the applicable PSL for the given analyte and medium, as defined in **Worksheet 15**. The reliability evaluation will be performed for all sample pairs with statistical outliers excluded. For each compound, when both tests are in agreement, results will be categorized as “Reliable.” When the two tests do not agree, results will be summed, including the false positive cases and the false negative cases, and categorized as “Not Reliable.” The number of Reliable results will be divided by the total number of sample pairs for each PFAS compound to compute a percent passing rate. If for a given PFAS compound the passing rate is greater than or equal to 85%, then the screening data based on this comparison will be considered acceptable for that compound.

Ultimately, screening data will be used to determine placement of definitive confirmation sampling locations, and final decisions will be determined by definitive sampling results. The screening data is intended to provide the basis for locating and collecting the definitive samples. The more reliable the screening data, the greater the likelihood that the step-out/step-in decision will be accurate. It is noted that regardless of laboratory precision, variability in split sample results could still occur due to inherent sample heterogeneities, such as incomplete homogenization of soil samples.

Investigation Derived Waste Management

Throughout the implementation of the Basewide RI field program, the waste streams generated will include soil and/or rock cuttings, groundwater purged during sampling, water from decontamination of drill tooling used for both boring installations and monitoring well installations, equipment used for well development and sampling, and used personal protective equipment, which may potentially contain PFAS. These waste

streams will be containerized and temporarily stored at the installation pending confirmatory waste characterization sampling.

Air Force guidance for IDW handling of PFAS-contaminated media is evolving and current guidance will be consulted prior to IDW disposal at EAFB. If non-PFAS contaminants of concern are present in the IDW, then the most stringent IDW management plan will be implemented.

Aqueous IDW (decontamination water, development water, and purge water) will be containerized at each site, marked with information pertaining to the areas the waste was generated and transported to the EAFB IDW area. The aqueous IDW will then be transferred to an industrial bulk container (IBC) tank to allow for sediments to settle. At the end of the project, the water will be treated with a portable onsite treatment system. The portable treatment system will consist of a series of GAC vessels with GAC media, 5-micron cartridge filters, and a resin vessel with SORBIX media. The treated water will be discharged to a secondary IBC tank and the effluent will be sampled. Effluent samples will be collected for PFAS, VOCs, SVOCs, chloride, sulfate, nitrate, nitrite, and metals. In addition, the effluent water will be observed for any sheen or any odors. PFAS concentrations must be reduced to less than or equal to the USEPA LHA of 70 ng/L. Total aromatic hydrocarbons (TAH) will be calculated from benzene, toluene, ethylbenzene, and xylenes (BTEX) analytical results and must be less than 10 µg/L. Total aqueous hydrocarbons (TaqH) will be calculated utilizing select SVOCs and BTEX results and must be less than 15 µg/L. If contaminants are present at concentrations greater than the USEPA LHA, TAH, TAqH, and/or any additional applicable state or local promulgated standards, the water will be treated and sampled again. The water will be staged temporarily until sample results are received and discharge is approved by both AFCEC and ADEC or it is deemed necessary for retreatment. The aqueous IDW will then be discharged to the Eielson AFB stormwater system at a location designated by the AFCEC RPM. All applicable permits will be acquired prior to discharge.

All soil cuttings will be containerized at each drilling site in 55-gallon steel drums and/or super sacks, properly labeled, and moved for staging at the EAFB IDW yard. To minimize the quantity of solid IDW for disposal, soils anticipated to be PFAS-free, defined as PFAS present at concentrations less than the LOD, will be segregated in separate containers from soils anticipated to be impacted by PFAS. PFAS-free soils are anticipated within the vadose zone at borings downgradient from any source areas and off-base. PFAS concentrations will be confirmed the soil boring analytical results. Composite samples of the soil cuttings and spent GAC will be collected and analyzed for TCLP VOCs, TCLP metals, pH, reactivity, and flashpoint. Spent GAC will also be analyzed for PFAS compounds. Soils and spent GAC containing PFAS in concentrations above the laboratory RL will be transported off-base for disposal in a Subtitle C Landfill. Soils and spent GAC with no PFAS detections will also be disposed of via Subtitle C landfill. The drums and super sacks will be marked with information pertaining to the areas the waste was generated and will be placed on pallets in the EAFB IDW yard. The WMP is provided in **Appendix E**.

RI Report

BEM will prepare and submit a pre-draft, draft, and final RI Report detailing the completion of all activities completed as part of this RI. The report will include information related to and generated by field activities:

- A description of the field activities, including site drawings, photographs, figures, and tables.
- The ranking and prioritizing of source zones.
- Environmental conditions and define the nature and extent of contamination determined through the collection of geologic, geophysical, hydrogeological, ecological, chemical, physical and hydrologic data, as well as appropriate environmental samples.
- A CSM, mass flux evaluation, and an evaluation of potential exposure pathways to receptors. The CSM shall provide information necessary for a toxicologist or qualified risk assessor to conduct a Human Health and/or Ecological risk assessment. The CSM will incorporate fate and transport analysis of contaminants through the interaction of soil/surface water/groundwater media and identify potential migration pathways to support further alternate analysis. The CSM will also include 3D graphical analysis that defines contaminant transport pathways and plume distribution.
- Analytical sampling results and figures and tables depicting the analytical sampling results (historical and during this RI effort). Cross sections including analytical sampling results for all samples collected for each source area and the vertical aquifer profile transects will also be provided.
- Appropriate data quality reviews, ADEC laboratory checklists, level 4 analytical data reports (fixed labs), level 2 analytical data reports (mobile lab), and electronic deliverables (ERPIMS)
- Geospatial data delivered in a geo-referenced GIS format, which will include Environmental Systems Research Institute's shapefile and geodatabase formats.
- Deviations from the established QAPP and the reasons for the deviations.
- A listing of material and items disposed during the RI activities, including waste characterization and disposal documentation.

A pre-draft, draft, and final RI Reports are required. The pre-draft RI Report will be submitted within 90 days of fieldwork completion. Two (2) hard copies and one (1) electronic copy (via email unless too large and then on CD-ROM) will be submitted to AFCEC. BEM will allow up to 30 days for review of the Pre-Draft RI Report. BEM will incorporate AFCEC comments and submit a draft within 15 days after receipt of pre-draft comments. One (1) electronic copy will be submitted to AFCEC and one (1) electronic copy to ADEC and USEPA. The final RI Report will be submitted within 10 days of the draft approval. Review comments will be attached to the final version of the document as an appendix. Final submittals will include two (2) hard copies and three (3) electronic copies on CD-ROM to AFCEC and one (1) electronic copy to ADEC and USEPA. Each CD-

ROM shall contain two (2) electronic versions of documents: one (1) in Adobe PDF and the other shall contain the editable files used in preparing the documents (e.g., Microsoft Excel, Microsoft Word, ArcGIS, etc.).

Schedule

The planned project schedule to complete the RI sampling event for EAFB is provided in **Worksheets #14 & 16** of this QAPP. The mobilization schedule will be determined upon the finalization of this QAPP. Necessary permits, forms, other project documentation, subcontracts, or project equipment will be procured before mobilization. In addition, access agreements will be obtained for all off-base areas, as necessary.

Environmental data will be collected as presented within this QAPP and in accordance with the field SOPs and applicable TGIs provided in **Appendix B,** at the locations defined in **Worksheet #18,** and on **Figures 8 through 14** included with this QAPP. Additionally, the QC sample requirements are listed in **Worksheet #20** of this QAPP. The sampling methods described in the SOPs establish equipment requirements; procedures for equipment calibration before sampling; sampling procedures under various conditions; equipment blank samples and field duplicate collection requirements; and requirements for storing samples to ensure that sample contamination does not occur during collection and transport.

A post-activity inspection will be conducted by the Field Team Lead identified in this QAPP and the attached APP (**Appendix F**) to ensure the location is left clean. The investigation team will demobilize once field activities are complete.

QAPP WORKSHEET #18: SAMPLING LOCATIONS AND METHODS

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.1 and 2.3.2)

The tentative sampling locations and associated analytes and parameters are summarized below; sampling locations are depicted on **Figures 8** through **14** (groundwater, surface water, sediment, and soil). **Table 9** provides sample ID formats and quantities for each sample type and media type. Due to the number of samples, individual sample identifications are not listed in **Table 9.** Adaptive samples will be named according to the formats listed in **Table 9**.

The group of PFAS constituents (including PFOS, PFOA, and PFBS) noted for analysis for groundwater, soil, surface water, pore water, sediment, fish tissue, and waste characterization samples in **Table 9** is summarized for all media in **Worksheet #15**. **Worksheet #17** describes the rationale for the various sampling locations and media. Field activities and sampling procedures will be conducted in accordance with the TGI and SOP documents in **Appendix B**. The frequency requirements for QA/QC samples noted in **Worksheet #20** will be met and sample ID formats are provided in **Table 9**. **Worksheet #20** and **Table 9** list the number and type of QA/QC samples anticipated for each medium based on the sampling plan presented herein; however, the final number and identifications of QA/QC samples listed in the table below are TBD based on progression of daily field activities.

1848 (Intentionally Blank)

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale
Base Contract Tasks														
Soil Samples Collected from Source Area 25 foot soil borings														
AFFF Area #6, Former Adak Building Fire	SS302P	EILSN-SS302P-SB01-Depth-MMDDYY to EILSN-SS302P-SB09-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	27	-	-	9	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #2, Air National Guard KC-135 hangar (B1176)	SS303P	EILSN-SS303P-SB01-Depth-MMDDYY to EILSN-SS303P-SB04-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	12	-	-	4	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #3, Corrosion Control (B1348)	SS304P	EILSN-SS304P-SB01-Depth-MMDDYY to EILSN-SS304P-SB04-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	12	-	-	4	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #12, Hangar (B1344)	SS305P	EILSN-SS305P-SB01-Depth-MMDDYY to EILSN-SS305P-SB04-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	12	-	-	4	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
Site 3, Former Ball Field Spray Test Area	SS306P	EILSN-SS306P-SB01-Depth-MMDDYY to EILSN-SS306P-SB07-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	21	-	-	7	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #10, Fuel Pump House (B1246)	SS307P	EILSN-SS307P-SB01-Depth-MMDDYY to EILSN-SS307P-SB08-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	24	-	-	8	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #14, Thunderdome (B1140)	SS309P	EILSN-SS309P-SB01-Depth-MMDDYY to EILSN-SS309P-SB04-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	9	-	-	4	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
Site 1, South Ramp Spray Test Area	SS310P	EILSN-SS310P-SB01-Depth-MMDDYY to EILSN-SS310P-SB14-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	42	-	-	14	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
Site 2, KC-135 Fire	SS311P	EILSN-SS311P-SB01-Depth-MMDDYY to EILSN-SS311P-SB06-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	18	-	-	6	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
Site 4, Foamed Runway	SS312P	EILSN-SS312P-SB01-Depth-MMDDYY to EILSN-SS312P-SB12-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	36	-	-	12	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #1, Air National Guard Hangar (B1171)	SS314P	EILSN-SS314P-SB01-Depth-MMDDYY to EILSN-SS314P-SB04-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	12	-	-	4	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #4, Current Fire Training Area (FT009)	FT009	EILSN-FT009-SB01-Depth-MMDDYY to EILSN-FT009-SB20-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	60	-	-	20	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #7, Former Fire Station 1	FT092	EILSN-FT092-SB01-Depth-MMDDYY to EILSN-FT092-SB05-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	15	-	-	5	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #8, Former FTA near Antenna Farm	FT092 Subsite	EILSN-FT092-SB06-Depth-MMDDYY to EILSN-FT092-SB10-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	15	-	-	5	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
AFFF Area #9, Former Fire Training Areas by the Current Entomology lab	FT092 Subsite	EILSN-FT092-SB11-Depth-MMDDYY to EILSN-FT092-SB18-Depth-MMDDYY	Surface Soil or Subsurface Soil	Grab	DPT	0 to 25 feet bgs	P10	24	-	-	8	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth. Prescriptive borings are located based on review of all available SI data and are designed to cover the approximate extent of the validated source area.
							Soil Samples	**342**	**0**	**0**	**114**	**0**	**0**	
Groundwater Samples Collected from Source Area 25-foot soil borings														
AFFF Area #6, Former Adak Building Fire	SS302P	EILSN-SS302P-GW01-Depth-MMDDYY to EILSN-SS302P-GW09-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	9	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #2, Air National Guard KC-135 hangar (B1176)	SS303P	EILSN-SS303P-GW01-Depth-MMDDYY to EILSN-SS303P-GW04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	4	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #3, Corrosion Control (B1348)	SS304P	EILSN-SS304P-GW01-Depth-MMDDYY to EILSN-SS304P-GW04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	4	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #12, Hangar (B1344)	SS305P	EILSN-SS305P-GW01-Depth-MMDDYY to EILSN-SS305P-GW04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	4	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
Site 3, Former Ball Field Spray Test Area	SS306P	EILSN-SS306P-GW01-Depth-MMDDYY to EILSN-SS306P-GW07-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	7	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #10, Fuel Pump House (B1246)	SS307P	EILSN-SS307P-GW01-Depth-MMDDYY to EILSN-SS307P-GW08-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	8	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #14, Thunderdome (B1140)	SS309P	EILSN-SS309P-GW01-Depth-MMDDYY to EILSN-SS309P-GW04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	4	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale
Site 1, South Ramp Spray Test Area	SS310P	EILSN-SS310P-GW01-Depth-MMDDYY to EILSN-SS310P-GW14-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	14	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
Site 2, KC-135 Fire	SS311P	EILSN-SS311P-GW01-Depth-MMDDYY to EILSN-SS311P-GW06-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	6	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
Site 4, Foamed Runway	SS312P	EILSN-SS312P-GW01-Depth-MMDDYY to EILSN-SS312P-GW12-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	12	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #1, Air National Guard Hangar (B1171)	SS314P	EILSN-SS314P-GW01-Depth-MMDDYY to EILSN-SS314P-GW04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	4	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #4, Current Fire Training Area (FT009)	FT009	EILSN-FT009-GW01-Depth-MMDDYY to EILSN-FT009-GW20-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	20	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #7, Former Fire Station 1	FT092	EILSN-FT092-GW01-Depth-MMDDYY to EILSN-FT092-GW05-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	5	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #8, Former FTA near Antenna Farm	FT092 Subsite	EILSN-FT092-GW06-Depth-MMDDYY to EILSN-FT092-GW10-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	5	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
AFFF Area #9, Former Fire Training Areas by the Current Entomology lab	FT092 Subsite	EILSN-FT092-GW11-Depth-MMDDYY to EILSN-FT092-GW18-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 25 feet bgs	P10 / P14	8	-	-	-	-	-	Three (3) soil samples will be collected per soil boring and one (1) groundwater sample from the base of each soil boring. The documented depth will be the base depth.
Screen point Groundwater Samples collected from 25-foot soil borings								**114**	**0**	**0**	**0**	**0**	**0**	
Groundwater Samples collected from 50-foot VAP Borings														
AFFF Area #6, Former Adak Building Fire	SS302P	EILSN-SS302P-VAP01-Depth-MMDDYY to EILSN-SS302P-VAP04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	16	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #2, Air National Guard KC-135 hangar (B1176)	SS303P	EILSN-SS303P-VAP01-Depth-MMDDYY to EILSN-SS303P-VAP02-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	8	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #3, Corrosion Control (B1348)	SS304P	EILSN-SS304P-VAP01-Depth-MMDDYY to EILSN-SS304P-VAP02-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	8	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #12, Hangar (B1344)	SS305P	EILSN-SS305P-VAP01-Depth-MMDDYY to EILSN-SS305P-VAP02-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	8	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
Site 3, Former Ball Field Spray Test Area	SS306P	EILSN-SS306P-VAP01-Depth-MMDDYY to EILSN-SS306P-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #10, Fuel Pump House (B1246)	SS307P	EILSN-SS307P-VAP01-Depth-MMDDYY to EILSN-SS307P-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #14, Thunderdome (B1140)	SS309P	EILSN-SS309P-VAP01-Depth-MMDDYY to EILSN-SS309P-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
Site 1, South Ramp Spray Test Area	SS310P	EILSN-SS310P-VAP01-Depth-MMDDYY to EILSN-SS310P-VAP04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	16	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
Site 2, KC-135 Fire	SS311P	EILSN-SS311P-VAP01-Depth-MMDDYY to EILSN-SS311P-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
Site 4, Foamed Runway	SS312P	EILSN-SS312P-VAP01-Depth-MMDDYY to EILSN-SS312P-VAP04-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	16	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #1, Air National Guard Hangar (B1171)	SS314P	EILSN-SS314P-VAP01-Depth-MMDDYY to EILSN-SS314P-VAP02-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	8	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #4, Current Fire Training Area (FT009)	FT009	EILSN-FT009-VAP01-Depth-MMDDYY to EILSN-FT009-VAP06-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	24	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #7, Former Fire Station 1	FT092	EILSN-FT092-VAP01-Depth-MMDDYY to EILSN-FT092-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #8, Former FTA near Antenna Farm	FT092 Subsite	EILSN-FT092-VAP04-Depth-MMDDYY to EILSN-FT092-VAP05-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	8	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.
AFFF Area #9, Former Fire Training Areas by the Current Entomology lab	FT092 Subsite	EILSN-FT092-VAP06-Depth-MMDDYY to EILSN-FT092-VAP08-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 50 feet bgs	P10 / P14	12	-	-	See note 4	-	-	Four (4) groundwater samples will be collected per 50-foot VAP boring at different depths. An HPT boring will be installed adjacent to VAP borings.

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale
Screen point Groundwater Samples collected from 50 foot VAP Borings								**184**	**0**	**0**	**0**	**0**	**0**	
Groundwater Samples collected from 4 Transects of VAP Borings installed to ~100 or ~150 feet bgs														
Transect 1	NA	EILSN-TR01-VAP01-Depth-MMDDYY to EILSN-TR01-VAP15-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 100 feet bgs	P10 / P14	120	-	-	See note 4	-	-	Transect 1 will consist of 15 100-foot VAPs. HPT borings will also be co-located with the VAP borings.
Transect 2	NA	EILSN-TR02-VAP01-Depth-MMDDYY to EILSN-TR02-VAP23-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 150 feet bgs	P10 / P14	248	-	-	See note 4 / 192	-	-	Transect 2 will consist of 7 100-foot VAPs and 16 150-foot VAPs. HPT borings will also be co-located with the 100-foot VAP borings. For the 150-foot VAPs, permeability will be characterized using grain size data.
Transect 3	NA	EILSN-TR03-VAP01-Depth-MMDDYY to EILSN-TR03-VAP07-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 150 feet bgs	P10 / P14	84	-	-	84	-	-	Transect 3 will consist of 7 150-foot VAPs. Permeability will be characterized using grain size data.
Transect 4	NA	EILSN-TR04-VAP01-Depth-MMDDYY to EILSN-TR04-VAP03-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 150 feet bgs	P10 / P14	32	-	-	See note 4 / 24	-	-	Transect 4 will consist of 1 100-foot VAP and 2 150-foot VAPs. HPT borings will also be co-located with the 100-foot VAP borings. For the 150-foot VAPs, permeability will be characterized using grain size data.
Transect 5	NA	EILSN-TR05-VAP01-Depth-MMDDYY to EILSN-TR05-VAP07-Depth-MMDDYY	Groundwater	Grab	Screen point Sampler	0 to 100 feet bgs	P10 / P14	56	-	-	See note 4	-	-	Transect 5 will consist of 7 100-foot VAPs. HPT borings will also be co-located with the 100-foot VAP borings.
Screen point Groundwater Samples collected from 100 or 150-foot VAP Borings								**484**	**0**	**0**	**300**	**0**	**0**	
Groundwater Samples collected from new shallow monitoring wells and from new nested monitoring wells														
TBD	TBD	EILSN-PFAS-RI-MW01-MMDDYY to EILSN-PFAS-RI-MW25	Groundwater	low-flow	peristaltic, submersible pump, or hydrasleeve	TBD	P11	25	-	-	-	-	-	25 permanent groundwater-monitoring wells to approximately 20 feet based on an average depth to groundwater of 10 feet. With a 10 foot screen. Depths and locations will be based on the prescriptive and adaptive phase of the RI.
TBD	TBD	EILSN-PFAS-RI-MW26A/B/C/D-MMDDYY to EILSN-PFAS-RI-MW45A/B/C/D-MMDDYY	Groundwater	low-flow	peristaltic, submersible pump, or hydrasleeve	TBD	P11	80	-	-	-	-	-	20 sets of nested wells with installations beginning at the surface/groundwater interface, 50-feet, 100-feet, and 150-feet (depths are approximate). Depths and locations will be based on the prescriptive and adaptive phase of the RI.
Low-Flow Groundwater Samples								**105**	**0**	**0**	**0**	**0**	**0**	
Surface Water and Porewater Samples (15 surface water sample locations will be porewater)														
AFFF Area #6, Former Adak Building Fire	SS302P	EILSN-SS302P-SW01-MMDDYY to EILSN-SS302P-SW04-MMDDYY EILSN-SS302P-PW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	10	8	8	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #2, Air National Guard KC-135 hangar (B1176)	SS303P	EILSN-SS303P-SW01-MMDDYY to EILSN-SS303P-SW02-MMDDYY EILSN-SS303P-PW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	6	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #3, Corrosion Control (B1348)	SS304P	EILSN-SS304P-SW01-MMDDYY to EILSN-SS304P-SW02-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	4	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #12, Hangar (B1344)	SS305P	EILSN-SS305P-SW01-MMDDYY to EILSN-SS305P-SW02-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	4	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 3, Former Ball Field Spray Test Area	SS306P	EILSN-SS306P-SW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	2	2	2	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #10, Fuel Pump House (B1246)	SS307P	EILSN-SS307P-SW01-MMDDYY to EILSN-SS307P-SW02-MMDDYY EILSN-SS307P-PW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	6	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #14, Thunderdome (B1140)	SS309P	EILSN-SS309P-SW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	2	2	2	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 1, South Ramp Spray Test Area	SS310P	EILSN-SS310P-SW01-MMDDYY to EILSN-SS310P-SW05-MMDDYY EILSN-SS310P-PW01-MMDDYY to EILSN-SS310P-PW02-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	14	10	10	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 2, KC-135 Fire	SS311P	EILSN-SS311P-SW01-MMDDYY to EILSN-SS311P-SW02-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	4	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #1, Air National Guard Hangar (B1171)	SS314P	EILSN-SS314P-SW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	2	2	2	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #4, Current Fire Training Area (FT009)	FT009	EILSN-FT009-SW01-MMDDYY to EILSN-FT009-SW05-MMDDYY EILSN-FT009-PW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	12	10	10	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #7, Former Fire Station 1	FT092	EILSN-FT092-SW01-MMDDYY EILSN-FT092-PW01-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	4	4	4	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #8, Former FTA near Antenna Farm	FT092 Subsite	EILSN-FT092-SW02-MMDDYY to EILSN-FT092-SW04-MMDDYY EILSN-FT092-PW02-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	8	6	6	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #9, Former Fire Training Areas by the Current Entomology lab	FT092 Subsite	EILSN-FT092-SW05-MMDDYY to EILSN-FT092-SW06-MMDDYY EILSN-FT092-PW03-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	6	6	6	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Basewide and Off-site	NA	EILSN-SW01-MMDDYY to EILSN-SW48-MMDDYY EILSN-PW01-MMDDYY to EILSN-PW06-MMDDYY	Surface Water	Grab	direct fill (surface water) and bailer (pore water)	Surface	P15	106	90	90	-	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale
						Surface Water/ Porewater Samples		**190**	**160**	**160**	**0**	**0**	**0**	
Sediment Samples														
AFFF Area #6, Former Adak Building Fire	SS302P	EILSN-SS302P-SD01-MMDDYY to EILSN-SS302P-SD04-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	8	-	8	8	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #2, Air National Guard KC-135 hangar (B1176)	SS303P	EILSN-SS303P-SD01-MMDDYY to EILSN-SS303P-SD02-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #3, Corrosion Control (B1348)	SS304P	EILSN-SS304P-SD01-MMDDYY to EILSN-SS304P-SD02-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #12, Hangar (B1344)	SS305P	EILSN-SS305P-SD01-MMDDYY to EILSN-SS305P-SD02-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 3, Former Ball Field Spray Test Area	SS306P	EILSN-SS306P-SW01-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	2	-	2	2	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #10, Fuel Pump House (B1246)	SS307P	EILSN-SS307P-SD01-MMDDYY to EILSN-SS307P-SD02-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #14, Thunderdome (B1140)	SS309P	EILSN-SS309P-SD01-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	2	-	2	2	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 1, South Ramp Spray Test Area	SS310P	EILSN-SS310P-SD01-MMDDYY to EILSN-SS310P-SD05-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	10	-	10	10	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Site 2, KC-135 Fire	SS311P	EILSN-SS311P-SW01-MMDDYY to EILSN-SS311P-SW02-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #1, Air National Guard Hangar (B1171)	SS314P	EILSN-SS314P-SD01-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	2	-	2	2	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #4, Current Fire Training Area (FT009)	FT009	EILSN-FT009-SD01-MMDDYY to EILSN-FT009-SD05-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	10	-	10	10	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #7, Former Fire Station 1	FT092	EILSN-FT092-SD01-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	4	-	4	4	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #8, Former FTA near Antenna Farm	FT092 Subsite	EILSN-FT092-SD02-MMDDYY to EILSN-FT092-SD04-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	6	-	6	6	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
AFFF Area #9, Former Fire Training Areas by the Current Entomology lab	FT092 Subsite	EILSN-FT092-SD05-MMDDYY to EILSN-FT092-SD06-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	6	-	6	6	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
Basewide and Off-site	NA	EILSN-SD01-MMDDYY to EILSN-SD48-MMDDYY	Sediment	Grab	push core, scoop, or trowel	0 to 0.5 feet bgs	P15	90	-	90	90	-	-	Surface Water/ Porewater and sediment sample locations will be colocated and collected during two (2) events, wet and dry seasons
							Sediment Samples	**160**	**0**	**160**	**160**	**0**	**0**	
Biota - Fish Fillet and Whole Fish Samples														
Location 1	-	EILSN-LOC1-F01-MMDDYY to EILSN-L0C1-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 2	-	EILSN-LOC2-F01-MMDDYY to EILSN-LOC2-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 3	-	EILSN-LOC3-F01-MMDDYY to EILSN-LOC3-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 4	-	EILSN-LOC4-F01-MMDDYY to EILSN-LOC4-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 5	-	EILSN-LOC5-F01-MMDDYY to EILSN-LOC5-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 6	-	EILSN-LOC6-F01-MMDDYY to EILSN-LOC6-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 7	-	EILSN-LOC7-F01-MMDDYY to EILSN-LOC7-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 8	-	EILSN-LOC8-F01-MMDDYY to EILSN-LOC8-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 9	-	EILSN-LOC9-F01-MMDDYY to EILSN-LOC9-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 10	-	EILSN-LOC10-F01-MMDDYY to EILSN-LOC10-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 11	-	EILSN-LOC11-F01-MMDDYY to EILSN-LOC11-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 12	-	EILSN-LOC12-F01-MMDDYY to EILSN-LOC12-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 13	-	EILSN-LOC13-F01-MMDDYY to EILSN-LOC13-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 14	-	EILSN-LOC14-F01-MMDDYY to EILSN-LOC14-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 15	-	EILSN-LOC15-F01-MMDDYY to EILSN-LOC15-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 16	-	EILSN-LOC16-F01-MMDDYY to EILSN-LOC16-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 17	-	EILSN-LOC17-F01-MMDDYY to EILSN-LOC17-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 18	-	EILSN-LOC18-F01-MMDDYY to EILSN-LOC18-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale
Location 19	-	EILSN-LOC19-F01-MMDDYY to EILSN-LOC19-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
Location 20	-	EILSN-LOC20-F01-MMDDYY to EILSN-LOC20-F04-MMDDYY	Fish Tissue	Composite	TBD	NA	P17	4	-	-	-	-	-	There will be four (4) biota samples per location and the samples will be analyzed for filet and whole body analysis.
							Biota Samples	**80**	**0**	**0**	**0**	**0**	**0**	
Waste Characterization Samples (quality control samples will not be collected)														
Aqueous IDW	-	EILSN-IDW-AQU-01 through EILSN-IDW-AQU-15	Soil or Spent GAC	Composite	direct fill	NA	-	15	-	-	-	15	-	Liquid IDW will consist of decontamination water, development water, or purge water. BTEX analytical results will be used to calculate the TAH and BTEX and PAH analytical results will be used to calculate the TAqH
Solid IDW	-	EILSN-IDW-SOL-01 through EILSN-IDW-SOL-15	Water	Composite	scoop, or trowel	NA	-	15	-	-	-	-	15	Solid IDW will consist of soil cuttings and spent GAC. Spent GAC will be analyzed for PFAS compounds. The soil cuttings will be characterized for PFAS compounds utilizing analytical data collected from the soil borings.
							Waste Characterization Samples	**30**	**0**	**0**	**0**	**15**	**15**	
Quality Control Samples (quantities do not include optional tasks)														
Field Duplicates	Same as the Primary Sample	Will differentiate from the Primary Sample ID by using a depth 1 foot deeper than the primary sample.	Soil	Grab	Same as the primary sample	Same as the primary sample	P10	35	-	-	-	-	-	10% of primary samples, rounded up, for each matrix.
		Will differentiate from the Primary Sample ID by using a depth 1 foot deeper than the primary sample.	Groundwater - from VAP borings	Grab	Screen point Sampler	Same as the primary sample	P14	79	-	-	-	-	-	
		ID will differentiate from Primary by adding 20 to monitoring well number	Groundwater from Monitoring Wells	low-flow	peristaltic or submersible pump	Same as the primary sample	P11	11	-	-	-	-	-	
		ID will differentiate from Primary by using consecutive numbers	Surface Water	grab	direct fill or peristaltic pump	Same as the primary sample	P15	19	-	-	-	-	-	
		ID will differentiate from Primary by using consecutive numbers	Sediment	grab	push core, scoop, or trowel	Same as the primary sample	P15	16	-	-	-	-	-	
		ID will differentiate from Primary by using consecutive numbers	Biota	Composite	TBD	Same as the primary sample	P17	8	-	-	-	-	-	
Matrix Spikes/Matrix Spike Duplicates	Same as associated sample	Same as associated sample	Soil	Grab	Same as the primary sample	Same as the primary sample	P10	18	-	-	-	-	-	5% of primary samples, rounded up, for each matrix. Collect triple volume (two extra sets of sample containers) for at least one sample for every 20 (rounded up) per matrix, per analyte. Sample with extra material for MS/MSD analysis must be indicated on Chain-of-Custody.
			Groundwater - from VAP borings	Grab	Screen point Sampler	Same as the primary sample	P14	40	-	-	-	-	-	
			Groundwater from Monitoring Wells	low-flow	peristaltic or submersible pump	Same as the primary sample	P11	6	-	-	-	-	-	
			Surface Water	grab	direct fill or peristaltic pump	Same as the primary sample	P15	10	-	-	-	-	-	
			Sediment	grab	push core, scoop, or trowel	Same as the primary sample	P15	8	-	-	-	-	-	
			Biota	Composite	TBD	Same as the primary sample	P17	4	-	-	-	-	-	
Equipment Blank	NA	EILSN-EB01-MMDDYY to EILSN-EB20-MMDDYY	Water	Grab	NA	NA	P09	20	-	-	-	-	-	1 per piece of relevant equipment per day. Consumable materials will be used as often as possible to limit the number of equipment blanks
Field Blanks	NA	EILSN-FB01-MMDDYY to EILSN-FB20-MMDDYY	Water	Grab	NA	NA	NA	20	-	-	-	-	-	One (1) field blank will be collected per week and the 2021 field season will consist of approximately 20 weeks.
Source Blank	NA	EILSN-SOB01-MMDDYY to EILSN-SOB20-MMDDYY	Water	Grab	NA	NA	NA	20	-	-	-	-	-	A water treatment system will be onsite and all water used on the project will be treated with the system to ensure PFAS is not detected in the water. One source blank will be collected per week.
							QC Total Samples	**314**	**0**	**0**	**0**	**0**	**0**	
							Total Samples	**1973**	**160**	**320**	**574**	**15**	**15**	

TABLE 9. PROPOSED PRESCRIPTIVE PHASE FIELD SAMPLING PROGRAM

Site Name	Site ID	Sample ID	Matrix	Sample Type	Sampling Method/ Tool	Estimated Sample Depth (feet bgs)	Sampling SOP	PFAS (EPA 537 Modified)[19]	TSS[5]	TOC[6]	Grain Size[4,7]	Aqueous IDW Samples[2]	Solid IDW Samples[3]	Sampling Description/Rationale

[1] Laboratory analysis will be completed using a combination of an onsite mobile lab provided by Pace Analytical Services, LLC (Pace) for "screening" samples and fixed laboratory services provided by Eurofins Lancaster Laboratories Environmental (ELLE) for "screening" and "definitive" samples.
The definitive samples are generally those with potential application for human health or ecological risk assessment purposes and will be analyzed per the DoD QSM method for 24 PFAS compounds as listed in Worksheet #15. Definitive sample media will include surface soil (0 to 0.5 foot bgs), surface water, stormwater, sediment, pore water, monitoring well groundwater, fish tissue and a representative set of subsurface soil and VAP groundwater. The screening samples are used for intermediate decision making to optimize placement of adaptive phase borings and samples. Screening sample media will include select subsurface soil (greater than 1-foot bgs), source area groundwater and VAP groundwater. Screening samples will be analyzed for PFOS, PFOA, and PFBS as indicated in Worksheet #15. Approximately 58% of samples will be definitive and approximately 42% of samples will be screening.
Samples will be collected following the DoD Field Sampling protocol for PFAS Compounds (PFOS/ PFOA/ PFBS) (DoD, 2020); PFAS Field Sampling Guidance (Arcadis, 2020); and ADEC Field Sampling Guidance (ADEC, 2019).
[2] All aqueous IDW will be analyzed for PFAS (DoD QSM Method for 24 PFAS compounds), Metals (SW6020), VOCs (SW8260C), and SVOCs (SW8270D).
[3] All solid IDW will be analyzed for PFAS (DoD QSM Method for 24 PFAS compounds)(spent GAC only), TCLP VOCs (SW8260D), TCLP Metals (SW6101D), pH (9045D), flashpoint (1010A), and reactivity (7.3.3 and 7.3.4).
[4] In the event that HPT cannot resolve permeability estimates, pneumatic slug testing will be conducted and discrete soil samples will be collected at each VAP sample interval for the 50-ft and 100-ft VAP sampling locations for analysis of grain size for prescriptive and adaptive borings.
[5] Prescriptive and adaptive samples for surface water will include analysis of TSS.
[6] Prescriptive samples for surface water and sediment will include analysis of TOC. Adaptive samples for sediment will include analysis of TOC.
[7] For source area soil borings and 150-ft VAP borings: grain size samples will be collected in the prescriptive and adaptive phase. For sediment samples: grain size samples will be collected in the prescriptive phase only.
[8] SPLP sampling will be completed in the adaptive phase as part of source area characterization based on the results of the prescriptive soil borings. At these locations, up to three (3) discrete soil samples will be collected and analyzed for PFAS, PFAS SPLP, AEC, CEC, and TOC.
[9] Moisture content is included as part of the soil analysis and will be reported by the the mobile laboratory and the fixed laboratories.

Notes:

ADEC = Alaska Department of Environmental Conservation
AEC = Anion Exchange Capacity
AFFF = Aqueous Film Forming Foam
BTOC = below top of casing
bgs = below ground surface
CEC = Cation Exchange Capacity
DoD= Department of Defense
DPT = direct push technology
EPA = U.S. Environmental Protection Agency
GAC = Granulated activated carbon
HPT = hydraulic profiling tool
ID = identification
IDW = investigation derived waste
MS = matrix spike
MSD = matrix spike duplicate
NA = not applicable
PFAS = Per- and polyfluoroalkyl substances
PFBS = Perfluorobutane sulfonate
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctanesulfonic acid
SOP = standard operating procedure
SPLP = Synthetic Precipitation Leaching Procedure
SVOC = semivolatile organic compound
TAH = Total aromatic hydrocarbons
TAqH = Total aqueous hydrocarbons
TBD = to be determined
TCLP = toxicity characteristic leaching procedure
TOC = total organic carbon
VAP = vertical aquifer profiling
VOC = volatile organic compound

QAPP WORKSHEET #19 & #30: SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES

(UFP-QAPP Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.2)

Laboratories:

Eurofins Lancaster Laboratories Environmental (ELLE)
2425 New Holland Pike
Lancaster, PA 17601
Contact: Stephen Gordon
Phone: 412.525.0071
Email: stephen.gordon@eurofinset.com
DoD Environmental Laboratory Accreditation Program (ELAP) Expiration Date: November 30, 2022 (Appendix G)
ADEC Laboratory Certification Program Expiration Date: February 28, 2022 (Appendix G)

Pace Mobile Lab Services (Pace Mobile Lab)
1 Home Farm Way
Montpelier, VT 05602
Contact: Mike Rossi
Phone: 802.839.0544
Email: mike.rossi@pacelabs.com
DoD ELAP Expiration Date: November 18, 2021

Back-up Laboratory:

Pace Lab Services (Pace)
106 Vantage Point Drive
West Columbia, SC 29172
Contact: Kathy Smith
Phone: 803.791.9700
Email: Kathy.Smith@pacelabs.com
DoD ELAP Expiration Date: November 18, 2021 (prior to field work the most recent certification will be provided)

ADEC Laboratory Certification Program Expiration Date: June 30, 2021

Pace National (Pace)
12065 Lebanon Road
Mt. Juliet, TN, 37122
Contact: Mike McFadden
Phone: 919.868.5215
Email: Mike.McFadden@pacelabs.com
DoD ELAP Expiration Date: November 30, 2021,
ADEC Laboratory Certification Program Expiration Date: December 30, 2021

Sample Delivery Method: Federal Express Overnight or Hand Delivery

Analyte/ Analyte Group	Method/ SOP	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Groundwater/Surface Water Sampling						
PFAS (Groundwater, Surface Water, Porewater)	PFAS per DoD QSM 5.3, Table B-15/ ELLE: T-PFAS-WI122030 Pace: ME003NI	High-density polyethylene (HDPE) with HDPE screw cap 2 x 250 milliliter (mL)	Cool to < 6 degrees Celsius (°C), or Trizma to extend the holding time	7 days without any preservation , or 14 days preserved with Trizma	28 days after extraction	21 calendar days
PFOS/PFOA/PFBS (Groundwater)	Pace Mobile Lab: ENV-SOP-MAD1-0101	HDPE with HDPE screw cap 2 x 15 mL	Cool to < 6 °C No preservative	14 days	28 days after extraction	2 calendar days
TSS (Surface Water Only)	SM2540D/ ELLE: T-WC-WI11604 Pace: ME0014X	1 x 1000 mL plastic bottle	Cool to < 6°C	NA	7 days	21 calendar days
TOC (Surface Water Only)	SW846 5310C / ELLE: WI11637 Pace: ME0016Q	2 x 40 ml Amber Vials	pH<2 ((H3PO4, H2SO4, or HCl), 6oC	28 days	NA	21 calendar days
Soil/Sediment Sampling						
PFAS (soil and sediment)	PFAS per DoD QSM 5.3, Table B-15/ ELLE: T-PFAS-WI22283 Pace: ME003NI	HDPE with HDPE screw cap 2 x 4 ounce (oz)	Cool to < 6°C	28 days	28 days after extraction	21 calendar days
PFOS/PFOA/PFBS (soil only)	Pace Mobile Lab: ENV-SOP-MAD1-0101	HDPE with HDPE screw cap 1 x 25 mL	No preservative Cool to < 6°C	14 days	28 days after extraction	2 calendar days

Analyte/ Analyte Group	Method/ SOP	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Moisture	ASTM-D2216-98 ELLE: WI10697	4 oz HDPE jar	Cool to < 6°C	NA	NA	21 calendar days
TOC (soil and sediment)	SW846 9060A/ ELLE: T-WC-WI11627 Pace: EVN-WET-BTRO	4-oz wide-mouth glass jar	Cool to < 6°C	NA	28 days	21 calendar days
AEC (soil)	ICP/Colorado State University: NA	1000 mL HDPE or Glass	Cool to < 6°C	6 months	NA	21 calendar days
CEC (soil)	SW846 9081/ ELLE: CC-ATM-M020 Pace: ENV-SOP-SHRT-0046	1000 mL HDPE or Glass	Cool to < 6°C	6 months	NA	21 calendar days
SPLP (Soil)	USEPA 1312/ ELLE: T-TL-WI7258 Pace: ME001IY	4-oz wide-mouth glass jar	Not Applicable (N/A)	14 days	14 days	21 calendar days
Grain Size (soil)	ASTM D422-63/ ELLE: T-WC-WI11514 Pace: Not Applicable (NA)	16-oz wide-mouth glass jar	NA	NA	NA	21 calendar days
Fish Tissue						
PFAS (fillet and whole fish)	PFAS per DoD QSM 5.3, Table B-15/ ELLE: WI22283[1] Pace: NA	100 grams minimum, Aluminum foil	Cool to < 0°C	28 calendar days	28 calendar days after extraction	21 calendar days

Analyte/ Analyte Group	Method/ SOP	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Aqueous IDW Sampling						
PFAS (decontamination, purge, and development water)	PFAS per DoD QSM 5.3, Table B-15/ Pace: ME003NI ELLE: T-PFAS-WI122030	HDPE with HDPE screw cap 2 x 250 mL	Cool to < 6°C	7 Days	30 days after extraction	21 calendar days
VOCs (decontamination, purge, and development water)	SW8260C ELLE: WI8194 Pace: Me0012X-21	3 x 40 ml Vials	HCL to pH <2, Cool to <6°C	14 days	14 days	21 calendar days
SVOCs (decontamination, purge, and development water)	SW8270D ELLE: WI9617 Pace: Me0014Q-15	2x1 L Amber glass TLC	Cool to < 6 °C	7 days	40 days	21 calendar days
Chloride/Sulfate	EPA 300.0 ELLE: WI11626	50 mL plastic vial	Cool to < 6°C	NA	48 hour (nitrate & nitrite); 28 days	21 calendar days
Nitrite/Nitrate Nitrogen	EPA 353.2 ELLE: WI11649, WI11650	2 x 40 mL glass vials	Cool, 6C, 1 vial H_2SO_4 to pH <2, 1 vial unpreserved	NA	48 hours/28 days	21 calendar days

Analyte/ Analyte Group	Method/ SOP	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Soil Cuttings and Spent GAC / IDW Sampling						
PFAS (GAC)	PFAS per DoD QSM 5.3, Table B-15 ELLE: T-PFAS-WI22283 Pace: ME003NI	HDPE with HDPE screw cap 2 x 4 oz	Cool to < 6°C	28 days	28 days after extraction	21 calendar days
TCLP VOCs (soil cuttings and GAC)	SW846-8260D ELLE: WI8544-14 / Pace: ME0019C-07	60 ml wide mouth glass (no headspace)	Cool to < 6°C	14 days	14 days after extraction	21 calendar days
TCLP Metals (soil cuttings and GAC)	SW846-6101D ELLE: WI17151-15	500 ml wide mouth glass	Cool to < 6°C	180 days, 28 days for Hg	180 days, 28 days for Hg	21 calendar days
pH (soil cuttings and GAC)	SW846-9045D ELLE: WI11518-13 PACE: NA	250 ml wide mouth glass	Cool to < 6°C	NA	NA	21 calendar days
Flashpoint (soil cuttings and GAC)	SW846-1010A ELLE: WI10437-11 PACE: NA					
Reactivity (soil cuttings and GAC)	7.3.3 & 7.3.4 ELLE: WI11574-15 Pace: not applicable	125 ml wide mouth glass (no headspace)	NA	NA	NA	21 calendar days

Notes:

Copies of the laboratory QA Manual is provided in Appendix G and the Laboratory SOPs in Appendix H.

QAPP WORKSHEET #20: FIELD QUALITY CONTROL SUMMARY

(UFP-QAPP Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.5)

Primary and QA/QC samples will be collected during field activities at the frequencies noted below. Field duplicates (FDs) will be collected at 1 per 10 primary samples and at a minimum one per day will be collected during the sampling event. Field blanks (FBs) and MS/ MSDs will be collected at a frequency of 1 per 20 of primary samples. Source blanks (SBs) will be collected from the source of water used for the initial decontamination step for equipment. QA/QC samples will be analyzed for PFAS only (same analyte list for groundwater on **Worksheet #15**). Field QC samples will not be collected for samples collected for waste characterization and geotechnical purposes.

Matrix	Analyte/ Analytical Group	Normal Samples	FD	MS	MSD	EB	FB	SB	Total # analyses for prescriptive phase
Groundwater	PFAS	943	95 [1 per 10 parent samples]	48 [1 per 20 parent samples]	48 [1 per 20 parent samples]	1 per piece of relevant equipment per day	1 per 20 samples	1 per each source of water used for decontamination per batch	minimum of 1,134
Surface Water/ Porewater	PFAS	190	19 [1 per 10 parent samples]	10 [1 per 20 parent samples]	10 [1 per 20 parent samples]	NA			229
	TSS	160	NA	NA	NA	NA			160
	TOC	160	NA	NA	NA	NA			160
Sediment	PFAS	160	16 [1 per 10 parent samples]	8 [1 per 20 parent samples]	8 [1 per 20 parent samples]	NA			192

Matrix	Analyte/ Analytical Group	Normal Samples	FD	MS	MSD	EB	FB	SB	Total # analyses for prescriptive phase
	TOC	160	NA	NA	NA	NA			160
Soil	PFAS	342	35 [1 per 10 parent samples]	18 [1 per 20 parent samples]	18 [1 per 20 parent samples]	NA			413
	SPLP	45	6	3	3	NA			57
	AEC	45	6	3	3	NA			57
	CEC	45	6	3	3	NA			57
	TOC	TBD	NA	NA	NA	NA			TBD
	Grain Size	TBD	NA	NA	NA	NA			TBD
Fish Tissue	PFAS	80	8 [1 per 10 parent samples]	4 [1 per 20 parent samples]	4 [1 per 20 parent samples]	NA			96

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QAPP WORKSHEET #21: FIELD SOPS

(UFP-QAPP Section 3.1.2)
(USEPA 2106-G-05 Section 2.3.2)

SOP # or Reference[1]	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)[2]	Modified for Project? Yes/No
P-01	Quality Procedure (QP) - Field Activities Documentation, Rev. C, November 2016	BEM	Applies to all field personnel.	No
P-02	SOP – Sample CoC, Rev. 1, 23 May 2017	BEM	Applies to all field personnel with 40-hour HAZWOPER and DOT HazMat #1 training.	No
P-03	Health and Safety Standard – Utility Location and Clearance, Rev. 16, 17 March 2017	BEM	Applies to all subsurface intrusive work	No
P-04	QP – Calibration and Control of measuring and test equipment, Rev. C, November 2016	BEM	Applies to all field personnel using equipment that is capable of calibration.	No
P-05	QP - Field Sampling, Measurement, and Observation, Rev. D, October 2017	BEM	Applies to all field personnel completing field sampling, measurement, and observations.	No
P-06	TGI - Soil Description, Rev. 2, 16 Feb 2018	BEM	Applies to all field personnel conducting soil logging.	No
P-07	TGI- Monitoring Well Development, Rev. 0, April 2017	BEM	Applies to all field personnel developing monitoring wells. See TGI for specific equipment needs.	No

SOP # or Reference[1]	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)[2]	Modified for Project? Yes/No
P-08	TGI- Monitoring Well Integrity Survey, Rev. 0, April 2017	BEM	See TGI for specific equipment needs.	No
P-09	TGI – Groundwater and Soil Sampling Equipment Decontamination, Rev. 0, 23 February 2017	BEM	Applies to soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment	No
P-10	TGI - PFAS Field Sampling (all media) Guidance, Rev.5, 15 October 2020	BEM	Applies to all field personnel collecting environmental samples for PFAS analysis. See TGI for specific equipment needs.	Yes[3]
P-11	TGI – PFAS Sampling Procedures and Low-Flow Groundwater Purging for Monitoring Wells, Rev. 0, 19 June 2018	BEM	Applies to low-flow sampling for PFAS.	No
P-12	PFAS-Specific Drilling and Monitoring Well Installation TGI, Rev. 4, 06 August 2020 (Appendix A)	BEM	Applies to all field personnel sampling soil or groundwater for PFAS via hand auger, drilling, or installing monitoring wells for PFAS analysis. See TGI for specific equipment needs.	No
P-13	TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis, Rev. 0, October 2018	BEM	Applies to all field personnel completing field sampling. See TGI for specific equipment needs.	No
P-14	TGI – VAP for PFAS Analysis, Rev. 1, 26 March 2019	BEM	Applies to all field personnel using Vertical Aquifer Profiling to collecting soil and groundwater samples. See TGI for specific equipment needs.	Yes

SOP # or Reference[1]	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)[2]	Modified for Project? Yes/No
P-15	TGI – Sediment, Surface Water, and Stormwater Sample Collection for PFAS Analysis, Rev. 2, 15 October 2020	BEM	Applies to all field personnel collecting sediment, surface water, and stormwater samples. See TGI for specific equipment needs.	Yes[3]
P-16	TGI – Investigation-Derived Waste Handling and Storage, Rev. 0, 23 February 2017	BEM	See TGI for specific equipment needs.	No
P-17	Fish Sampling Procedures	BEM	See Procedure for specific equipment needs	Yes[4]
P-18	Field Processing Procedures for Fish Samples	BEM	See Procedure for specific equipment needs	Yes
P-19	Piezometer and Porewater Sampling SOP	BEM	See Procedure for specific equipment needs	No
P-20	TGI – Geoprobe Hydraulic Profiling Tool	BEM	See Procedure for specific equipment needs	No

Notes:

[1]Copies of the field SOPs/ TGIs are included in **Appendix B**.

[2]For all TGIs pertaining to the collection of samples for PFAS analysis, there is concern that sampling for PFAS using sampling equipment manufactured from fluoropolymers could result in sample cross-contamination. The materials of construction of all downhole and surface sampling and monitoring equipment — including pumps, packers, transducers, tubing, liners, valves, and wiring — should be free from polytetrafluorethylene or ethylene tetrafluoroethylene to the maximum extent practicable. In addition, well drilling procedures and completion materials should avoid the use of fluorocarbon-based lubricants, O-rings and pipe thread pastes, tapes, and sealants. If possible, a confirmation letter with analytical testing results should be obtained from a manufacturer or service provider certifying that the equipment (or supplies) are free of any PFAS.

[3] In SOPs P-10 and P-15 the surface water interval was adjusted per USAF preference to sample surface water at the surface. The specific modifications are detailed on the "Version Control" pages of the SOPs, indicating date, description, and page number of the modifications.

[4] In SOP P-17 the sample container was changed to aluminum foil. The specific modifications are detailed on the "Version Control" pages of the SOPs, indicating date, description, and page number of the modifications.

1924 (Intentionally Left Blank)

QAPP WORKSHEET #22: FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION

(UFP-QAPP Section 3.1.2.4)
(USEPA 2016-G-05 Section 2.3.6)

Instrument or Equipment	Description	Field Calibration Procedure	Performance Criteria	Responsible Personnel
Water Quality Meter – YSI 6-Series Multi-Parameter Instrument or Equivalent	Multi-parameter tool designed for field use with battery operation. Ranges: 0 – 14 pH -999 to +999 millivolt Oxidation-Reduction Potential -5 to 50 degrees °C 0 to 50 milligrams per liter (mg/L) Dissolved Oxygen 0 to 100 millisiemens per centimeter (mS/cm) Specific Conductivity Dissolved Oxygen: ± 0.01 mg/L Temp: ± 0.01 °C	The unit is factory calibrated. Unit responsiveness will be checked prior to use each day with appropriate standards provided by the supplier. Unit responsiveness is checked against the solution standards provided by each manufacturer.	+/- 10% of included standard solutions with meter	Sample Collection Personnel
Turbidimeter – Hach 2100P or Equivalent	Designed for field use with battery operation. Range: 0 to 1,000 NTU.	Each day prior to use, the turbidimeter is calibrated against the standard solutions provided by each manufacturer.	+/- 10% of included standard solutions with turbidimeter	Sample Collection Personnel
GPS	Benchmark check. Perform daily benchmark check and document in field log	Per manufacturer's instructions	Sample location coordinates	Sample Collection Personnel

Instrument or Equipment	Description	Field Calibration Procedure	Performance Criteria	Responsible Personnel
HPT	Pre-test calibration of the HPT to ensure the pressure responses are consistent with expected values	Per manufacturer's instructions	Determine by the specific method of testing used	HPT operator

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QAPP WORKSHEET #23: ANALYTICAL SOPS

(UFP-QAPP Section 3.2.1)
(USEPA 2016-G-05 Section 2.3.4)

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
T-PFAS-WI36459[2]	Polyfluorinated Alkyl Substances (PFAS) in Solids by Method 537 Version 1.1 Modified QSM 5.3 Table B-15 Using LC/MS/MS, Rev 1, 1/29/2021	Definitive	PFAS/Soil and Sediment	liquid chromatography -mass spectrometry (LC-MS/MS)	ELLE	N
S-SS-WI10697	% Moisture Calculation and % Solids Calculation (Gravimetric), Rev 18, 6/8/2020	Definitive	Moisture/Soil and Sediment	See lab SOP	ELLE	N
T-PFAS-WI36458	Polyfluorinated Alkyl Substances (PFAS) in Aqueous Samples by Method 537 Version 1.1 Modified QSM5.3 Table B-15 Using LC/MS/MS, Rev 1, 1/28/2021	Definitive	PFAS/ Groundwater and Surface Water, Leachate	LC-MS/MS	ELLE	N
Attachment 7	Extraction of PFAS from Fish/Marine Tissue	Definitive	PFAS/Fish tissue	See lab SOP	ELLE	N
T-OE-GEN-WI11408	Percentage Lipids Using Soxhlet Extraction by Method 3540C, Rev 14, 2/28/2021	Definitive	Lipids	See lab SOP	ELLE	N
T-WC-WI11627	TOC and Total Carbon in Solids and Sludges by Combustion by SM 5310B, USEPA 415.1, SW-846 9060/9060A, Lloyd Kahn, Rev. 17, 7/9/2019	Definitive	TOC/ Soil	TOC Analyzer	ELLE	N
T-WC-WI11637	Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), and Total Inorganic Carbon (TIC),	Definitive	TOC/ Water	TOC Analyzer	ELLE	N

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
	by SM 5310C or EPA 415.1 in Waters, Rev 16, 9/25/2018					
T-WC-WI11604	TSS-Gravimetric by SM 2540 D-2011 or SM 2540 D-1997 and Total Filtered: Total Volume Test by NJDEP in Waters. Rev 11. 12/24/2018	Definitive	TSS / Water	Analytical Balance	ELLE	N
T-WC-WI11518	pH by USEPA 9045C, 9045D and Corrosivity by SW-846 Chap 7 of Solids, Soils, and Solvents using Electrometric Methods, Rev 13, 7/8/2019	Definitive	pH/Soil	pH Meter	ELLE	N
T-WC-WI11514	Particle Size Distribution of Soils and Solids/Grain Size Classification by ASTM D422-63 (reapproved 2007), Rev 10, 1/24/2019	Definitive	Grain Size/Soil	Sieve and hydrometer	ELLE	N
T-VOA-WI8194	VOCs and GRO by GC/MS in Waters and Wastewaters by USEPA 8260C, Rev 6, 3/21/2019	Definitive	VOC/Water	GC/MS	ELLE	N
CC-ATM-M020	CEC of Soils, Rev 8, 5/20/2019	Definitive	CEC /Soil	Inductively Coupled Plasma atomic Emission Spectrometry (ICP) /ICPMS	Eurofins TestAmerica Corpus Christi	N
CC-ATM-M005	Trace Metals Analysis by ICP-atomic emission spectroscopy (AES), Rev 9, 8/15/2018	Definitive	CEC/Soil	ICP-AES	Eurofins TestAmerica Corpus Christi	N
CC-ATM-M025	Trace Metals Analysis by ICP-MS, Rev 7, 6/15/2018	Definitive	CEC/Soil	ICP-MS	Eurofins TestAmerica Corpus Christi	N

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
NA	The Method For AEC (P-Fixation), 2/12/2012	Definitive	AEC/Soil	ICP	Colorado University	N
T-VOA-WI8544	TCLP and SPLP; VOCs by GCMS in Zero Headspace Extraction (ZHE) by 8260B/C/D, Rev 14 11/2/2020	Definitive	VOC/TCLP and SPLP	GC/MS	ELLE	N
T-TL-WI7258	Volatiles by Zero Headspace Extractor (ZHE) -Toxicity Characteristic Leaching Procedure (TCLP) by EPA 1311 and Synthetic Precipitate Leaching Procedure (SPLP) by EPA 1312, Rev 13, 7/17/2019	Definitive	VOC/TCLP and SPLP	GC/MS	ELLE	N
T-TL-WI7151	Non-volatiles - TCLP by USEPA 1311 and SPLP by EPA 1312, Rev. 15 10/13/2020	Definitive	TCLP and SPLP	GC/MS	ELLE	N
T-SVOA-WI9617	SVOCs by Method 8270D/E in Aqueous and Nonaqueous Matrices using GC-MS Rev 10 4/26/2019	Definitive	SVOC/Water, TCLP	GC/MS	ELLE	N
T-OE-SVOA-WI10935	Separatory Funnel Extraction (Method 3510C) or Waste Dilution (Method 3580A) of Base Neutrals and Acid Extractables in Leachates, Rev 14, 1/10/2020	Definitive	SVOC Prep	See lab SOP	ELLE	N
T-OE-SVOA-WI11432	Separatory Funnel Extraction by Method 3510C for BNAs in Wastewater, Rev 18, 2/28/2021	Definitive	SVOC Prep	See lab SOP	ELLE	N
T-MET-WI11931	Metals by ICP for Methods SW-846 6010B/C/D (aqueous,	Definitive	Metal/TCLP	ICP	ELLE	N

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
	solid, tissue) and EPA 200.7 (aqueous), Rev 13, 7/17/2019					
T-MET-WI11941	Sample Preparation of Wastewater and Leachates for Analysis of Total Metals by Inductively Coupled Plasma Atomic Emission Spectrometry, Rev 12, 1/19/2015	Definitive	Metal Prep	See lab SOP	ELLE	N
T-WC-WI10437	Flash Point for Liquids and Solids by ASTM D93, EPA 1010A or EPA 1010B, Rev 11, 11/30/2020	Definitive	Flash point	Pensky-Martens closed-cup tester	ELLE	N
T-WC-WI11574	Reactivity of Waste, Rev 15, 11/30/2020	Definitive	Reactivity	See lab SOP	ELLE	N
T-WC-WI11626	Determination of Inorganic Anions by Ion Chromatography in Waters and Soil by EPA 300.0, SW846 9056, and SW846 9056A, Rev 22, 12/24/2018	Definitive	Chloride, Sulfate/ Water	IC	ELLE	N
T-WC-WI11649	Nitrate Nitrogen in Water and Wastewater by EPA 353.2 (Colorimetric, Automated Cadmium Reduction), Rev 15, 3/20/2020	Definitive	Nitrate-N/ Water	Flow analyzer	ELLE	N
T-WC-WI11650	Nitrite Nitrogen in Water and Wastewater (Colorimetric, Automated), Rev 14.1, 5/19/2017	Definitive	Nitrite-N/ Water	Flow analyzer	ELLE	N
ME003NI	PFAS by LC/MS/MS (Isotope Dilution) Rev 3 10/09/2020	Definitive	PFAS/Soil, Water	LC-MS/MS	Pace	N

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ENV-WET-BTRO	TOC in Solids, Rev 8,	Definitive	TOC/ Soil	TOC Analyzer	Pace	N
ME0014X	TSS and Total Volatile Suspended Solid (TVSS), Rev 8 07/21/2020	Definitive	TSS / Water	Analytical Balance	Pace	N
ME0014S	pH by Electrometric Measurement / pH Paper Method SM4500-H B-2011 / 9040C / 150.1 / 9041A / 9045D Rev 7 11/13/2019	Definitive	pH/Soil	pH Meter	Pace	N
NA	Grain Size Determined by Sedimentation Analysis (Hydrometer)	Definitive	Grain Size/Soil	Hydrometer	Pace-Schnabel engineering	N
ME0012X	GC/MS Volatiles Analysis, Rev 21, 7/18/2020	Definitive	VOC/Soil, Water	GC/MS	Pace	N
ME0014Q	Semivolatile Organic Compounds by GC/MS Analysis, Rev 15, 9/8/2020	Definitive	SVOC/Soil, Water	GC/MS	Pace	N
ME0016Q	Total Organic Carbon (TOC), Rev 5, 7/21/2021	Definitive	TOC/Water	TOC Analyzer	Pace	N

SOP Reference Number[1]	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix/ Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ME0019C	Toxicity Characteristic Leaching Procedure, Rev 7, 7/17/2020	Definitive	TCLP Prep	See lab SOP	Pace	N
ME001IY	Synthetic Precipitation Leaching Procedure (SPLP), Rev 5, 7/7/2020	Definitive	SPLP Prep	See lab SOP	Pace	N
MIN4-0016	Lipid Determination, Rev 1, 4/12/2021	Definitive	Lipids/Fish tissue	See lab SOP	Pace	N
MTJL-0155	Determination of Elements in Water and Solids by Ion Chromatography (EPA Methods 300.0, 300.1, 9056, 9056A and SM 4110B), Rev 5, 3/10/2021	Definitive	Chloride, Sulfate/ Water	IC	Pace	N
MTJL-0359	Nitrate/Nitrite-Lachat, Rev 1, 9/19/2020	Definitive	Nitrate-N, Nitrite-N/ Water	See lab SOP	Pace	N
SHRT-0046	CEC USEPA 9081, Rev 1, 11/10/2020	Definitive	CEC/Soil	ICP	Pace	N
MAD1-0101	Accelerated PFAS by LCMSMS, 5/20/2020	Screening	PFAS/Soil, Water	LC/MS/MS	Pace Mobile	N

Notes:
[1]Copies of the laboratory SOPs are included in **Appendix H**.
[2]Proprietary SOP available upon request.

QAPP WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION

(UFP-QAPP Section 3.2.2)
(USEPA 2016-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
LC-MS/MS for PFAS per DoD QSM Version 5.3 Table B-15	Mass Calibration	Initially prior to use and after performing major maintenance, as required to maintain documented instrument sensitivity and stability performance.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer	NA	Analyst / Section Supervisor	WI22283 WI14355 (ELLE) ME003NI (Pace Fixed Lab) ENV-SOP-MAD1-0101 (Pace Mobile)
	Tune Check	When the masses fall outside of the ±0.5 amu of the true value.	Mass assignments of the tuning standard within 0.5 amu of true value.	Retune instrument and verify		
	Initial Calibration (ICAL) Standards containing both branched and linear isomers must be used when commercially available. Isotope Dilution or Internal Standard Calibration is required. Minimum five-point	Initial calibration prior to sample analysis	S/N Ratio: ≥ 10:1 for all ions used for quantification. For analytes having a promulgated standard, (e.g., health advisory levels for PFOA and PFOS), the qualitative (confirmation) transition ion must have a S/N Ratio of ≥ 3:1. Average RF: RSD of	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
	initial calibration for linear, or six-point calibration for quadratic.		the RFs for each analyte ≤ 20% Linear or non-linear Calibration: $r^2 \geq 0.99$. Analytes must be within 70-130% of their true value for each calibration standard.			
	Instrument Sensitivity Check (ISC). ISC can serve as initial daily Continuing Calibration Verification (CCV)	Prior to analysis and at least once every 12 hours	Analyte concentrations must be at LOQ; concentrations must be within ±30% of true value.	Correct problem, rerun ISC. If problem persists, report ICAL.		
	Initial Calibration Verification (ICV)	Once after each ICAL; analysis of second source standard prior to sample analysis.	Analyte concentrations must be within ±30% of true value.	Correct problem, rerun ICV. If problem persists, report ICAL.		
	CCV	Prior to sample analysis, after every 10 field samples, and at end of analytical sequence.	Analyte concentrations must be within ±30% of true value. Concentration of analytes must range from LOQ to mid-level calibration concentrations.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. Otherwise, perform corrective action, repeat CCV (or ICAL), and reanalyze all		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
				associated samples since the last successful CCV.		
	Instrument Blanks	Immediately following highest standard analyzed and daily prior to sample analysis.	Concentration of each analyte must be ≤ ½ the LOQ.	If acceptance criteria are not met after the highest calibration standard, calibration must be performed using a lower high standard until criteria is met.		
LC-MS/MS for PFAS per Pace Accelerated Method	Mass Calibration	Initially prior to use and after performing major maintenance, as required to maintain documented instrument sensitivity and stability performance.	Calibrate the mass scale of the MS with calibration compounds and procedures described by the manufacturer	NA	Analyst / Section Supervisor	ENV-SOP-MAD1-0101 (Pace Mobile)
	Tune Check	When the masses fall outside of the ±0.5 amu of the true value.	Mass assignments of the tuning standard within 0.5 amu of true value.	Retune instrument and verify		
	Initial Calibration (ICAL) Standards containing both branched and linear isomers must be used when commercially available. Isotope Dilution or Internal Standard	Initial calibration prior to sample analysis	S/N Ratio: ≥ 10:1 for all ions used for quantification. For analytes having a promulgated standard, (e.g., health advisory levels for PFOA and PFOS), the qualitative (confirmation) transition ion must	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
	Calibration is required. Minimum five-point initial calibration for linear, or six-point calibration for quadratic.		have a S/N Ratio of ≥ 3:1. Average RF: RSD of the RFs for each analyte ≤ 20% Linear or non-linear Calibration: $r^2 \geq 0.99$. Analytes must be within 50-150% of their true value for the lowest ICAL point and within 70-130% for the midpoint ICAL.			
	Instrument Sensitivity Check (ISC). ISC can serve as initial daily Continuing Calibration Verification (CCCV)	Prior to analysis and at least once every 12 hours	Analyte concentrations must be at LOQ; concentrations must be within ±50% of true value.	Correct problem, rerun ISC. If problem persists, repeat ICAL.		
	Initial Calibration Verification (ICV)	Once after each ICAL; analysis of second source standard prior to sample analysis.	Analyte concentrations must be within ±30% of true value.	Correct problem, rerun ICV. If problem persists, repeat ICAL.		
	CCV	Prior to sample analysis, after every 20 field samples, and at end of analytical sequence.	Analyte concentrations must be within ±30% of true value. Concentration of analytes must range from LOQ to mid-level	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. Otherwise, perform corrective action, repeat CCV (or		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
			calibration concentrations.	ICAL), and reanalyze all associated samples since the last successful CCV. All CCV's must meet acceptance criteria, if bracketing CCV fails high, only samples that are ND can be reported. If bracketing CCV fails low, all samples must be re-analyzed.		
	Instrument Blanks	Immediately following highest standard analyzed and daily prior to sample analysis. IBLK must contain EIS to enable quantitation of contamination.	Concentration of each analyte must be ≤ ½ the LOQ.	Re-analyze the IBLK. No sample shall be analyzed until the IBLK has met acceptance criteria.		
Extracted Internal Standard (EIS) Analytes (Pace Mobile)	NA	All standards and every field and QC sample. Added to samples and batch QC prior to SPE.	EIS recoveries must be within 40% to 160% of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	If peak areas are unacceptable, analyze a second aliquot of the extract or extract new	Analyst / Section Supervisor	ENV-SOP-MAD1-0101 (Pace Mobile)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
				sample if sufficient volume remains. If there is not enough extract, reanalyze the first aliquot. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags.		
GC/MS	TUNE	Prior to ICAL and prior to each 12-hour period of sample analysis.	Specific ion abundance criteria of BFB from the table in ME0012X	Re-tune as needed, re-analyze	Analyst / Section Supervisor	See lab SOPs in Appendix H
	ICAL	Initially and as needed after ICV and CCV failure.	<15% RSD; R2 > 0.99	As needed and re-analyze		
	ICV	Once after each ICAL, second source standard prior to sample analysis	+/- 20%	Correct problem, rerun. If rerun fails, rerun ICAL.		
	CCV	Beginning and end of each 12-hour shift	+/- 20%			

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP/ICP-MS/ICP-AES/ICP-OES	Minimum of a blank and one standard	Daily calibration prior to sample analysis	If more than one calibration standard is used, r2 ≥ 0.99.	Terminate analysis; Correct the problem; Recalibrate	Analyst / Section Supervisor	WI11931, CC-ATM-M005 (ELLE)
	ICV	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.		
	Initial Calibration Blank (ICB)	Immediately after the ICV	The absolute values of all analytes must be < ½ LOQ or < 1/10th the amount measured in any associated sample. Results may not be reported without valid Calibration Blanks. Non-detects(ND) associated with positive blank infractions may be reported. Sample results >10X the LOQ associated with negative blanks may be reported.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL.		
	CCV	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
				cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.		
	CCB	Immediately after every CCV.	The absolute values of all analytes must be < ½ LOQ or < 1/10th the amount measured in any associated sample. Results may not be reported without valid Calibration Blanks. Non-detects associated with positive blank infractions may be reported. Sample results >10X the LOQ associated with negative blanks may be reported. For CCB, failures due to carryover may not require an ICAL.	Terminate analysis; Correct the problem; Recalibrate.		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
	ISCA / ICSAB	After ICAL and prior to sample analysis. All analytes must be within the LDR. ICSAB is not needed if instrument can read negative responses.	ICSA: Absolute value of concentration for all non-spiked project analytes <1/2 LOQ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICSA (and ICSAB if applicable), reanalyze all samples.		
IC	Initial calibration with a minimum of 5 points with a concentration span of 15x or 30x depending on the analyte	Every 60 days or when CCV fails	r^2 >0.995; Level 1 standard must recover ≥50% of the true value	Perform more aggressive instrument maintenance and recalibrate	Analyst / Section Supervisor	WI11626
	ICB	After each initial calibration	No analytes detected > 1/2 LOQ	Correct problem and reanalyze the ICB. Recalibrate if needed.		
	LOD	Quarterly	Detect the compound	Reanalyze the LOD		
	ICV	After each initial calibration	Within +/- 10% of the nominal concentration	If ICV fails again do system maintenance and recalibrate.		
	CCV	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	Within +/- 10% of the nominal concentration	Recalibrate; reanalyze affected samples		

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
	CCB	If instrument is idle > 4 hours, after every 10 field samples, and at the end of the sequence	No analytes detected > 1/2 LOQ	Recalibrate; reanalyze affected samples		
Flow Analyzer	Initial Calibration with a minimum 6 points ranging from 0.1 mg/L to 4.0 mg/L.	Each run	Correlation Coefficient of >0.995	Recalibrate, perform instrument maintenance if calibration cannot conform to criteria, recalibrate	Analyst / Section Supervisor	WI11649, WI11650
	ICV Standard	After each ICAL	±10% D	Reanalyze the ICV. If ICV fails again do system maintenance and recalibrate.		
	LOD	Quarterly	Detect the compound	Reanalyze the LOD		
	ICB Standard	After the ICV	< MDL	Do system maintenance and recalibrate		
	CCV Standard	Every 10 injections	±10% D	Immediately reanalyze the CCV. If CCV fails again do system maintenance and recalibrate.		
	CCB Standard	After each CCV	< MDL	Do system maintenance and recalibrate		

Notes:
[1]Copies of the laboratory SOPs are included in **Appendix H**.
[2]Proprietary SOP available upon request

1944 # QAPP WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE,
1945 # TESTING, AND INSPECTION

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
LC-MS/MS	See Laboratory QA Manual[1]	PFAS	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	Analyst, Section Supervisor	See Laboratory QA Manual[1]
Analytical Balance	See Laboratory QA Manual[1]	All	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	See Laboratory QA Manual[1]	Analyst, Section Supervisor	See Laboratory QA Manual[1]
TOC Analyzer	See laboratory QA manual[1]	TOC	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	Analyst, Section Supervisor	See laboratory QA manual[1]
GC/MS	See laboratory QA manual[1]	VOC	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]
Hydrometer	See laboratory QA manual[1]	Grain Size	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]
pH Meter	See laboratory QA manual[1]	pH	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]
ICP-AES, ICP-MS	See laboratory QA manual[1]	CEC, AEC	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]
IC	See laboratory QA manual[1]	Chloride, Sulfate	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]
Flow analyzer	See laboratory QA manual[1]	NO_2/ NO_3-N	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]	See laboratory QA manual[1]

1946 **Note:** [1]A copy of the Laboratory QA Manual is included in **Appendix G**

1947 (Intentionally Left Blank)

QAPP WORKSHEET #26 & #27: SAMPLE HANDLING, CUSTODY, AND DISPOSAL

(UFP-QAPP Manual Section 3.3)
(USEPA 2016-G-05 Section 2.3.3)

Sampling Organization: BEM Team
Laboratory: Pace and ELLE
Method of sample delivery (shipper/carrier): On-site delivery to mobile lab and/or Federal Express/Alaska Air GoldStreak
Number of days from reporting until sample disposal: at least 60 days

Activity	Title or position of person responsible for the activity and organization	SOP reference
Sample labeling	Field Team Leader BEM Team	See Field SOP P-01. Sample identification will be site-specific.
Chain-of-custody form completion	Field Team Leader BEM Team	See Field SOPs P-01 and P-02.
Packaging	Field Team Leader BEM Team	See Field SOPs P-01 and P-02.
Shipping coordination	Field Team Leader BEM Team	See Field SOPs P-01 and P-02.
Sample receipt, inspection, and log-in	Pace/ELLE	See "Laboratory Custody Procedures" below.
Sample custody and storage	Pace/ELLE	See "Laboratory Custody Procedures" and "Final Evidence Files" below.
Sample disposal	Pace/ELLE	See Laboratory QA Manual[1] and/or Sample Disposal SOP

Note:
[1]A copy of the Laboratory QA Manual is included in **Appendix G.**

Laboratory Custody Procedures

A designated sample custodian accepts custody of the samples and verifies that the information on the sample labels matches that on the CoC. The sample custodian will document any discrepancies and will sign and date all appropriate receiving documents. The sample custodian will also document

the condition of the samples upon receipt at the laboratory. If a sample container is missing, a sample container is received broken, the sample is in an inappropriate container, or the sample has not been preserved by appropriate means, BEM personnel will be notified as per direction on **Worksheet #6**.

In accordance with laboratory custody and security requirements, the laboratory sample custodian will be responsible for logging the samples in, assigning a unique laboratory identification number to each sample to assure traceability of samples while in possession of the laboratory, labeling the sample bottle with the laboratory identification number, and moving the sample to an appropriate storage location to await analysis. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory tracking system. Relevant custody documentation will be placed in the project file.

The following stages of analysis must be documented by the laboratory:

- Sample Extraction/Preparation
- Sample Analysis
- Data Reduction
- Data Reporting

Laboratory personnel are responsible for the custody of the samples until they are returned to the sample custodian.

Final Evidence Files

This is the final phase of sample custody. The CoC records and sample analysis request form copies are archived in their respective project files. Laboratory custody forms, sample preparation and analysis logbooks, and data packages will become part of the laboratory final evidence file. Other relevant documentation including records, reports, correspondence, logs, pictures, and data review reports will be archived.

QAPP WORKSHEET #28: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTION

(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix	Soil, Sediment, Water (Groundwater, Surface Water, Porewater, and Fish Tissue), SPLP
Analytical Group	PFAS
Analytical Method/SOP Reference[1]	PFAS per DoD QSM 5.3 Table B-15/ ELLE SOPs T-PFAS-WI22030/ T-PFAS-WI22283 / Pace Mobile SOP EN-SOP-MAD-0101/ Pace SOP ME003NI

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Duplicate	10% of number of normal field samples	RPD ≤ 50% for soil/sediment; ≤ 30% for water	Qualify data as appropriate	Data Validator	Overall precision	RPD ≤ 50% for soil/sediment; ≤ 30% for water
Method blank	1 per analytical batch of no more than 20 samples	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Correct problem. If required, re-prep and reanalyze method blank and all QC samples and field samples processed with the contaminated blank.	Analyst / Section Supervisor	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
Equipment blank (per piece of reusable equipment, as needed)	1 per piece of relevant equipment per day	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Qualify data as appropriate	Data Validator	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
Field Blank	1 per 20 samples	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Qualify data as appropriate	Data Validator	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Source Blank	1 per each treated batch of water used for decontamination	No target analyte concentrations >= MDL associated sample	- Re-check the water treatment system performance. - Re-treat the batch of water associated with SB exceeding MDL. - Collect a SB from treated water and analyze for 24 PFAS compounds by the fixed lab under a rush TAT if necessary. - If one of 24 PFAS compounds is detected at concentrations greater than the MDL then the media in the water treatment system will be replaced and the system will be checked again.	Field Team Lead	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
LCS	1 per analytical batch of no more than 20 samples	Water: See Table C-44 of DoD QSM 5.3 Soil/Sediment: See Table C-45 of DoD QSM 5.3	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst / Section Supervisor	Accuracy/Bias	Water: See Table C-44 of DoD QSM 5.3 Soil/Sediment: See Table C-45 of DoD QSM 5.3

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Extracted Internal Standards[1]	Every field sample, standard, blank, and QC sample.	Added to solid sample prior to extraction. Added to aqueous samples, into the original container, prior to extraction. For aqueous samples prepared by serial dilution instead of SPE, added to the final dilution of samples prior to analysis. %R 50 to 150% of ICAL midpoint standard area or area measured in the initial CCV on days when ICAL is not performed.	If recoveries are acceptable for QC samples, but not field samples, may indicate matrix effect. If QC samples fail, correct problem; rerun all failed samples, report and narrate. If EIS recovery is >10% [but less than 50%] and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be increased as necessary and appropriate so that reported values accurately reflect the sensitivity of the analysis.	Analyst / Section Supervisor	Accuracy/bias	%R 50 to 150% of ICAL midpoint standard area or area measured in the initial CCV on days when ICAL is not performed.
MS / MSD	5% of number of normal field samples. Not required for aqueous samples prepared by serial dilution instead of SPE.	Sample spiked with all analytes at concentration ≥ LOQ and ≤ mid-level calibration concentration. RPD ≤30%	If criteria not met, qualify as appropriate.	Analyst / Section Supervisor	Accuracy/bias	RPD ≤30% Water: See Table C-44 of DoD QSM 5.3 Soil/Sediment: See Table C-45 of DoD QSM 5.3

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
		Water: See Table C-44 of DoD QSM 5.3 Soil/Sediment: See Table C-45 of DoD QSM 5.3				
Post spike sample. Only applies to aqueous samples prepared by serial dilution instead of SPE that have reported value of "<LOQ" for analyte(s).	Spike aliquot(s) of sample at the final dilution(s) reported for sample with all analytes that have reported value of "<LOQ" in the final dilution. The spike must be at the LOQ concentration to be reported with the sample (the "<LOQ" value).	When analyte concentrations are calculated as "<LOQ," the spike must recover within 70-130%of its true value.	When analyte concentrations are calculated as "<LOQ," and the spike recovery does not meet the 70-130% acceptance criteria, the sample, sample duplicate, and post spike sample must be reanalyzed at consecutively higher dilutions until the criteria is met.	Analyst / Section Supervisor	Accuracy/bias	Post spike recovery must be within 70 to 130% of the true value.

Notes:

[1]A copy of the Laboratory SOP is included in **Appendix H**.

[2]The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation). If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation.

RPD – relative percent difference

Matrix	Soil, Water (Groundwater and Surface Water)
Analytical Group	PFAS
Analytical Method/SOP Reference[1]	PFAS per Pace Mobile SOP ENV-SOP-MAD-0101

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Duplicate	10% of number of normal field samples	RPD ≤ 50% for soil≤ 30% for water	Qualify data as appropriate	Data Validator	Overall precision	RPD ≤ 50% for soil≤ 30% for water
Method blank	1 per analytical batch of no more than 20 samples	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Correct problem. If required, re-prep and reanalyze method blank and all QC samples and field samples processed with the contaminated blank.	Analyst / Section Supervisor	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
Equipment blank (per piece of reusable equipment, as needed)	1 per piece of relevant equipment per day	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Qualify data as appropriate	Data Validator	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
Field Blank	1 per 20 samples	No target analyte concentrations ≥ ½ LOQ or > 1/10th the amount measured in any associated sample	Qualify data as appropriate	Data Validator	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ
Source Blank	1 per each treated batch of	No target analyte concentrations >=	- Re-check the water treatment system performance.	Field Team Lead	Contamination/ Bias	No target analyte concentrations ≥ ½ LOQ

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
	water used for decontamination	MDL associated sample	- Re-treat the batch of water associated with SB exceeding MDL. - Collect a SB from treated water and analyze for 24 PFAS compounds by the fixed lab under a rush TAT if necessary. - If one of 24 PFAS compounds is detected at concentrations greater than the MDL then the media in the water treatment system will be replaced and the system will be checked again.			
LCS	1 per analytical batch of no more than 20 samples	In-house LCS limits. 70-130	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst / Section Supervisor	Accuracy/Bias	

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Extracted Internal Standards[1]	All standards and every field and QC sample. Added to samples and batch QC prior to SPE.	EIS recoveries must be within 40% to 160% of ICAL midpoint standard area or area measured in the initial CCV on days when an ICAL is not performed.	If peak areas are unacceptable, analyze a second aliquot of the extract or extract new sample if sufficient volume remains. If there is not enough extract, reanalyze the first aliquot. If second analysis meets acceptance criteria, report the second analysis. If it fails, either analysis may be reported with the appropriate flags.	Analyst / Section Supervisor	Accuracy/bias	%R 40 to 160% of ICAL midpoint standard area or area measured in the initial CCV on days when ICAL is not performed.
MS / MSD	5% of number of normal field samples.	Sample spiked with all analytes at concentration ≥ LOQ and ≤ mid-level calibration concentration. RPD ≤30% Water; ≤50% Soil Laboratory will use limits of 60-140%	If criteria not met, qualify as appropriate.	Analyst / Section Supervisor	Accuracy/bias	RPD ≤30%Water≤50% Soil

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
		until in-house limits are established				
Extracted Surrogate Standard (ESS) Analytes	Added to samples and batch QC prior to SPE.	Recoveries must be within 50%-150%.	Verify calculations, standard solutions, possible interference, and instrument performance. Reanalyze the extract. If reanalysis is acceptable, report only reanalysis. If reanalysis fails and the following CCV is acceptable, qualify the result.	Analyst / Section Supervisor		Recoveries within 50%-150%.

Notes:

[1]A copy of the Laboratory SOP is included in **Appendix H**.

[2]The isotopically labeled analog of an analyte (Extracted Internal Standard Analyte) must be used for quantitation if commercially available (Isotope Dilution Quantitation). If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time to the analyte must be used for quantitation.

RPD – relative percent difference

1997

Matrix	Soil, Sediment
Analytical Group	TOC
Analytical Method/SOP Reference	ELLE SOPs T-WC-WI11627/T-WC-WI10037[1] and Pace SOPs ME001BG

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	1 per analytical batch of no more than 20 samples	No TOC concentrations ≥ ½ LOQ	Correct problem. If required, Re-prep and reanalyze method blank and all QC samples and field samples processed with the contaminated blank.	Analyst/Section Supervisor	Contamination/ Bias	No TOC concentrations ≥ ½ LOQ
Laboratory control sample	1 per analytical batch of no more than 20 samples	%R 80-120%	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst/Section Supervisor	Accuracy/Bias	%R 80-120%

1998 **Notes:**

1999 [1]A copy of the Laboratory SOP is included in **Appendix H**.

2000

Matrix	Surface Water
Analytical Group	TSS
Analytical Method/SOP Reference	ELLE SOP T-WC-WI11604[1] and Pace SOP ME0014X

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method blank	1 per analytical batch of no more than 20 samples	No TSS concentrations ≥ LOQ	Correct problem. If required, re-prep and reanalyze method blank and all QC samples and field samples processed with the contaminated blank.	Analyst/Section Supervisor	Contamination/ Bias	No TSS concentrations ≥ LOQ
Laboratory control sample	1 per analytical batch of no more than 20 samples	%R 80-120% (ELLE) 90-110% (Pace)	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst/Section Supervisor	Accuracy/Bias	%R 80-120% (ELLE) 90-110% (Pace)

Notes:

[1]A copy of the Laboratory SOP is included in **Appendix H.**

Matrix	TCLP
Analytical Group	VOC, SVOC
Analytical Method/SOP Reference	ELLE SOP WI8194, WI9617

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Surrogate Spike	Per sample (including MS/MSD, LCS, and Blanks)	Recovery limits per QSM 5.3. Laboratory statistical limits for surrogates not in QSM 5.3.	If obvious matrix interference report data with a comment. Otherwise, re-extract and re-analyze.	ELLE Analyst	Accuracy	Results within acceptance limits
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any associated sample or 1/10 the regulatory limit, whichever is greater	Reanalyze to confirm detections. If detects confirm re-extract samples that are not ND or not >10x the blank value	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any associated sample or 1/10 the regulatory limit, whichever is greater
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤20%	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3. Laboratory statistical limits for compounds not in QSM 5.3.; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-extracted.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
Internal standards	Per sample (including MS/MSD, LCS, and blanks)	-50% to +100% of internal standard area of 12 hour STD. RT within ±10 sec. of midpoint standard in the ICAL	Flag data	ELLE Analyst	Precision	Results within acceptance limits

2004

Matrix	TCLP
Analytical Group	Metals
Analytical Method/SOP Reference	ELLE SOP WI11931

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 RL or >1/20 the amount measured in any associated sample	Reanalyze blank to confirm detections. If detects confirm, redigest samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 RL or >1/20 the amount measured in any associated sample
MS/MSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.1 ±25% for elements not in QSM 5.1; RPD ≤20%	Analyze post digestion spike and serial dilution	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS/LCSD	1 per prep batch of up to 20 samples	Recovery limits per QSM 5.3 ±20% for elements not in QSM 5.1; RPD ≤20%	Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-digested	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQI	Measurement Performance Criteria
			and reanalyzed.			
Duplicate	1 per prep batch of up to 20 samples	RPD must be ≤20%	Flag data	ELLE Analyst	Precision	Results within acceptance limits
Serial Dilutions	Must be prepared with each background sample, evaluated only when analyte concentrations are >50x the LOQ	The percent difference must be ≤10%	Flag data	ELLE Analyst	Precision	Results within acceptance limits
Post Digestion Spike	Prepare with each background sample	± 20% True Value	No specific action needed unless required by the project. PDS is reported in data package	ELLE Analyst	Accuracy/Bias	Results within acceptance criteria
Internal Standard	Every sample and QC	Must be 50%-130% of the calibration blank	Reanalyze at a dilution	ELLE Analyst	Precision	Results within acceptance criteria

2005
2006

Matrix	Water
Analytical Group	Chloride, Sulfate
Analytical Method/SOP Reference	EPA 300.0/ELLE SOP WI11626, Pace: MTJL-0155

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method blanks	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample	Reanalyze blank to confirm detections. If detects confirm, re-prep samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample
MS	1 per 10 samples	Laboratory statistical limits	Flag outliers	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
LCS	1 per prep batch of up to 20 samples	Laboratory statistical limits	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-prepped or re-digested.	ELLE Analyst	Accuracy/Bias/Precision	Results within acceptance limits
Duplicate	1 per 10 samples	Laboratory limits	Flag data	ELLE Analyst	Precision	Results within acceptance limits

2007

Matrix	Water
Analytical Group	Nitrite/Nitrate-Nitrogen
Analytical Method/SOP Reference	EPA 353.2/ELLE SOP WI11649, WI11650, Pace: MTJL-0359

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per prep batch of up to 20 samples	No analytes detected > 1/2 LOQ or >1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater	Reanalyze blank to confirm detections. If detects confirm, reanalyze samples that are not ND or not >10x the blank value.	ELLE Analyst	Accuracy/Laboratory Contamination	No analytes detected > LOQ or >1/10 the amount measured in any sample
Matrix Spike	1 per 10 samples	Method windows	Flag outliers	ELLE Analyst	Accuracy/Bias	Results within acceptance limits
LCS	1 per prep batch of up to 20 samples	Method windows	Reanalyze LCS and associated samples. Analytes in the LCS that fail high and are ND in the samples can be reported. All others are re-analyzed.	ELLE Analyst	Accuracy/Bias	Results within acceptance limits
Duplicate	1 per 10 samples	Laboratory statistical RPD	Flag data	ELLE Analyst	Precision	Results within acceptance limits

2008

2009 # QAPP WORKSHEET #29: PROJECT DOCUMENTS AND RECORDS TABLE

2010 **(UFP-QAPP Manual Section 3.5.1)**
2011 **(USEPA 2106-G-05 Section 2.2.8)**
2012

Sample Collection and Field Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Safety forms	BEM Team Field Staff	BEM Field Leader	Project File
Digital Field notes and/or data collection sheets	BEM Team Field Staff	BEM Field Leader	
Chain-of-custody forms	BEM Team Field Staff	BEM Field Leader	
Airbills	BEM Team Field Staff	BEM Field Leader	
Daily QC reports	BEM Team Field Staff	BEM Field Leader	
Field change requests	BEM Team Field Leader	BEM Project Manager	
Corrective action reports	BEM Team Field Staff	BEM Project Manager	
Correspondence	BEM Team Field Staff	BEM Field Leader	
Project Assessments and Deliverables			
Record	**Generation**	**Verification**	**Storage Location/Archival**
QAPP	BEM Project Manager	BEM Program Manager	Project File
APP and HSP	BEM Project Manager	BEM Program Manager	
Field audit checklists	BEM Team Field Team Leader	BEM QC Manager	
Data verification/validation checklists	Synectics	BEM QC Manager	
Data validation report	Synectics	BEM QC Manager	
Data usability assessment	BEM Chemist	BEM QC Manager	
Audit reports	BEM Chemist	QA/QC Manager	
Final Report and Digital CSM	BEM Team Project Staff	BEM Program Manager	

Contractor-Specific Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Training Files	All project team members	BEM Project Manager	The respective team corporate personnel file
Laboratory Records			
Record	**Generation**	**Verification**	**Storage Location/Archival**
Laboratory raw data package	Laboratory analyst	Laboratory QA Manager (QAM)	Documents provided to BEM and then to AFCEC via ERPIMS
Electronic copy of analytical data	Laboratory Information Technology personnel	Laboratory QAM/Supervisor	
Laboratory sample custody log	Laboratory sample custodian	Laboratory QAM/Supervisor	Laboratory
Laboratory equipment calibration logs	Laboratory analyst	Laboratory QAM/Supervisor	
Sample preparation logs	Laboratory analyst	Laboratory QAM/Supervisor	
Run logs	Laboratory analyst	Laboratory QAM/Supervisor	
Sample preparation logs	Laboratory sample custodian	Laboratory QAM/Supervisor	
Corrective action reports	Laboratory personnel	Laboratory QAM/Supervisor	
Correspondence	Laboratory Project Manager	Laboratory Director	
Laboratory competency certifications, training and experience records	Laboratory QAM	Laboratory Director	

2013

QAPP WORKSHEET #31, #32 & #33: ASSESSMENTS AND CORRECTIVE ACTION

(UFP-QAPP Manual Section 4.1.1 and 4.1.2)
(USEPA 2106-G-05 Section 2.4 and 2.5.5)

ASSESSMENTS:

Assessment Type	Frequency	Internal or External	Organization Performing	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person (s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Field QC audit	Once	Internal	BEM	BEM Team QC manager or designee	BEM Team field manager	BEM Team field manager	BEM QA/ QC Manager
Analytical QC audit	Once	Internal	BEM	QA/QC Manager	Laboratory project manager	Laboratory project manager	QA/QC Manager

ASSESSMENT FINDINGS AND CORRECTIVE ACTION:

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA
Field QC audit: Operational Readiness Review	Checklist or logbook entry	BEM Team field manager	Immediately to within 24 hours of review	Checklist or logbook entry	BEM Project Manager
Field QC audit: Deviations from QAPP	Logbook or field change request	BEM Team project manager and regional lead	Immediately to within 24 hours of deviation	Logbook or field change request	BEM Project Manager
Analytical QC audit: Laboratory technical systems/performance	Email followed by deficiency report	BEM Project Manager, BEM chemist	Immediately to within 24 hours of deviation	Corrective Action report	BEM Project manager and BEM chemist

2021 **QUALITY CONTROL MANAGEMENT REPORTS TABLE:**

Type of Report	Frequency	Projected Delivery	Person(s) Responsible	Person(s) Responsible for Report Preparation	Report Recipients
QC audit	Once	Prior to beginning sample analyses	QA/QC Manager	BEM Project Manager	QC audit
Data validation report	As performed	Up to 30 business days after receipt of data package	Synectics	Contents summarized in base-specific inspection report	Data validation report
Laboratory technical systems/performance audits	Per QSM V 5.3	Per certification requirements	BEM Team project manager	BEM Project Manager and laboratory coordinator	Laboratory technical systems/performance audits
Laboratory DoD ELAP re-certification	Per certification or every two years	November 2020*	BEM Team project manager	BEM Project Manager and laboratory coordinator	Laboratory DoD ELAP re-certification
Variance request form	As required per variance/field change	Prior to field change if feasible	BEM Team project manager	AFCEC project manager	Variance request form

2022 *Recertification is currently under review and a current certification will be provided once obtained.

QAPP WORKSHEET #34: DATA VERIFICATION AND VALIDATION INPUTS

(UFP-QAPP Manual Section 5.2.1)
(USEPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	**X**	
2	Contract	**X**	
3	Field SOPs	**X**	
4	Laboratory SOPs	**X**	
Field Records			
5	Field logs	**X**	
6	Equipment calibration records	**X**	
7	Chain-of-Custody Forms	**X**	
8	Sampling logs	**X**	
9	Drilling logs	**X**	
10	Well construction logs	**X**	
11	Well development		
12	Relevant Correspondence	**X**	
13	Change orders/deviations	**X**	
14	Field audit reports	**X**	
15	Field corrective action reports/Field non-conformance reports	**X**	
Analytical Data Package			
16	Cover sheet (laboratory identifying information)	**X**	**X**
17	Case narrative	**X**	**X**
18	Internal laboratory Chain-of-Custody	**X**	**X**
19	Sample receipt records	**X**	**X**
20	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	**X**	**X**
21	Communication records	**X**	**X**
22	LOD/LOQ establishment and verification	**X**	**X**
23	Standards Traceability	**X**	**X**
24	Instrument calibration records	**X**	**X**
25	Definition of laboratory qualifiers	**X**	**X**

Item	Description	Verification (completeness)	Validation (conformance to specifications)
26	Results reporting forms	**X**	**X**
27	QC sample results	**X**	**X**
28	Corrective action reports	**X**	**X**
29	Raw data	**X**	**X**
30	EDD	**X**	**X**

2027

2028 # QAPP WORKSHEET #35: VALIDATION PROCESS TABLE

2029 **(UFP-QAPP Manual Sections 5.2.2)**
2030 **(USEPA 2106-G-05 Sections 2.5.1)**
2031

Validation Input	Description	Responsible for Validation (Name, Organization)
Data deliverables and UFP-QAPP	Ensure the data from **Worksheet #34** were provided.	Project Chemist, BEM Team
Analytes	Ensure all analytes specified in **Worksheet #15** were analyzed and reported by the laboratory.	Project Chemist, BEM Team
Chain of custody	Evaluate the traceability of the data from the time of sample collection through reporting of the data results.	Project Chemist, BEM Team
Holding times	Confirm samples were evaluated within the allowable holding times.	Project Chemist, BEM Team
Data qualifiers	Evaluate the laboratory data qualifiers and ensure definitions are appropriate and applied as specified in methods, procedures, and contracts.	Synectics
Raw data	Review 10% of the raw data to confirm laboratory calculations.	Synectics
Sampling plan	Confirm that the number and type of soil samples specified in **Worksheet #20** were collected and analyzed.	Project Chemist, BEM Team
Sampling procedure	Confirm sampling SOPs were followed.	Regional Lead/Field Team Leader, BEM Team
Field QC samples	Confirm that the number and type of QC samples specified in **Worksheet #20** were collected and analyzed. Compare the results of co-located FDs with criteria established in the UFP-QAPP.	Regional Lead/Field Team Leader, BEM Team
Project quantitation limits	Determine whether the sample results met the project quantitation limits and qualify the data, as necessary. To be sufficient for project decision making, project quantification limits should be lower than the project screening levels unless there was no known use of this chemical in DoD operations at the base, and detections of the chemical are considered unlikely.	Project Chemist, BEM Team
Laboratory data packages	Laboratory data packages will be validated by the laboratory performing the work for technical accuracy before they are submitted.	Stephen Gordon, PM, ELLE

Validation Input	Description	Responsible for Validation (Name, Organization)
	Data packages will be evaluated externally by undergoing data validation. Rejection of data is not allowed by external validators and is reserved for the project team. One hundred percent of the data will be checked for completeness of deliverables. 10 percent of the data will be fully validated. Ninety percent of the results will undergo a Level 2b validation only. A validation report will summarize results and include qualified results. One hundred percent of manual entries will be reviewed to confirm that they are free of transcription errors and manual calculations are accurate; computer calculations will be spot-checked.	Mike Rossi, Laboratory Director, Pace
Review of data validation reports	Data validation reports will be reviewed in conjunction with the project DQOs and DQIs.	Emily Underwood, PM, Synectics

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QAPP WORKSHEET #36: DATA VALIDATION PROCEDURES

(UFP-QAPP Manual Sections 5.2.2)
(USEPA 2106-G-05 Sections 2.5.1)

Data validation will be conducted in accordance with the DoD QSM (DoD 2019a), the DoD Environmental Data Quality Working Group Data Validation Guidelines (DoD 2019c), and DoD data validation guidelines specific to PFAS (DoD 2020).

Data Validator: Synectics

Analytical Group/Method:	PFAS	TOC, TSS, VOC, SVOC and Metals	Grain Size, waste characterization and other Secondary Analyses
Data deliverable requirements:	Level 4 Data Package(pdf); ERPIMS	Level 4 Data Package(pdf); ERPIMS	Level 2 Data Package(pdf); ERPIMS
Analytical specifications:	PFAS per DoD QSM 5.3, or later versions	TOC by SW-846 9060A, TSS by SM2540D, VOC by SW-846 8260, SVOC by SW846-8270, Metals by SW-846 6020	Grain Size by ASTM D422-63 and various methods
Measurement performance criteria:	DoD QSM 5.3	DoD QSM 5.3	Laboratory SOPs and QC Control Limits
Percent of data packages to be validated:[1]	100%	0%	0%
Percent of raw data reviewed:	10%	0%	0%
Percent of results to be recalculated:	10%	0%	0%
Validation procedure:	This QAPP, DoD QSM 5.3, DoD General Data Validation Guidelines (November 2019), DoD Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (May 2020), analytical methods; laboratory SOPs	N/A	N/A

Note: [1] 100% of the PFAS data will be reviewed and verified at Stage 2B. In addition, 10% of the sample results will be validated at Stage 4.

The following data qualifiers will be applied during data validation according to DoD QSM 5.3. Potential impacts on project-specific data quality objectives will be discussed in the QC summary report. Only definitive data will be validated and uploaded to ERPIMS.

U - Undetected: The analyte was analyzed for, but not detected.

UJ - The analyte was not detected; however, the result is estimated due to discrepancies in meeting certain analyte-specific QC criteria.

J - Estimated: The analyte was positively identified; the quantitation is an estimation due to discrepancies in meeting certain analyte-specific QC criteria.

R - The data are rejected due to deficiencies in meeting QC criteria and may not be used for decision making.

B - Blank contamination: The analyte was found in an associated blank above one half the RL, as well as in the sample.

UB - The analyte was also detected in an associated laboratory or field blank at a concentration comparable to the concentration in the sample. The reported result has been requalified as not detected.

X - 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.

QAPP WORKSHEET #37: DATA USABILITY ASSESSMENT

(UFP-QAPP Manual Sections 5.2.3)
(USEPA 2106-G-05 Sections 2.5.2, 2.5.3, 2.5.4)

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Project Manager:	BEM Project Manager
Project QC Manager:	BEM QC Manager
Geologist/Hydrogeologist:	BEM Team Technical Leads
Project Chemist:	BEM Team Project Chemists
Data Validator:	Synectics (third-party)

The Data Usability Assessment will be performed by BEM for data associated with the USACE PFAS PA/SI Program. Documentation generated during the Data Usability Assessment will consist of a Data Usability Summary Report in accordance with the USACE Engineer Manual 200-1-10 and a statement of overall data usability.

After analytical data has been reviewed, verified, and validated in accordance with the procedures described in **Worksheets #34** and **#35**, the data must be further evaluated to determine if the DQOs have been met. Documentation generated during the Data Usability Assessment will consist of data validation checklists with a brief summary of overall data usability. Only definitive analytical data will be validated and uploaded to ERPIMS. The verification process for screening data is described in Worksheet #17.

The DQIs used to evaluate conformance with the project DQOs are presented below.

DQIs are generally defined in terms of six parameters:

1. representativeness
2. comparability
3. completeness
4. precision
5. accuracy
6. sensitivity

Each parameter is defined below. Specific objectives for the site actions are presented in other sections of the QAPP addenda.

Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions and is dependent on sampling and analytical variability and the variability of environmental media at the site. Actions have been designed to assess the presence of chemical constituents at the time of sampling. The QAPP presents the rationale for sample quantities and location. This QAPP presents field sampling and laboratory analytical methodologies. Use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data.

Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between phases of the actions (if additional phases are required) will be maintained through consistent use of the sampling and analytical methodologies set forth in this QAPP, established QA/QC procedures, and the use of appropriately trained personnel.

Completeness

Completeness will be determined for Field Sampling and Analytical. Field sampling completeness is defined as the measure of the quantity of samples collected compared to the quantity of samples that were planned to be collected. Field sampling completeness will be calculated as:

$$\text{Field Completeness} = \frac{\text{Number of samples collected}}{\text{Total number of samples planned for collection}} \times 100$$

The field sampling completeness goal for each installation is 100%.

Analytical completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results. Completeness of a laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$\text{Completeness} = \frac{\text{Number valid results}}{\text{Total number of results generated}} \times 100$$

As a general guideline, the analytical completeness for each installation is expected to be at least 95%. The assessment of analytical completeness will require professional judgment to determine data usability for intended purposes.

Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the action. To maximize precision, sampling and analytical procedures will be followed. All work for the site actions will adhere to established protocols presented in this QAPP. Checks for analytical precision will include the analysis of matrix spike/ MSDs, laboratory duplicates, and field duplicates.

The precision of data will be measured by calculating the RPD by the following equation:

$$RPD = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements.

B = Analytical result from the second measurement.

Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through the initial and continuing calibration of instruments. In addition, reference standards, matrix spikes, blank spikes, and surrogate standards will be used to assess the accuracy of the analytical data.

Accuracy will be calculated in terms of percent recovery as follows:

$$\% \text{ Recovery} = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard.

X = Value measured in the original sample.

B = True value of amount added to sample or true value of standard.

Sensitivity

Sensitivity is a quantitative measurement to determine if the analytical laboratory's procedures/methodologies and their associated detection limits can satisfy the project requirements. LODs are updated annually by the laboratory. The current LODs for the analytical laboratories are presented in **Worksheet #15**.

Field Data Review

Field data are generated from in-field measurement, which may include a geophysical survey, well development, and groundwater sampling. The quality objective for the in-field measurement activities is to obtain accurate measurements of sample characteristics, including aqueous pH, conductivity, temperature, turbidity, and dissolved oxygen, using appropriate equipment. Data are recorded in field logbooks or on field sampling sheets and calibration logs. Calibration logs will be reviewed by Field Team Leaders with other field documentation to identify any potential impacts to data quality and usability. Field logbooks are reviewed as part of the QC inspections.

Reconciliation with Data Usability Requirements

Data results will be examined to determine the performance that was achieved for each data usability criterion. The performance will then be compared with the project objectives and DQOs. Deviations from objectives will be noted. Data that have been rejected will not be used. Data that have been qualified but not rejected will be considered useable (i.e., qualified as estimated) and definitive data. If there is an instance where further limitations must be placed on qualified data, the data will be additionally qualified with "X." This would indicate that the associated data are non-definitive data and should be used for screening purposes only.

Additional action may be warranted when performance does not meet performance objectives for critical data. Options for corrective action relating to incomplete information, questionable results, or inconsistent data may include any or all of the following:

- retrieval of missing information
- request for additional explanation or clarification

- reanalysis of sample from extract (when appropriate)
- recalculation or reinterpretation of results by the laboratory

These actions may improve the data quality, reduce uncertainty, and eliminate the need to qualify or reject data. If these actions do not improve the data quality to an acceptable level, the following additional actions may be taken:

- extrapolation of missing data from existing data points
- use of historical data
- evaluation of the critical/non-critical nature of the sample

If the data gap cannot be resolved by these actions, the data bias and potential for false negatives and positives can be evaluated. If the resultant uncertainty level is unacceptable, the following action must be taken:

- additional sample collection and analysis

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2066

2067 (Intentionally Left Blank)

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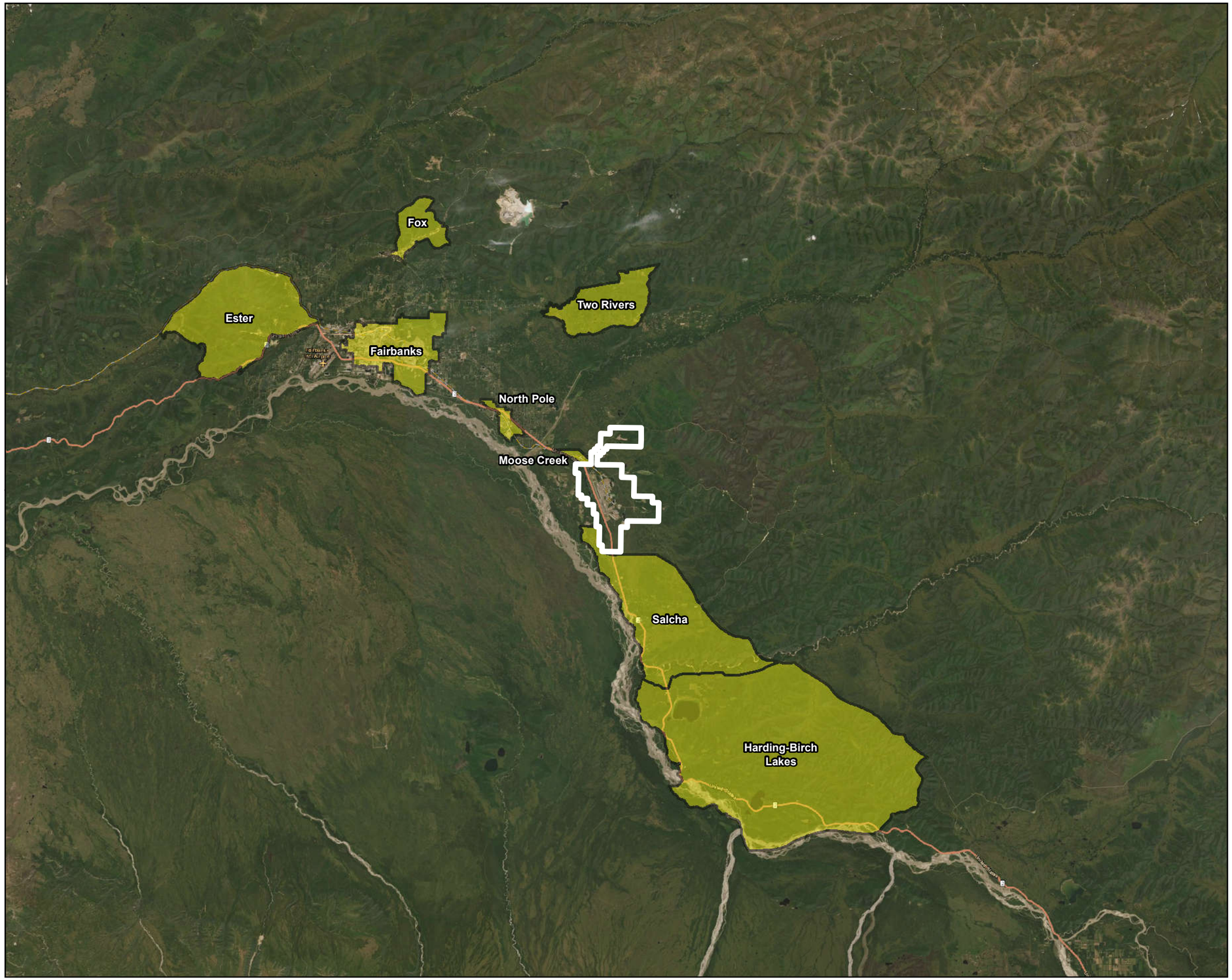
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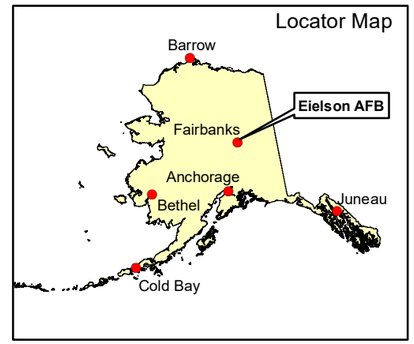
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Figures





Legend

- Eielson AFB Installation Boundary
- Cities and Places

Notes:
1. CIP Source: USAF (2020)
2. Cities, States, Roads: ESRI (2014)
3. Image Source: Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

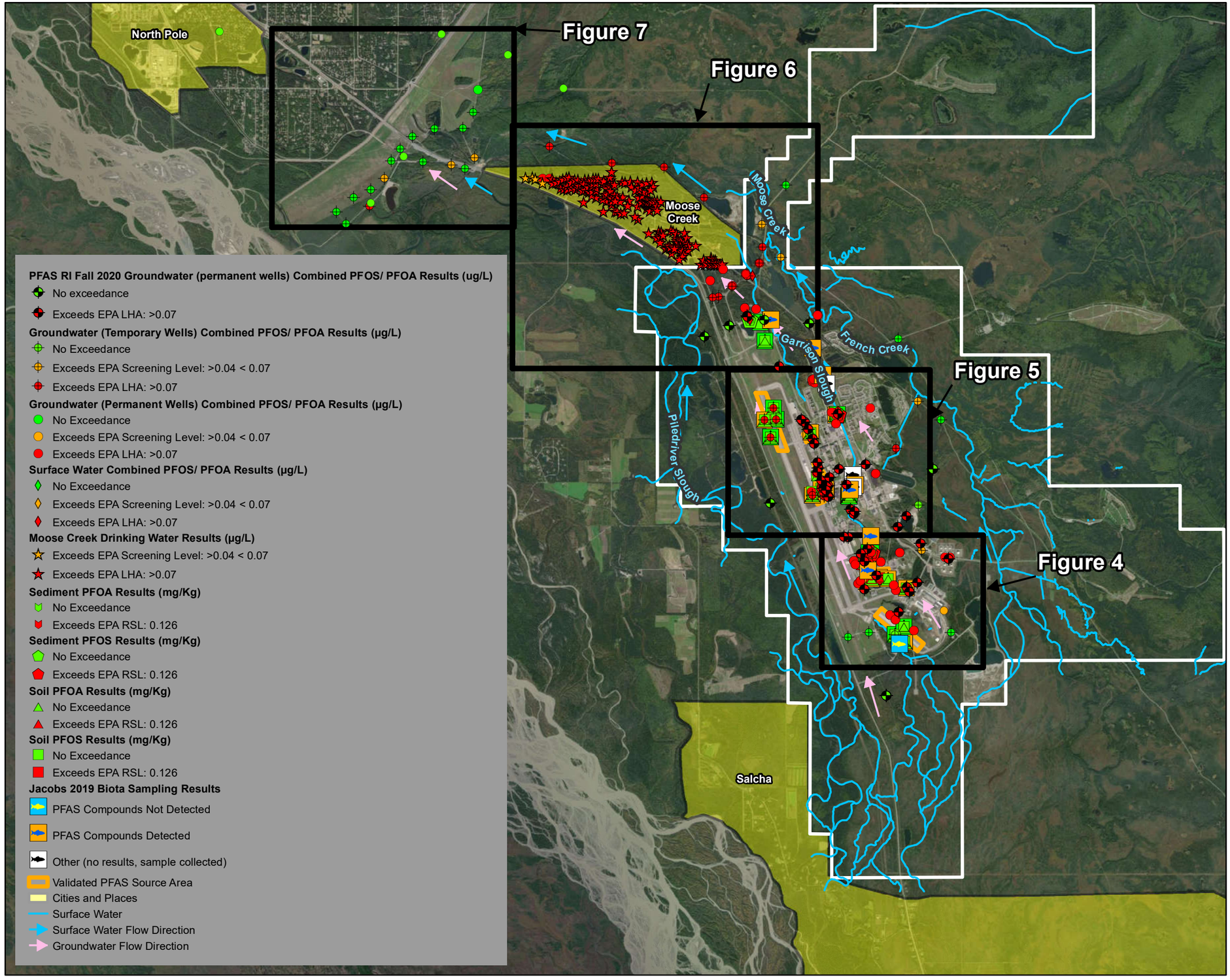
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Miles

Figure # 1

Site Location Map
Eielson AFB, Alaska

Drawn By:	Date:
AM	November 2020
Checked By:	Contract No.
LZ	FA890316D0041





RSL: Regional Screening Level
LHA: Lifetime Health Advisory
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
2019 Biota Analytical Data is Preliminary Data and has not been finalized at the time of this report
Fall 2020 Groundwater Monitoring analytical is preliminary and has not been validated. The Final QAPP will include final analytical data.
All Fall 2020 preliminary analytical results indicate combined PFOS/PFOA either greater than 0.07 ug/L or less than 0.04 ug/L.

N

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

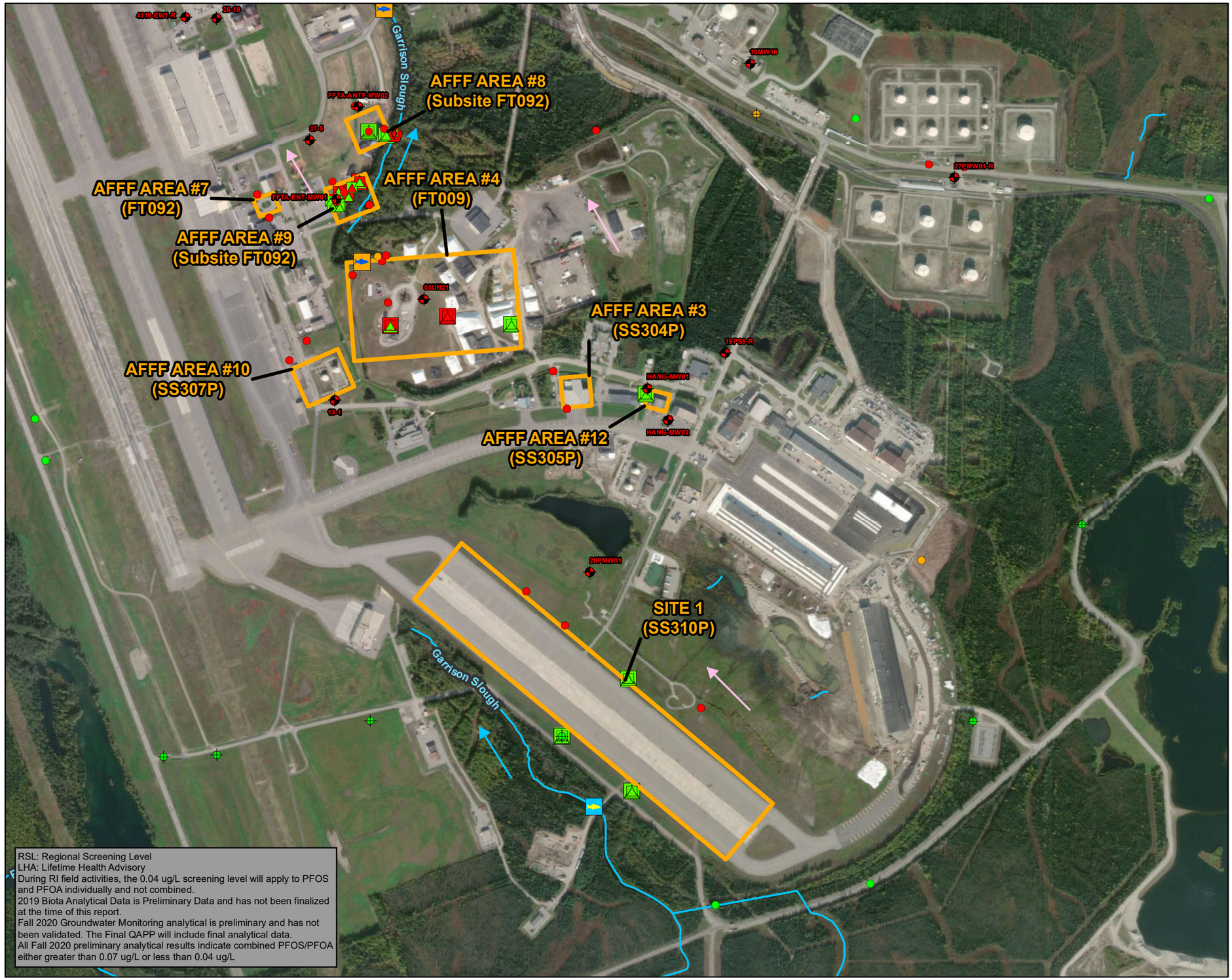
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Figure # 3

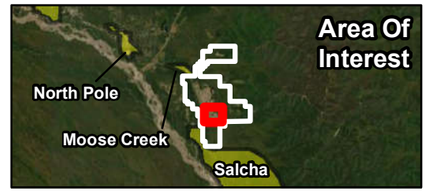
Previous Sample Locations and Results Key Map

Eielson AFB, Alaska

Drawn By:	Date:
AM	January 2021
Checked By:	Contract No.
LZ	FA890316D0041



RSL: Regional Screening Level
LHA: Lifetime Health Advisory
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All Fall 2020 preliminary analytical results indicate combined PFOS/PFOA either greater than 0.07 ug/L or less than 0.04 ug/L



PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)
- Exceeds EPA LHA: >0.07

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA Screening Level: >0.04 < 0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Surface Water Combined PFOS/ PFOA Results (µg/L)
- Exceeds EPA LHA: >0.07

Sediment PFOA Results (mg/Kg)
- No Exceedance

Sediment PFOS Results (mg/Kg)
- Exceeds EPA RSL: 0.126

Soil PFOA Results (mg/Kg)
- No Exceedance
- Exceeds EPA RSL: 0.126

Soil PFOS Results (mg/Kg)
- No Exceedance
- Exceeds EPA RSL: 0.126

Jacobs 2019 Biota Sampling Results
- PFAS Compounds Not Detected
- PFAS Compounds Detected
- Groundwatrer Flow Direction
- Surface Water Flow Direction
- Surface Water
- Validated PFAS Source Area

N

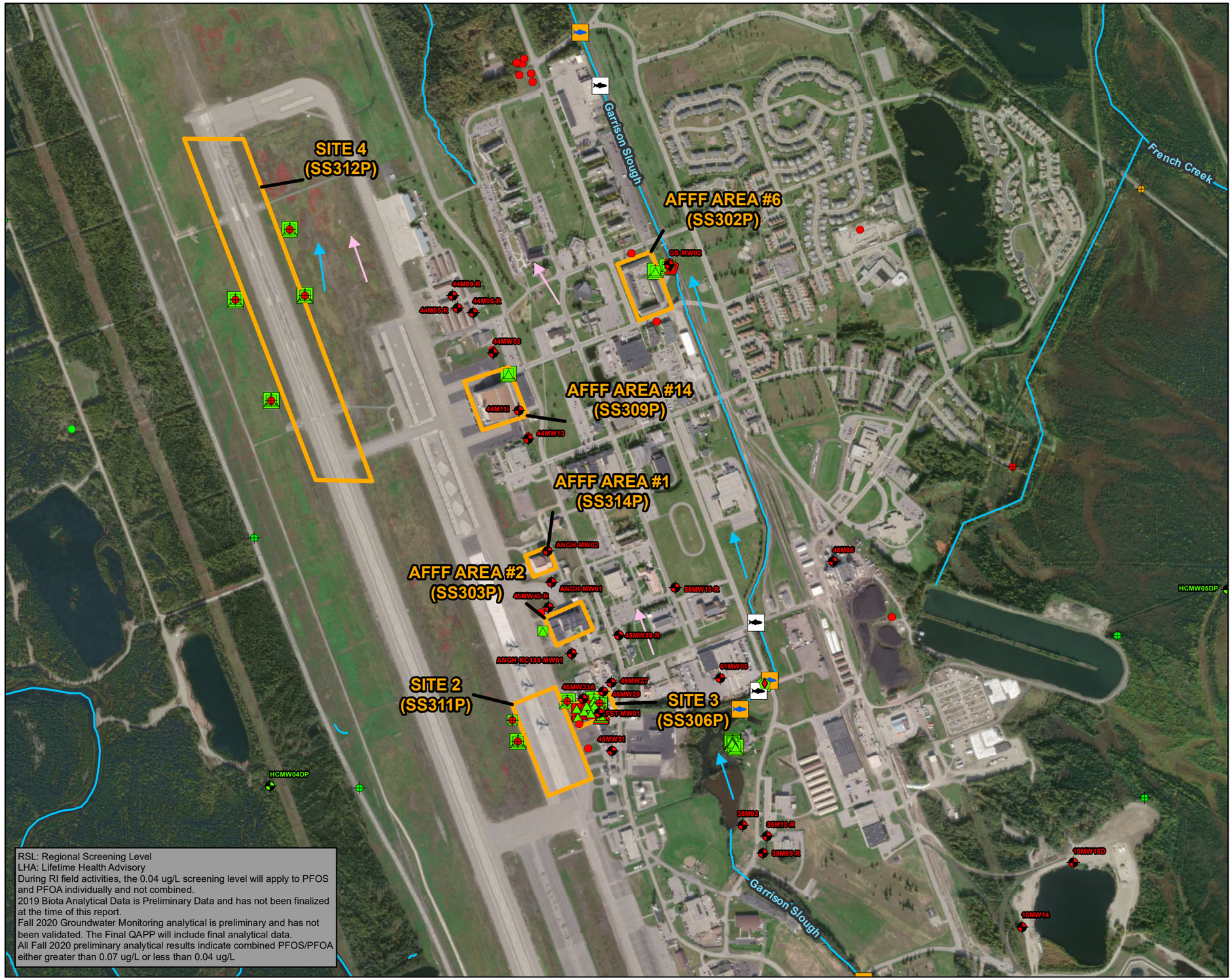
Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 800 1,600 Feet

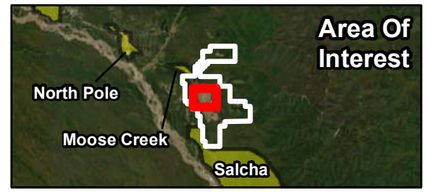
Figure # 4

Previous Sample Locations and Results South
Eielson AFB, Alaska

Drawn By:	Date:
AM	January 2021
Checked By:	Contract No.
LZ	FA890316D0041



RSL: Regional Screening Level
LHA: Lifetime Health Advisory
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
2019 Biota Analytical Data is Preliminary Data and has not been finalized at the time of this report.
Fall 2020 Groundwater Monitoring analytical is preliminary and has not been validated. The Final QAPP will include final analytical data.
All Fall 2020 preliminary analytical results indicate combined PFOS/PFOA either greater than 0.07 ug/L or less than 0.04 ug/L



PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)
- No exceedance
- Exceeds EPA LHA: >0.07

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA LHA: >0.07

Surface Water Combined PFOS/ PFOA Results (µg/L)
- Exceeds EPA LHA: >0.07

Sediment PFOA Results (mg/Kg)
- No Exceedance

Sediment PFOS Results (mg/Kg)
- No Exceedance
- Exceeds EPA RSL: 0.126

Soil PFOA Results (mg/Kg)
- No Exceedance
- Exceeds EPA RSL: 0.126

Soil PFOS Results (mg/Kg)
- No Exceedance
- Exceeds EPA RSL: 0.126

Jacobs 2019 Biota Sampling Results
- PFAS Compounds Detected
- Other (no results, sample collected)

- Groundwatrer Flow Direction
- Surface Water Flow Direction
- Surface Water
- Validated PFAS Source Area

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

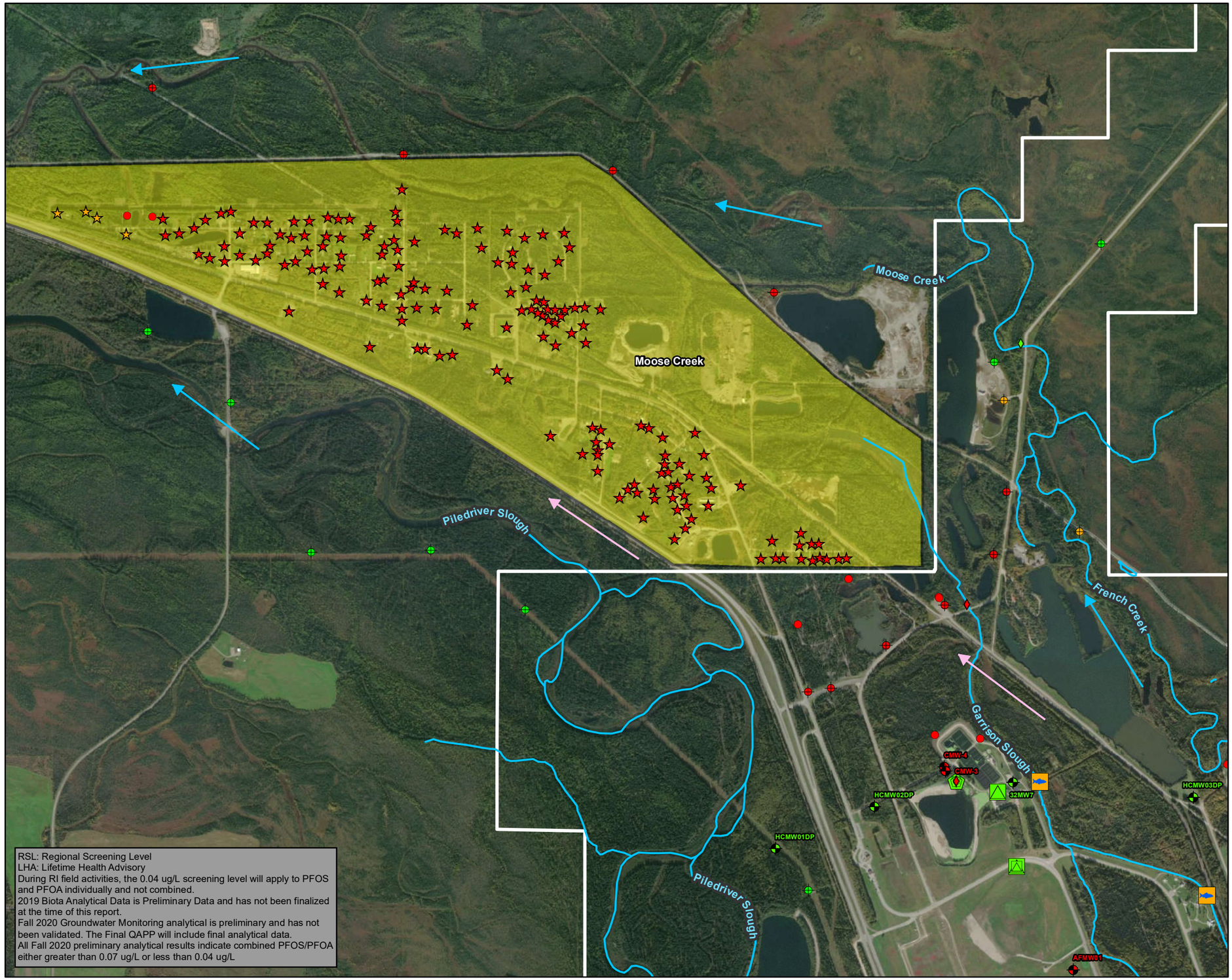
N

0 1,000 2,000 Feet

Figure # 5

Previous Sample Locations and Results North
Eielson AFB, Alaska

Drawn By:	Date:
AM	January 2021
Checked By:	Contract No.
LZ	FA890316D0041



RSL: Regional Screening Level
LHA: Lifetime Health Advisory
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
2019 Biota Analytical Data is Preliminary Data and has not been finalized at the time of this report.
Fall 2020 Groundwater Monitoring analytical is preliminary and has not been validated. The Final QAPP will include final analytical data.
All Fall 2020 preliminary analytical results indicate combined PFOS/PFOA either greater than 0.07 ug/L or less than 0.04 ug/L



PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)
- No exceedance
- Exceeds EPA LHA: >0.07

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)
- Exceeds EPA LHA: >0.07

Surface Water Combined PFOS/ PFOA Results (µg/L)
- No Exceedance
- Exceeds EPA LHA: >0.07

Sediment PFOA Results (mg/Kg)
- No Exceedance

Sediment PFOS Results (mg/Kg)
- No Exceedance

Soil PFOA Results (mg/Kg)
- No Exceedance

Soil PFOS Results (mg/Kg)
- No Exceedance

Moose Creek Drinking Water Results (µg/L)
- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Jacobs 2019 Biota Sampling Results
- PFAS Compounds Detected
- Groundwatrer Flow Direction
- Surface Water Flow Direction
- Surface Water
- Cities and Places

N

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 1,500 3,000 Feet

Figure # 6

Previous Sample Locations and Results
Moose Creek
Eielson AFB, Alaska

Drawn By:	Date:
AM	January 2021
Checked By:	Contract No.
LZ	FA890316D0041





Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)

- No Exceedance
- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)

- No Exceedance
- Groundwatrer Flow Direction
- Surface Water Flow Direction
- Cities and Places

RSL: Regional Screening Level
LHA: Lifetime Health Advisory
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
2019 Biota Analytical Data is Preliminary Data and has not been finalized at the time of this report.
Fall 2020 Groundwater Monitoring analytical is preliminary and has not been validated. The Final QAPP will include final analytical data.
All Fall 2020 preliminary analytical results indicate combined PFOS/PFOA either greater than 0.07 ug/L or less than 0.04 ug/L

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

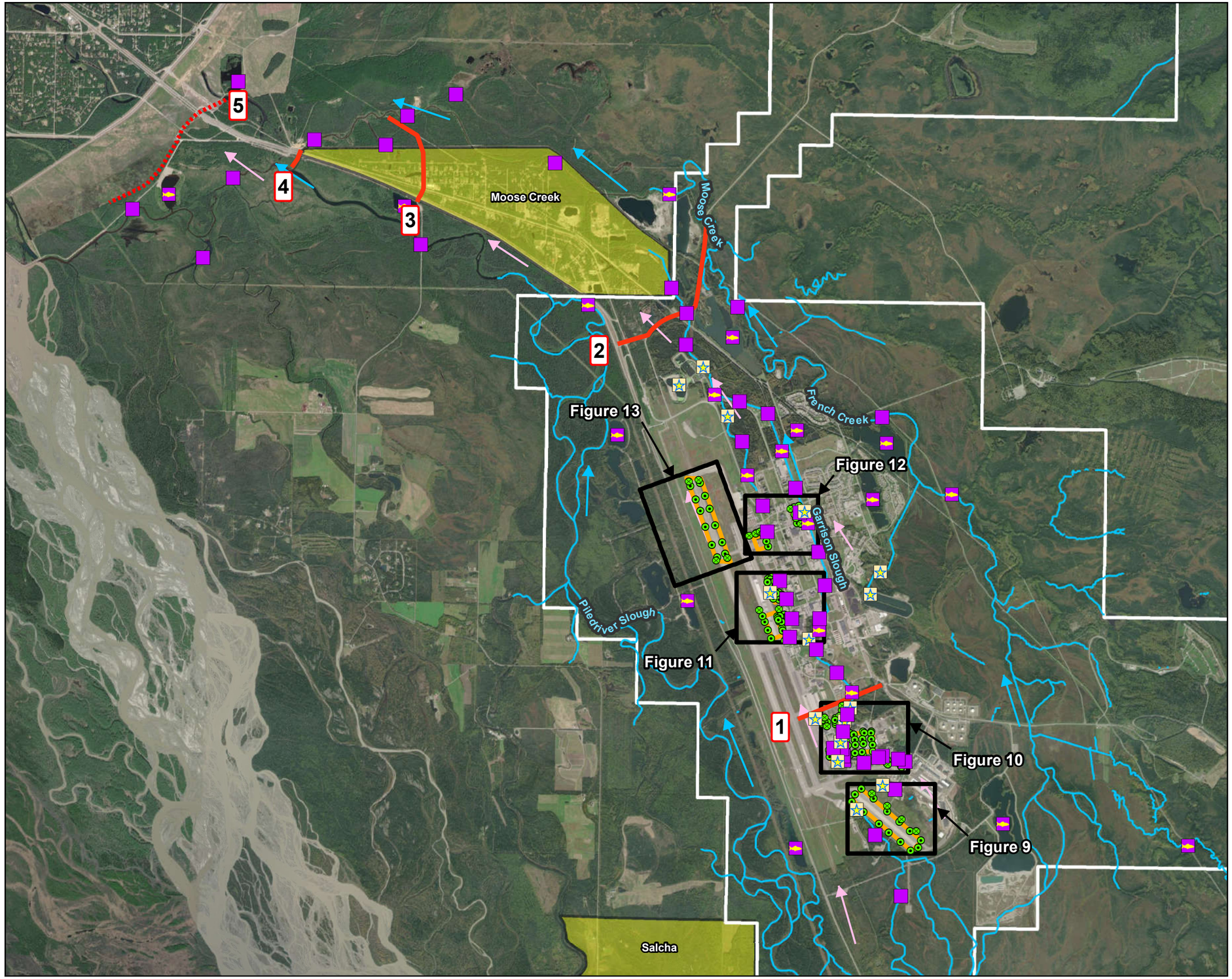
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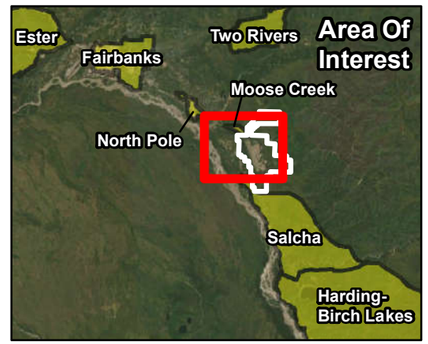
0 1,200 2,400 Feet

Figure # 7

Previous Sample Locations and Results Downgradient of Moose Creek
Eielson AFB, Alaska

Drawn By:	Date:
AM	January 2021
Checked By:	Contract No.
LZ	FA890316D0041





Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Fish Tissue
- Surface Water / Sediment / Pore Water
- VAP Transect
- VAP Transect (tentative location*)
- Validated PFAS Source Area
- Installation Boundary
- Cities and Places
- Surface Water
- Surface Water Flow Direction
- Groundwater Flow Direction

During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.
* Transect 5 final location will be selected after review of the Expanded SI Phase 4 analytical data.

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

0 2,100 4,200 8,400 Feet

Figure # 8

Proposed Sample Locations
Key Map
Eielson AFB, Alaska

Drawn By:	Date:
AM	November 2020
Checked By:	Contract No.
LZ	FA890316D0041



Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Pore Water

Previous Sample Results

PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)

- Exceeds EPA LHA: >0.07

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)

- Result < EPA screening level: 0.04

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Soil PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13

Soil PFOS Results (mg/Kg)

- Result < EPA RSL: 0.13

Jacobs 2019 Biota Sampling Results

- PFAS Compounds Not Detected
- Surface Water
- Surface Water Flow Direction
- Groundwatrer Flow Direction
- Building^
- Validated PFAS Source Area

Refer to Figure 8 for the Key Map.
^ building number is shown.
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Fairbanks North Star Borough: (2020)

N

0 150 300 600
Feet

Figure # 9

Site SS310P Proposed Sample Locations
Eielson AFB, Alaska

Drawn By:	Date:
AM	April 2021
Checked By:	Contract No.
LZ	FA890316D0041

AFFF AREA #8
(Subsite FT092)

AFFF AREA #9
(Subsite FT092)

AFFF AREA #7
(FT092)

AFFF AREA #4
(FT009)

AFFF AREA #3
(SS304P)

AFFF AREA #10
(SS307P)

AFFF AREA #12
(SS305P)

FLIGHTLINE AVENUE

LIGHTNING STREET

POWDER STREET

THUNDERBOLT ROAD

CHENA STREET

LOOP ACCESS ROAD

FLIGHTLINE ACCESS

CARGOAIR ROAD

Garrison Slough

4304 4308 4361 4362 4360 4336 4335 4370 4371 4375 4377 4386 4387 4327 4328 1245 1246 1347 1348 1352 1353 1346 1344 1340 1341 1315

Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Pore Water

Previous Sample Results

PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)

- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA Screening Level: >0.04 < 0.07
- Exceeds EPA LHA: >0.07

Surface Water Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Sediment PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13

Sediment PFOS Results (mg/Kg)

- Exceeds EPA RSL: 0.13

Soil PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13
- Exceeds EPA RSL: 0.13

Soil PFOS Results (mg/Kg)

- Result < EPA RSL: 0.13
- Exceeds EPA RSL: 0.13

Jacobs 2019 Biota Sampling Results

- PFAS Compounds Detected
- Surface Water
- Surface Water Flow Direction
- Groundwatrer Flow Direction
- Building^
- Validated PFAS Source Area

Refer to Figure 8 for the Key Map.
^ building number is shown.
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.

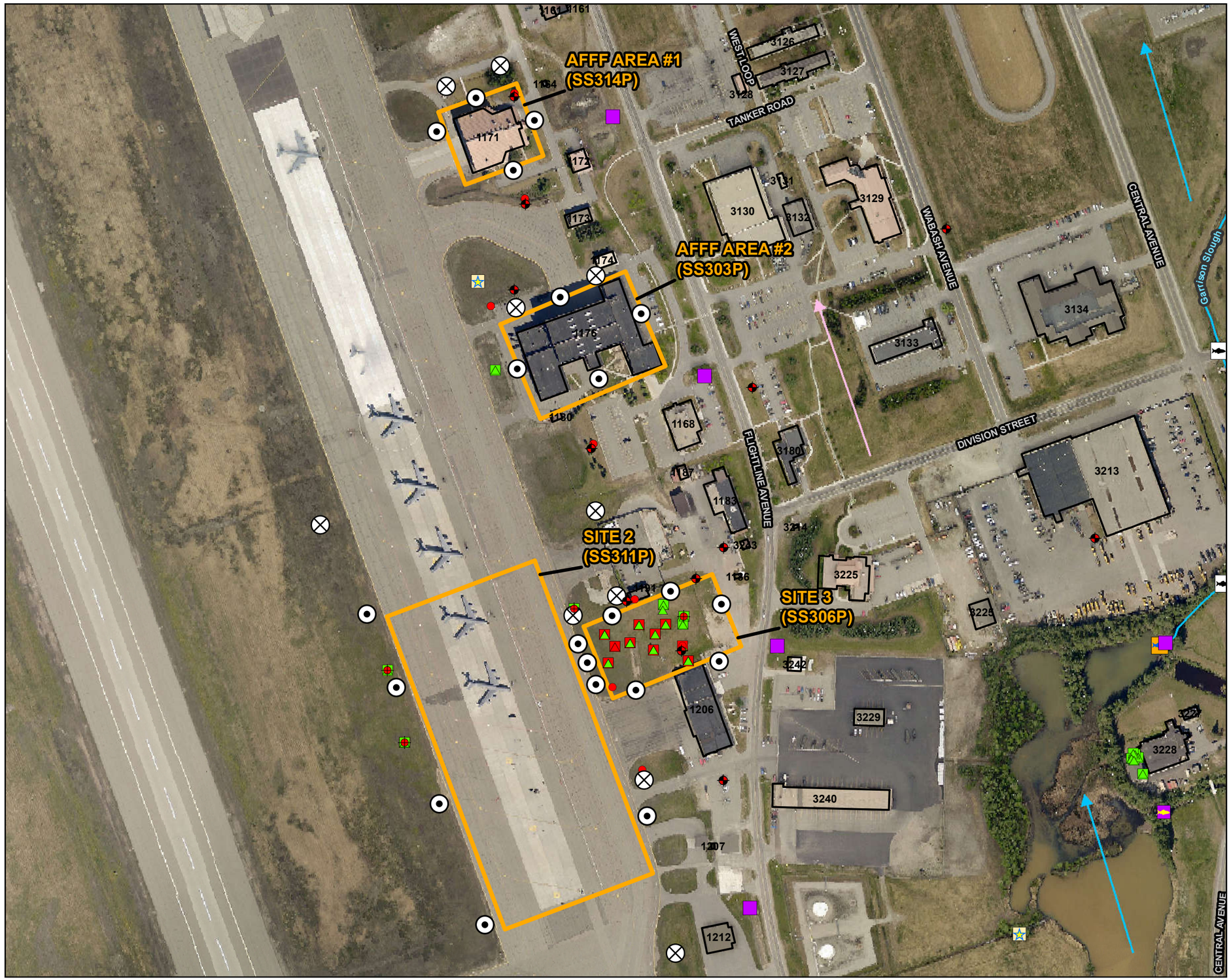
Notes:
1. CIP Source: USAF (2020)
2. Imagery: Fairbanks North Star Borough: (2020)

0 150 300 600 Feet

Figure # 10

Sites SS304P, SS305P, SS307P, FT009, and FT092 Proposed Sample Locations
Eielson AFB, Alaska

Drawn By:	Date:
AM	April 2021
Checked By:	Contract No.
LZ	FA890316D0041



Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Fish Tissue
- Surface Water / Sediment / Pore Water

Previous Sample Results

PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)

- Exceeds EPA LHA: >0.07

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Soil PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13
- Exceeds EPA RSL: 0.13

Soil PFOS Results (mg/Kg)

- Result < EPA RSL: 0.13
- Exceeds EPA RSL: 0.13

Jacobs 2019 Biota Sampling Results

- PFAS Compounds Detected
- Other (no results, sample collected)
- Surface Water
- Surface Water Flow Direction
- Groundwatrer Flow Direction
- Building^
- Validated PFAS Source Area

Refer to Figure 8 for the Key Map.
^ building number is shown.
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Fairbanks North Star Borough: (2020)

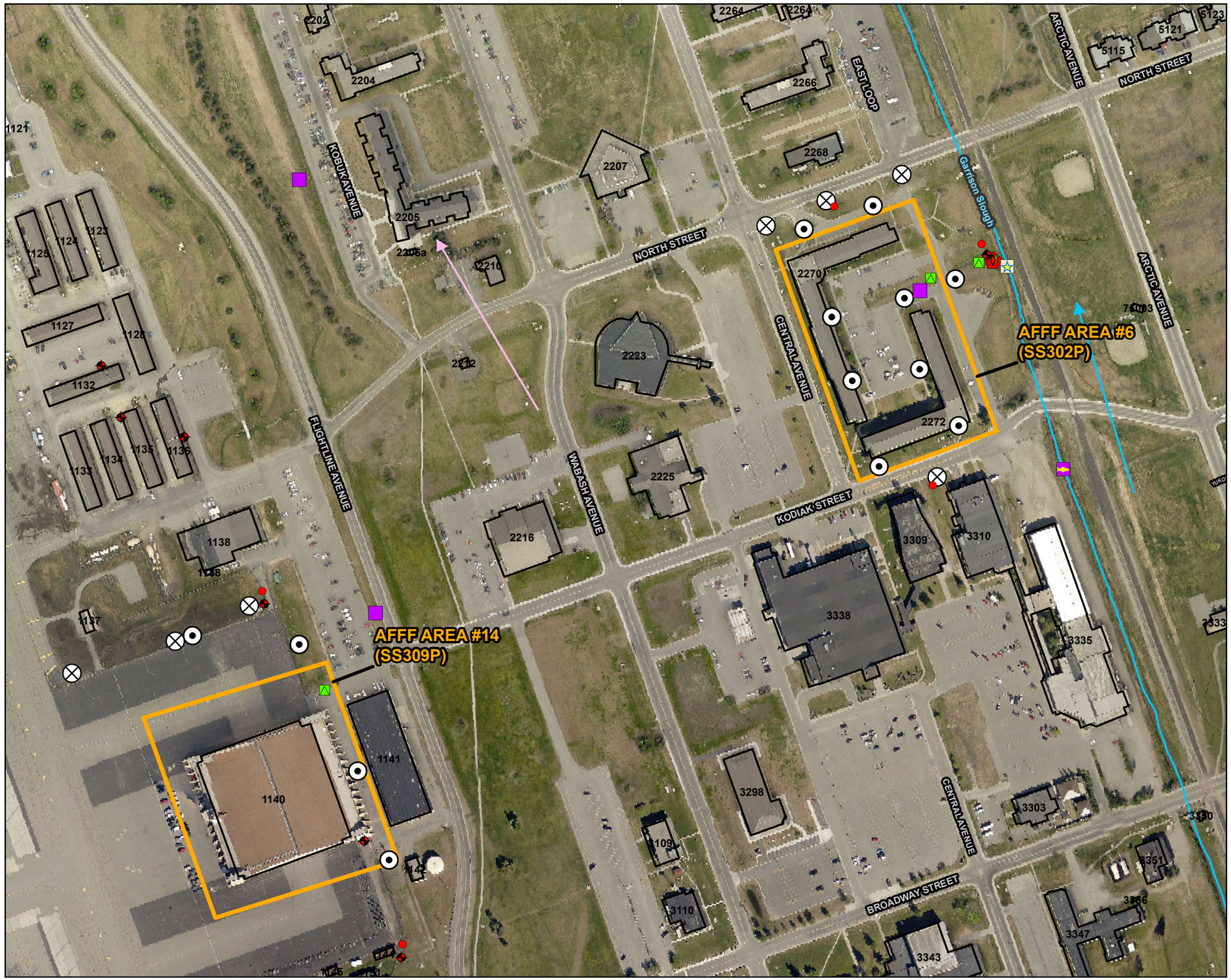
N

0 150 300 600
Feet

Figure # 11

Sites SS303P, SS306P, SS311P, and SS314P Proposed Sample Locations
Eielson AFB, Alaska

Drawn By:	Date:
AM	April 2021
Checked By:	Contract No.
LZ	FA890316D0041



Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Fish Tissue
- Surface Water / Sediment / Pore Water

Previous Sample Results

PFAS RI Fall 2020 Groundwater (permanent wells) Combined PFOS/ PFOA Results (ug/L)

- Exceeds EPA LHA: >0.07

Groundwater (Permanent Wells) Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Surface Water Combined PFOS/ PFOA Results (µg/L)

- Exceeds EPA LHA: >0.07

Sediment PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13

Sediment PFOS Results (mg/Kg)

- Exceeds EPA RSL: 0.13

Soil PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13

Soil PFOS Results (mg/Kg)

- Result < EPA RSL: 0.13
- Surface Water
- Surface Water Flow Direction
- Groundwatrer Flow Direction
- Building^
- Validated PFAS Source Area

Refer to Figure 8 for the Key Map.
^ building number is shown.
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Fairbanks North Star Borough: (2020)

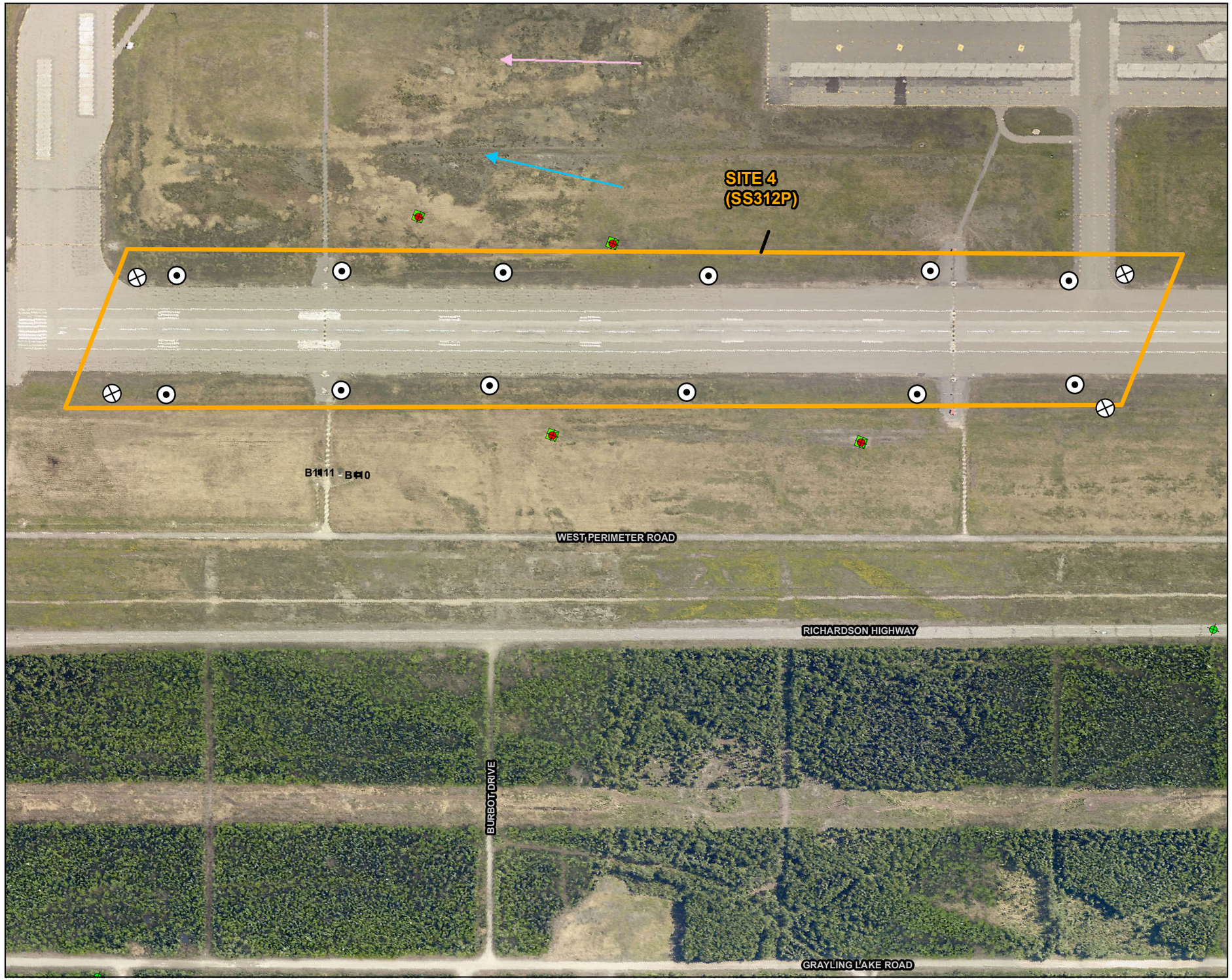
N

0 125 250 500 Feet

Figure # 12

SItes SS302P and SS309P Proposed Sample Locations
Eielson AFB, Alaska

Drawn By:	Date:
AM	April 2021
Checked By:	Contract No.
LZ	FA890316D0041



Legend

Proposed 2021 Sample Locations

- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft

Groundwater (Temporary Wells) Combined PFOS/ PFOA Results (µg/L)

- Result < EPA screening level: 0.04
- Exceeds EPA LHA: >0.07

Soil PFOA Results (mg/Kg)

- Result < EPA RSL: 0.13

Soil PFOS Results (mg/Kg)

- Result < EPA RSL: 0.13
- Surface Water Flow Direction
- Groundwatrer Flow Direction
- Building^
- Validated PFAS Source Area

Refer to Figure 8 for the Key Map.
^ building number is shown.
During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.

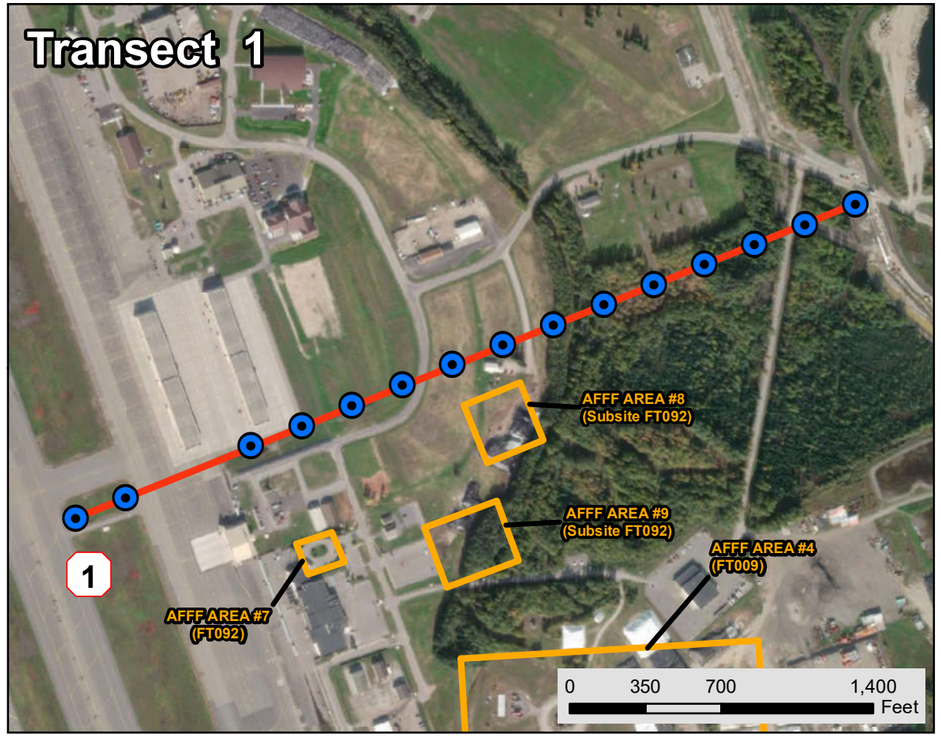
Notes:
1. CIP Source: USAF (2020)
2. Imagery: Fairbanks North Star Borough: (2020)

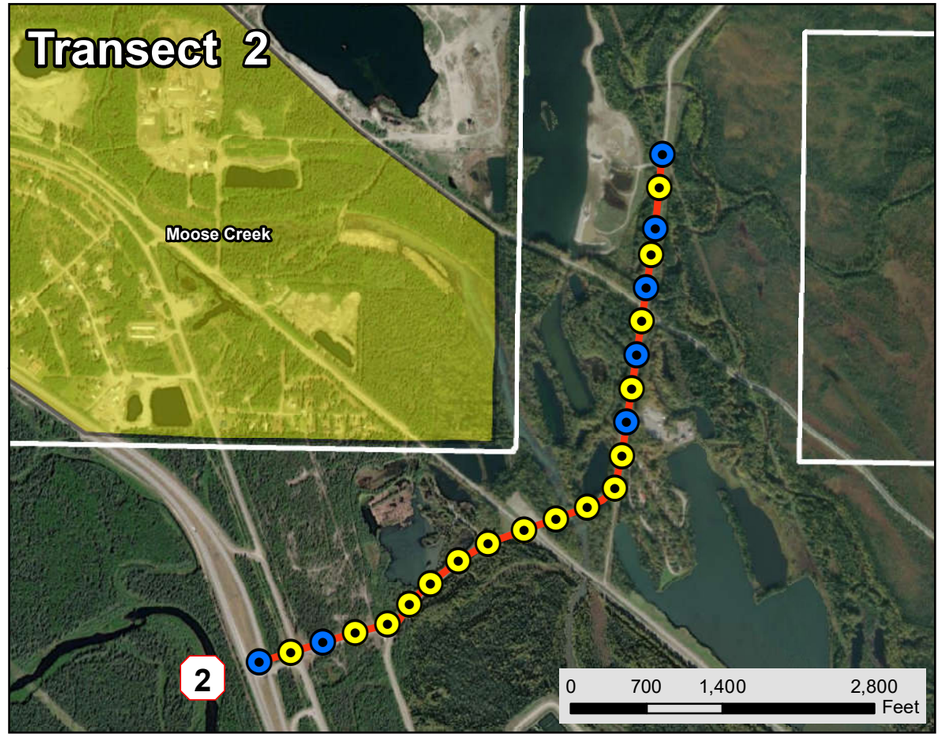
0 175 350 700 Feet

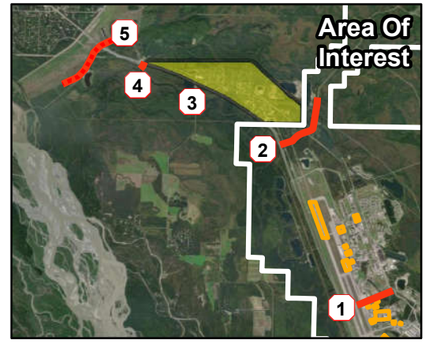
Figure # 13

Site SS312P Proposed Sample Locations
Eielson AFB, Alaska

Drawn By:	Date:
AM	April 2021
Checked By:	Contract No.
LZ	FA890316D0041



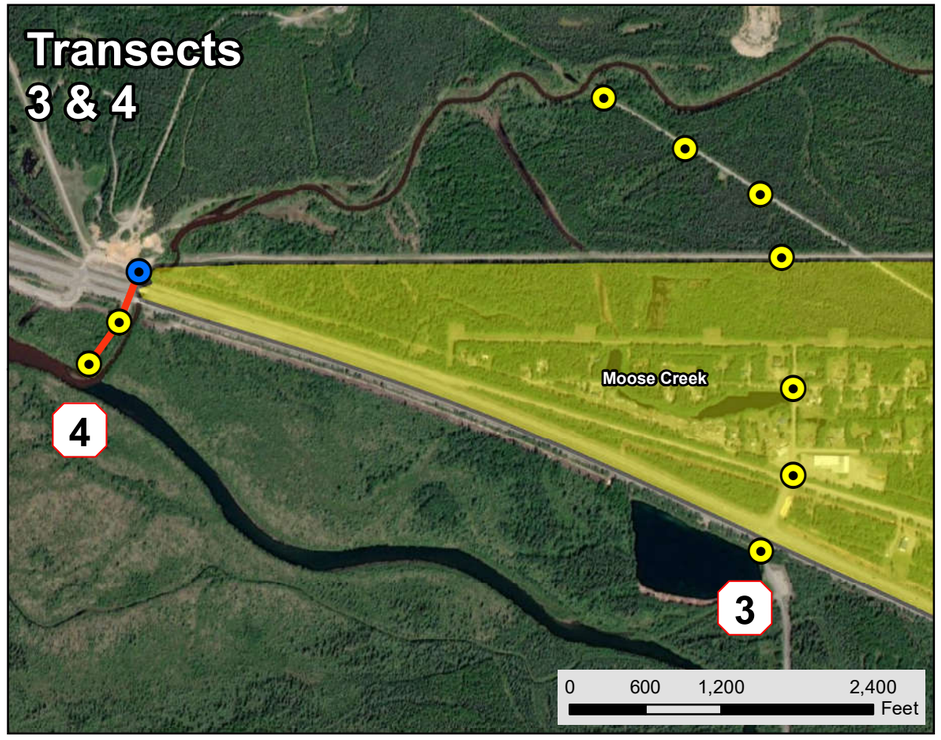


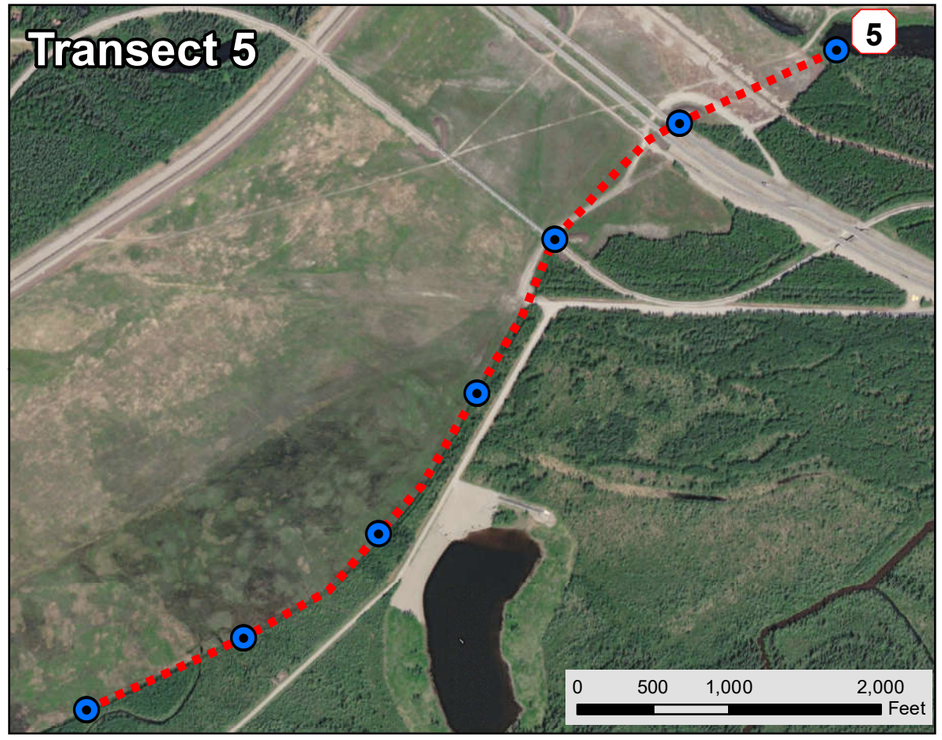


Legend

Transect VAP Boring

- 100-ft
- 150-ft
- VAP Transect
- VAP Transect (tentative location*)
- Validated PFAS Source Area
- Installation Boundary





During RI field activities, the 0.04 ug/L screening level will apply to PFOS and PFOA individually and not combined.
All sample locations are contingent of site conditions at the time of the sampling. During the field event there may be changes to the sample locations.
* Transect 5 final location will be selected after review of the Expanded SI Phase 4 analytical data.

N

Notes:
1. CIP Source: USAF (2020)
2. Imagery: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure # 14

Proposed VAP Transects
Eielson AFB, Alaska

Drawn By:	Date:
AM	November 2020
Checked By:	Contract No.
LZ	FA890316D0041

Appendix A

Field Change Form

RI for PFAS at Various Sites at Eielson AFB, AK
Field Change Form

Project Name and Location	**Project/Task Order Number**	**Client Name**
Remedial Investigation (RI) for per- and polyfluoroalkyl substances (PFAS) at Various Sites at the Eielson Air Force Base (EAFB) in Fairbanks North Star Borough, Alaska.	Contract No. FA8903-016-D-0041, Task Order No. FA8903-20-F-1108	AFCEC
Date prepared	Three Party Site	**Prepared by**

Title and version of work plan

FINAL Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base, Alaska.

Reason for action

Existing plan or procedure

Proposed change

Internal Review

Check appropriate box and forward as necessary per project communication pathways:

- ☐ Internal Change: Proceed with Change, in-scope and within approved budget, PM will forward cost estimate to project controls
- ☐ Technical Change: PM to initiate discussion with stakeholders per project communication pathways for approval or concurrence
- ☐ External Scope Change: PM to submit to client's Contracting Officer for approval, coordinate with contracts administrator
- ☐ Rejected: take no further action

Project Manager:_____ **Date:**_____

External Review

Installation Remedial Project Manager: Date:

ADEC Remedial Project Manager: Date:

EPA Remedial Project Manager: Date:

Appendix B

Field SOPs/TGIs

ENV Quality Procedure - SOP #P-01	
TOPIC: **FIELD ACTIVITIES DOCUMENTATION**	
Revision Date: November 2016 **Revision Letter: C**	**QP#: 3.06**

STATEMENT OF POLICY:

It is Arcadis Environment Business Line (ENV) policy that field activities must be documented to facilitate the interpretation of data; show compliance with project plans, work plans, and contract terms; and to serve as evidentiary records. Documentation reflecting activities performed must be legible, organized, and complete. Applicable regulatory and client requirements should be considered when documenting field activities. Project-specific requirements for documentation typically should be described in the Work Plan, Field Sampling Plan (FSP), and/or in the Quality Assurance Project Plan (QAPP).

1. Purpose

The purpose of this Quality Procedure (QP) is to provide a standard procedure for the documentation of fieldwork activities. This documentation pertains to site-related projects, but is not limited to the collection of samples, subsurface information, and oversight of construction activities. Field documentation must include, at a minimum, project title and number, date and times of activities, the identification of the employee performing the work, and the specifics of the work being performed.

2. Responsibilities

Certified Project Manager (CPM) – is responsible for the project-related administration of this QP.

Quality Consultant – is responsible for providing quality assurance and quality control guidance to the CPM in implementing this procedure. Note that for federal projects, there are specific requirements and qualifications for the QA Officer assigned to the project.

Project Team Members – who are assigned to document field activities, are responsible for compliance with this procedure.

3. Terms and Definitions

Field Sampling Plan (FSP) – A document that describes the procedures and protocols necessary to complete field sampling and data collection activities.

Work Plan – A document that describes proposed project activities.

Quality Assurance Project Plan (QAPP) – A document that prescribes the quality assurance/quality control (QA/QC) procedures to be followed. Uniform Federal Policy (UFP) QAPPs are now frequently required for environmental projects by most federal regulatory agencies. A UFP QAPP includes Worksheets used to document the entire project plan developed following the systematic planning process. For more details on the UFP QAPP see http://www.epa.gov/fedfac/documents/qualityassurance.htm. Note that if the project QAPP is written following the UFP format, it will also contain a description of the sampling rationale and sampling locations

Printed copies of this procedure are uncontrolled.

as well as QA/QC requirements. The UFP QAPP format is designed to capture the entire systematic planning process. If a UFP QAPP is written for a project, a separate FSP is generally not required unless specified by the particular client or contract.

Standard Operating Procedure (SOP) and Technical Guidance Instruction (TGI) – Documents that describe a procedure and or protocol necessary to conduct a specific activity.

4. Related Forms

Forms used for documenting field activities may be included as attachments to the FSP or the QAPP and may include the following examples:

- Chain-of-custody (COC) form
- Sample data log
- Field modification form
- Sample receipt form
- Corrective action form
- Field activity log
- Calibration log
- Analysis request and chain-of-custody record
- Daily quality control reports
- Purge log
- Soil boring log.

Examples of SOPs and TGIs with field forms and check-lists can be found in the Arcadis Procedure Library at: https://arcadiso365.sharepoint.com/TEAMS/US_envsoplibrary/SitePages/Home.aspx.

DESCRIPTION OF PROCEDURE:

1. General Requirements

1.1 Documentation Format

Documentation of field activities provides an accurate and comprehensive record of the work performed sufficient for a technical peer to reconstruct the day's activities and confirm that necessary client, regulatory, contract, and work plan requirements were met. General requirements include:

- Use of field books (preferably bound) as the primary source for information collection and recording. Field books should be dedicated to the project and appropriately labeled.
- Use of personal digital assistant (PDA) to document select field sampling and data collection activities using Arcadis' electronic data gathering system (EDGE); examples include subsurface data, well/piezometer

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installation, groundwater sampling, and water-level measurements. Use of PDAs with EDGE is optional but encouraged.

- Use of a Field Activity Log is suggested to formally document activities and events as a supplement to bound field books. The Field Activity Log can be a standard or project-specific form or a bound field book. Preprinted standard forms are available for many activities and should be used whenever possible. These forms will provide prompts and request additional information that may be useful and/or needed. Project-specific field forms may be generated or existing forms may be modified to meet specific project needs. Client-supplied forms may be substituted, as required.
- Appropriate header information is documented on the first page of notes for each day of fieldwork, including project title, project number, date, time, author, and relevant setting information such as weather conditions, topography, surface water conditions, observed site activities/uses, and other persons in field team. In addition, include on every page of notes the page number and date. Project-specific information depends on the nature of work being performed and should be discussed by the project team prior to commencing fieldwork. As appropriate, dedicated field logs/journals or forms should be used. When Field Activity Log Forms are used, information fields that are not applicable should be noted as such with the symbol "N/A" or other appropriate notation.
- Field documentation entries shall be made using indelible ink.
- Data entries shall be legible. A single line should be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Units of measurement shall be specified. The level of accuracy shall be indicated (e.g., observed estimate, quantified census from direct count, and electronic data collection).
- Field records are to be maintained in project files unless otherwise specified by a client or stipulated by a contract.
- Unless addressed specifically by a client or stipulated by a contract, site photographs should be taken to document the general setting and landscape as well as site-specific issues/resources of interest. Photo locations and the compass direction of view should be recorded in the notes with the photo number.

1.2 Documentation Entries

A chronology of field events should be recorded. General entry requirements include:

- Visitors to the site, including owner and regulatory agency representatives
- Summary of pertinent project communications with the client, regulators, or other site visitors during the fieldwork
- Other contractors or entities working on site
- A description of the day's field activities, generally in chronological sequence or in order of significance, using military time notation (e.g., 9:00 a.m. as 0900, and 5:00 p.m. as 1700)
- If applicable, calibration of measuring and test equipment and identification of the calibration standard(s) (use a Calibration Log, if available, with cross-reference entered into the field book)
- Field equipment identification, including information such as the type, manufacturer, model number, or other specific information

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- If applicable sampling activities are being performed, weather information such as temperature, wind speed and direction, precipitation, time of measurement, and units
- Documentation of safety meeting (e.g., tailgates and tailboards) topics and attendees
- Verification of subsurface utility clearance in accordance with ENV ivision policy
- Safety and/or monitoring equipment readings, including time of measurements and units
- If applicable, specific forms used for collection of data are referenced in the field notebook
- Subcontractor progress and/or problems encountered
- Changes in the scope of work
- Other unusual events.

2. Specific Requirements

2.1 Sample Collection

Sample collection data are documented in a bound field book, PDA, and/or on a Field Activity Log. Where both are being used, information contained in one is cross-referenced to the other. Entries such as the following examples should be consistent with the requirements in the project-specific Work Plan, FSP, and QAPP:

- Sample identification number, location taken, depth interval, sample media, sample preservative, collection time, and date
- Sample collection method and protocol
- Physical description of the sample (using a standard classification system for soil)
- If a composite sample, include the number, location(s), and depth(s) of grab samples incorporated in the composite
- Quality-related samples (e.g., field duplicates, trip blanks, equipment rinse, blanks matrix spikes, and matrix spike duplicates)
- Container description and sample volume
- Pertinent technical data, such as pH, conductivity, temperature, and head-space readings
- Pertinent technical comments
- Identification of personnel collecting the sample.

2.2 Sample Labeling

Sample labels must be prepared and attached to sample containers. Labels are either provided by the laboratory performing the analyses or are generated internally. Labels should be indelible and securely attached to the container. The information to be provided may include:

- Sample identification number
- Sample date, initials or name of who collected the sample, and collection time
- Physical description of the sample (e.g., water, solid, gas, or other physical medium)
- Analytical parameters and method(s)

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- Preservatives, if present
- Sample location and depth, if applicable
- Client.

Although this information is typically written out, it can also be recorded in an electronic tracking system if a bar code is used.

2.3 Analysis Request and Chain-of-Custody Record

A critical component of data collection is the documentation that the samples were obtained from specific locations and received by the laboratory or archive without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal or archive must be properly documented. Documentation will be accomplished through a COC record that documents each sample and identifies the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if at least one of the following criteria is met:

- The sample is in a person's actual possession
- The sample is in unobstructed view, after being in the person's actual possession
- The sample is locked and only accessible by the custodian after having been in the person's actual possession
- The sample is in a secured area, restricted to authorized personnel (e.g., laboratory).

An example COC form to be used by ENV personnel in collecting and shipping samples can be found on the corporate Intranet. A laboratory typically will not accept samples for analysis without a correctly prepared COC form. The COC must be signed by each individual who has the sample in his/her custody. Each sample shipped to a laboratory for analyses must be documented on the COC. Information on this form correlates with other supporting documentation, including the field log book, sample labels, and sample collection logs.

The COC documents the elapsed time and the custodians of the sample from the time of its collection. The individuals who have physically handled the sample(s) or witnessed initial sample collection and packaging (sample team member) must be identified on the form. A sample team member relinquishes the sample by signing the COC. Individuals who either relinquish or receive samples must include their complete names, company affiliation, and the date and time the sample(s) were relinquished. The times that the samples are relinquished and received by the next custodian should coincide, with the exception of transfer by commercial carriers. These carriers will not be required to sign the COC.

If a sample is to be stored for a period of time (e.g., overnight), measures are taken to secure the sample container in a manner that only provides access to the custodian of record. If samples are relinquished to a commercial carrier (i.e., UPS or Federal Express), the carrier waybill number is recorded, and a copy of the waybill is attached to the COC. These documents are maintained with other field documentation. The original COC is sealed inside a zip-top plastic bag and placed inside the shipping container with the samples.

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If corrections are made to the COC, the corrections should be made (single line through the error, initial, and date) by the originator of the change, and, if necessary, an explanation of the change should be provided. The documentation should be of a level of detail that clearly documents the change to a third-party reviewer.

Guidance for choosing a laboratory and completing analyses requests and COC can be found in QP 2.09-Subcontracting Laboratory Services and on the corporate Intranet for the Arcadis Laboratory Program (ALP) and should also be described in the project-specific planning documents (i.e., Work Plan, FSP. or QAPP).

2.4 Subsurface Logs

Test pits, soil borings, monitoring wells or rock coreholes wells, and piezometer installations are to be recorded in bound field books or PDA and may be supplemented with prepared forms. Personnel completing the log are to supply the following information:

- Administrative and technical information included in the header.
- Types of equipment used (e.g., drill rig type, drilling tools used [including diameter and length], or backhoe model).
- Subcontractor/driller used.
- Descriptions of subsurface materials encountered and the number and type of samples collected, if any.
- Subsurface exploration depth and units of measure.
- For drilling, length of recovery.
- Sample type and sample number for geotechnical or analytical samples collected. These data are to be also entered on the sample collection log (if used) and the sample label.
- Classification standard protocol used, if any (e.g., ASTM International Standard Penetration Test).
- Narrative description of the soil, sediment, or bedrock (using standard classification system) and other pertinent information.
- Additional data, such as background and sample vapor/gas readings, observation of sheens, non-aqueous-phase liquid, depth to water (if encountered), presence of (but generally not description of) odors, changes in drilling conditions, and other pertinent information.
- Description of the materials used to seal the boring, unless it is completed as a well or piezometer.

2.5 Monitoring Well/Piezometer Installation

In addition to requirements in Section 2.4, subsequent well or piezometer development activities may involve transcription of field data from the field book onto a computer-based boring log. The field notebook or PDA is to be used to identify the chronology and major events of the installation activity, and the computer-based boring log is to be used to correlate the geologic strata to the major elements of the monitoring well construction. Information to be collected and recorded must meet the regulatory and client requirements and may include the following:

- Location identity
- Screen and riser type, length, diameter, and location

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- Diameter
- Total depth
- Sump location and depth and diameter
- Materials of construction (e.g., stainless steel, polyvinyl chloride, or other material)
- Seal type(s) and or depth(s)
- Sand or gravel pack type, including materials (e.g., silica) and gradation
- Depth to water before and after installation.

2.6 Air Sampling Logs

At a minimum, air sampling documentation should include:

- Start and finish time of sampling
- Sampling location
- Sampling method/media
- Volume sampled.

2.7 Construction, Demolition, Abandonment, and Related Activities

Monitoring and documentation of construction and comparable activities shall be documented in bound field books and/or on appropriate company forms and should include similar information as specified above, including information such as:

- Project name and number
- Owner or client name
- Contractor or subcontractors performing the work
- Contractor or subcontractor superintendent(s) and personnel (as available) on site
- Chronological sequence and description of work activities performed, including workday start and completion times
- Reference to contract sections, work plans, or specifications describing work being performed
- Reference to relevant permit conditions and regulatory requirements and/or reference to regulatory guidance documents controlling work approach
- Listing of all trades performing work by contractor and subcontractor
- Hours worked per trade
- Work hours per day per shift, if applicable
- Equipment on site (e.g., description, model number, size, and type) and hours of use
- Listing of equipment on site being left idle
- Description and quantity of materials used or incorporated, with reference to contract or specification item number, if feasible; include simple sketch of excavation with approximate dimension, if applicable
- Calculations with dimensions for quantities of material used or incorporated

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- Delineation of the work area and access routes (e.g., fencing, flagging, or staking), confirmation that activities occurred within the work area or description of work occurring outside the delineated work area and justification (as needed), and characterization of impacts outside the designated work area
- Documentation of compliance with speed limits, dust control, erosion control best management practices, and other basic elements of construction activities as dictated by project work plans and applicable permits and regulatory criteria.

2.8 Daily Safety Meeting

A Daily Safety Meeting is to be conducted and documented each workday prior to the initiation of field activities, with on-site ENV personnel, contractors, subcontractors, and visitors if possible. Safety topics discussed are entered on the Daily Safety Meeting Form (available on the corporate Intranet). Topics discussed should include site-specific conditions, procedures to be followed that day, and protective equipment. A printed listing of the attendees at the meeting and their signatures should be included. Other required data are:

- Identification of the individual conducting the meeting and his/her signature
- Identification of the project supervisor and project manager.

2.9 Calibration

Documentation of the calibration and calibration results shall be made for field equipment requiring calibration measuring and test equipment calibration data are recorded in the field book or on the Field Activity Log. Calibration data include the following:

- Unique identification of instrument being calibrated, including type, model, and serial number
- Date and time of calibration
- Standards used in the calibration, including standard identity, concentration, lot number, and manufacturer of the standard
- Instrument reading with respect to each calibration standard
- Comments, as necessary, regarding instrument performance.

2.10 Photographs and Videos

When the client allows, photographs and videos may be used to help document pre-, active, and post-field activities. In sensitive areas (e.g., secured or confidential), the client must be contacted to evaluate security procedures concerning use of photographs or videos. Photographic and video documentation should include project title, project number, date, time, and description of conditions. The time should also be documented if time is important to a sequence of photographs.

Photographs are documented by numbering digital photographs and identifying the number and subject on the Field Activity Log. Individual prints may be marked with a stamp or preprinted self-adhesive labels, or by writing

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the project number and sequential number of each photograph and referencing the numbers in the field book, the Field Activity Log, or a dedicated photo log. Videos used for field documentation are to be identified by project title, project number, and description.

2.11 Subcontractor Preparedness Checklist

Prior to starting work, a review is to be made and documented of a subcontractor's preparedness to perform specified activities. This review may be documented on the Field Activities Log or on checklists that may be developed according to requirements for subcontracted work activities. Particular emphasis should be on site-specific issues that may require special consideration such as health and safety, access, and unique settings. These should be discussed in advance with the CPM and the client in developing and implementing the Scope of Work.

— END OF PROCEDURE —

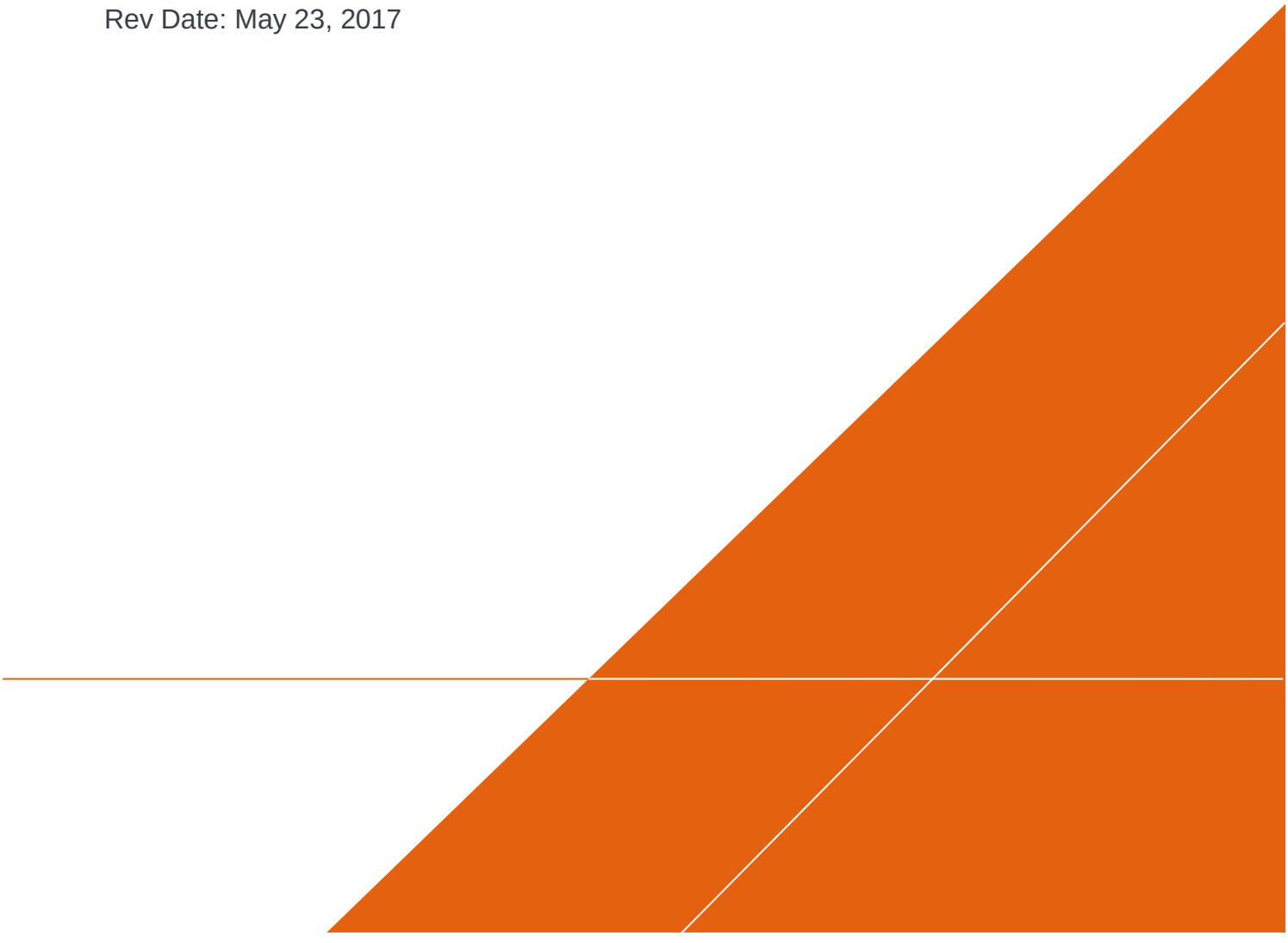
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SOP # P-02

SOP - SAMPLE CHAIN OF CUSTODY

Rev: #1

Rev Date: May 23, 2017



SOP # P-02

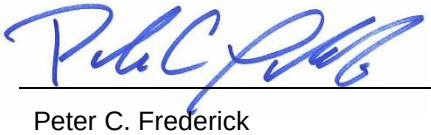
VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 19, 2017	All	Re-write to COC only	Richard Murphy
1	May 23, 2017	4	Add: Guidance on use of previous version of SOP.	Peter Frederick
		9	Add: Info on COCs for multiple shipping containers	
		7	Modify: Move letter i. to letter m. and change to “when appropriate”	

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APPROVAL SIGNATURES

Prepared by: 

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05/23/2017

Date:

Technical Expert Reviewed by: 

Richard J. Murphy

05/23/2017

Date:

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SOP # P-02

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the general Chain of Custody (COC) procedures and guidance instructions for samples collected from project sites that are relinquished from Arcadis' possession.

COC is defined as the maintenance of an unbroken record of possession of an item from the time of its collection through some analytical or testing procedure. COC is typically documented by a written record of the collection, possession, and handling of samples collected from a project location. Each sample will be tracked by a documented record that efficiently documents the individuals who were responsible for the sample during each successive transfer of that sample to various recipients beyond Arcadis' possession. This information can be used to legally establish the integrity of the samples and therefore the analytical results derived from the samples. This information can be used in addition to other records and documentation regarding the samples, such as field forms, field logs, and photographs.

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A sample is considered under custody if:

- It is in your possession; or
- It is in your view, after being in your possession; or
- It was in your possession and then you then locked it up to prevent tampering; or
- It is in a designated secure area.

Continued use of previous version of SOP:

Although not recommended, Arcadis program-, project-, and client-teams may be able to use the previous version of this SOP provided that it meets all of the quality expectations of Arcadis and client, and meets applicable regulatory requirements. It is up to the program, project, and/or client-team leader to determine whether it is appropriate to adopt the current SOP or to continue using the previous version.

However, all new work not associated with the previous version of this SOP must be performed with the current version of the SOP.

When adopting this new SOP, users of the previous versions must be aware that specific handling, packing, and shipping procedures and guidance has been removed and that those should be addressed within program or project plans (e.g. QAPPs, Work Plans, SAPs, etc.) or in a more detailed SOP or TGI specific to that sampling activity, whether related to media, constituent/analyte, client, state, etc.

In addition, adopting this new SOP will require users to refer to the Arcadis DOT Safety Program for procedures and guidance on the determination and handling, packing, and shipping of samples that are or may be considered hazardous materials.

3 PERSONNEL QUALIFICATIONS

Arcadis personnel performing work under the purview of this SOP will have received appropriate training and have field experience regarding the collection of samples from project locations. Arcadis personnel will have all other applicable and appropriate training relevant to the sampling work and project site.

4 EQUIPMENT LIST

The following list provides materials that may be required for each COC. Project reporting and documentation requirements must be reviewed with the CPM prior to execution of work. Additional materials, tools, equipment, etc. may be required, and project staff are required to verify with the CPM and/or Technical Expert what specific equipment is required to complete the COC.

- Indelible ink pen (preferably either black or blue ink);
- COC form https://thesourceus.arcadissource.com/TKI/Documents/COC%20Form.pdf (**Appendix A**) from either Arcadis, laboratory receiving and analyzing the samples, or other applicable and appropriate entity for the work performed;
- When appropriate, such as for litigation or expert testimony work, custody seals or tape.

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5 CAUTIONS

One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

A proper chain of custody requires three types of affirmations: (1) affirmation that a sample is what it purports to be (for example, soil collected from a specified location and depth); (2) affirmation of continuous possession by each individual who has had possession of the sample from the time it is collected until the time it is analyzed or held by a laboratory; and (3) affirmation by each person who has had possession that sample remained in substantially the same condition and not contaminated or affected by outside influences from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, affirmation that the sample was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the samples in question, by showing the absence of alteration, substitution, or change of condition.

Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material are planned for and provided at the site at the time of sample collection.

Understand the offsite transfer requirements of the samples for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation.

An Arcadis employee appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging, and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

6 HEALTH AND SAFETY CONSIDERATIONS

Follow the health and safety procedures outlined in the project/site Health and Safety Plan (HASP) as well as other applicable H&S requirements, such as:

- Arcadis Hazardous Material/DOT handling, packaging, and shipping training
- Project site-specific H&S training
- Client-specific H&S training
- Constituent-specific H&S training
- Media-specific H&S training

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7 PROCEDURE

Collected samples must be uniquely identified, and properly documented, containerized, labeled with unique identifier, possessed in a secure manner during remainder of sampling event, packaged, and shipped to recipient laboratory.

Sample Identification

The method of sample identification depends on the type of measurement or analyses performed. In some cases, in-situ measurements of existing conditions and/or sample location must be made during sample collection. These data will be recorded directly on field forms, logbooks, or other project record data sheets used to permanently retain this information for the project file. Examples of location identification information includes: latitude/longitudinal measurements, compass directions, well number, building number, floor number, room name, or proximity to a site feature unique to the site. Examples of in-situ measurements are pH, temperature, conductivity, flow measurement, or physical condition of the media being sampled. Physical samples collected are identified by a unique identifying number or code on a sample tag or label. These physical samples are removed from the sample location and transported to a laboratory for analyses.

In some cases, before samples are placed into individual containers and labeled as individual samples, samples may be separated into portions depending upon the analytical methods and required duplicate or triplicate analyses to be performed.

When completing a COC for samples, personnel must complete the following:

1. Written COCs must be completed with indelible ink (preferably either black or blue colored ink).
2. Written COCs must be completed using legible printed writing, and not cursive writing.
3. All entry fields on the COC form must be completed. If information is not applicable for a specific entry field, personnel will either put “N/A” or use a strike-out line or dash like “----------“ to indicate no applicable information is needed for that field.
4. Use of quotation marks or lines/down arrows to represent repetitive/duplicative text in similar fields.
5. Regardless of the type or specific COC form, the following pertinent information must be provided on the COC form:
    a. project number
    b. project name
    c. Project location, including street address, city, state, building number, providing as much detail as appropriate
    d. Recipient laboratory contact and sample receiving shipping location information
    e. Entities’/persons’ contact information for who will be receiving analytical results
    f. Name of sampler, i.e. person collecting sample and relinquishing possession of samples to the next entity in the chain of custody
    g. Date of sample collection

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h. If appropriate for the sample media, contaminant/constituent of concern, or analytical method, document time of sample collection using standard military time

i. Sample analytical method(s)

j. Turnaround time required for analyses and/or reporting

k. Instructions to laboratory regarding handling, timing, analyses, etc. as applicable and appropriate

l. Printed name and signature of the individual person who collected the samples and relinquishing possession of the samples

m. If appropriate or when documentation of the specific sample collection method will influence how the laboratory handles, prepares, or analyzes the samples, document the sample collection methodology used for collecting the samples (e.g. ASTM D5755)

6. The following additional specific information will be entered on the COC form, regardless of what type of COC is being used:

   a. Unique Sample Identifier – The sample identifier (ID) must be unique to the individual sample it is applied to. The information in which the sample ID conveys is determined by the CPM, Technical Expert, and/or other project team members in advance of sample collection so that sample identification is consistently applied for the project. The sample nomenclature may be dictated by a specific client, program, or project database and require unique identification for each sample collected for the project. Consult with the CPM and/or Technical Expert for additional information regarding sample identification.

      The sample ID could convey specific information regarding the sample to aid personnel in recognizing what the sample represents, or they may be arbitrary so as to facilitate the anonymity of the sample location, media, constituent of concern, project site, etc.

      Examples of unique identifiers include:

      1. Well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. DO NOT use the apostrophe or quotes in the sample ID.

      2. Sample names may also use the abbreviations “FB,” “TB,” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively.

   b. List the date of sample collection. All indicated dates must be formatted using either mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).

   c. When appropriate for the analytical procedure used, list the local time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

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d. Samples should be indicated to be either “Grab” or “Composite”. Grab samples are collected from only one unique location at one specific point in time.

e. Composite samples are a group of individual samples that are combined for analysis in their totality. Composite samples need to be documented if they are either collected from a number of different locations over a broader area to be representative of the entire area being sampled, or if they are representative of a single location over an extended period of time.

f. If used, preservatives for the individual sample will be noted.

g. The requested analytical method(s) that the samples are being analyzed for must be indicated. As much detail, as necessary, should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering “EPA Method 8082 – PCBs” or “EPA PLM 600-R93-116.” In cases where multiple analytical methods and/or analytical parameters are required for an individual sample, each method should be indicated for the sample (e.g., EPA 8082/8260/8270 or EPA PLM/400-point count).

h. If there are project-specific sample analytes to be reported, they should be specifically listed for each individual sample (e.g., 40 CFR 264 Appendix IX).

i. The total number of containers for each analytical method requested should be documented. This information may be included under the parameter or as a total for the sample.

j. When necessary, note which samples should be used for site specific matrix spikes.

k. Indicate special project-specific requirements pertinent to the handling, shipping, or analyses. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG).

l. Indicate turnaround time (TAT) required for samples on COC. If individual samples have differing TATs, the different TATs for each sample or groups of samples must be clearly indicated.

m. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory. The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

n. If available, attach the Laboratory Task Order or Work Authorization forms.

o. The “Relinquished By” field must contain the signature of the Arcadis person who relinquished custody of the samples to the next entity in the chain of custody, which may be another person, the shipping courier, or the analytical laboratory.

p. Dates and times must be indicated using the following format:

   1) Date: either mm/dd/yy e.g., 01/01/17 OR mm/dd/yyyy e.g., 01/01/2017

   2) Time: use military format, e.g. 9:30 a.m. is 0930 and 9:30 p.m. is 2130

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q. The “Received By” section is signed by sample courier or laboratory representative who received the samples from the sampler or it is signed upon laboratory receipt from the overnight courier service.

4. When more than one page of the COC form is required to complete the total number of samples, use as many sheets as necessary to accurately and clearly document the samples and information. Some COCs may have a standard first page/cover page, and subsequent pages may not contain all the detailed fields as the first page/cover page. Ensure that any subsequent pages convey all of the necessary and pertinent information for each individual sample as required in this procedure document.
5. Pages of the COC must retain a page count of the total number of pages; e.g., Page 1 of 3, Page 2 of 3, Page 3 of 3.
6. Upon completing the COC forms, forward the original signed COC with the sample package. Ensure that the original COC form is secured with the sample package so that it remains with the physical samples for the duration of transport and handling to its final destination and ensure that the COC form will not be become damaged or rendered unreadable due to sample breakage/leakage if stored inside the sample shipping container or outside influences if COC is stored in an outside plastic pouch to the container.
7. If you’ve collected enough samples that would require more than one container to ship them all to the same laboratory or location, then each separate/individual container that contains any number of samples must have a separate COC representing only those samples contained within that specific container. For example, if you have 3 total shipping containers for all of your samples, you must have a total of 3 separate, individual COCs for each of the 3 containers representing only those samples in their representative container. Thus, every container holding samples must have its own, individual COC.
8. If electronic chain of custody (eCOC) forms are utilized, ensure that the requirements of this procedure and guidance instructions are followed to the extent possible. Verify that proper signature and COC procedures are maintained with the CPM and/or Technical Expert when using eCOC.

8 WASTE MANAGEMENT

Not Applicable.

9 DATA RECORDING AND MANAGEMENT

The original signed COC shall be submitted with the samples. Copies of COC records will be transmitted to the CPM or designee at the end of each day unless otherwise directed by the CPM. The sampling team leader retains copies of the chain of custody forms for filing in the project file. Record retention shall be in accordance with client- and project-specific requirements and Arcadis policies, the most stringent will apply.

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10 QUALITY ASSURANCE

COC forms will be legibly completed in accordance with this procedure and guidance instruction document, as well as other applicable and appropriate project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents.

COC records will be reviewed by the CPM or their appropriate designee for completeness and accuracy to the applicable requirements. Non-conformances will be noted and corrected in a timely manner on the copies retained by Arcadis as well as contacting the ultimate receiving entity for correction to the originally signed COC in their possession.

11 REFERENCES

Arcadis Client Document Retention Guide

Arcadis Transportation Safety Program requirements, procedures, and guidance instructions

EPA Samplers' Guide – Contract Laboratory Program Guidance for Field Samplers, EPA document EPA-540-R014-013 October 2014

EPA Region III – *Sample Submission Procedures for the Office of Analytical Services and Quality Assurance (OASQA) Laboratory Branch* revision 13.0 January 29, 2014

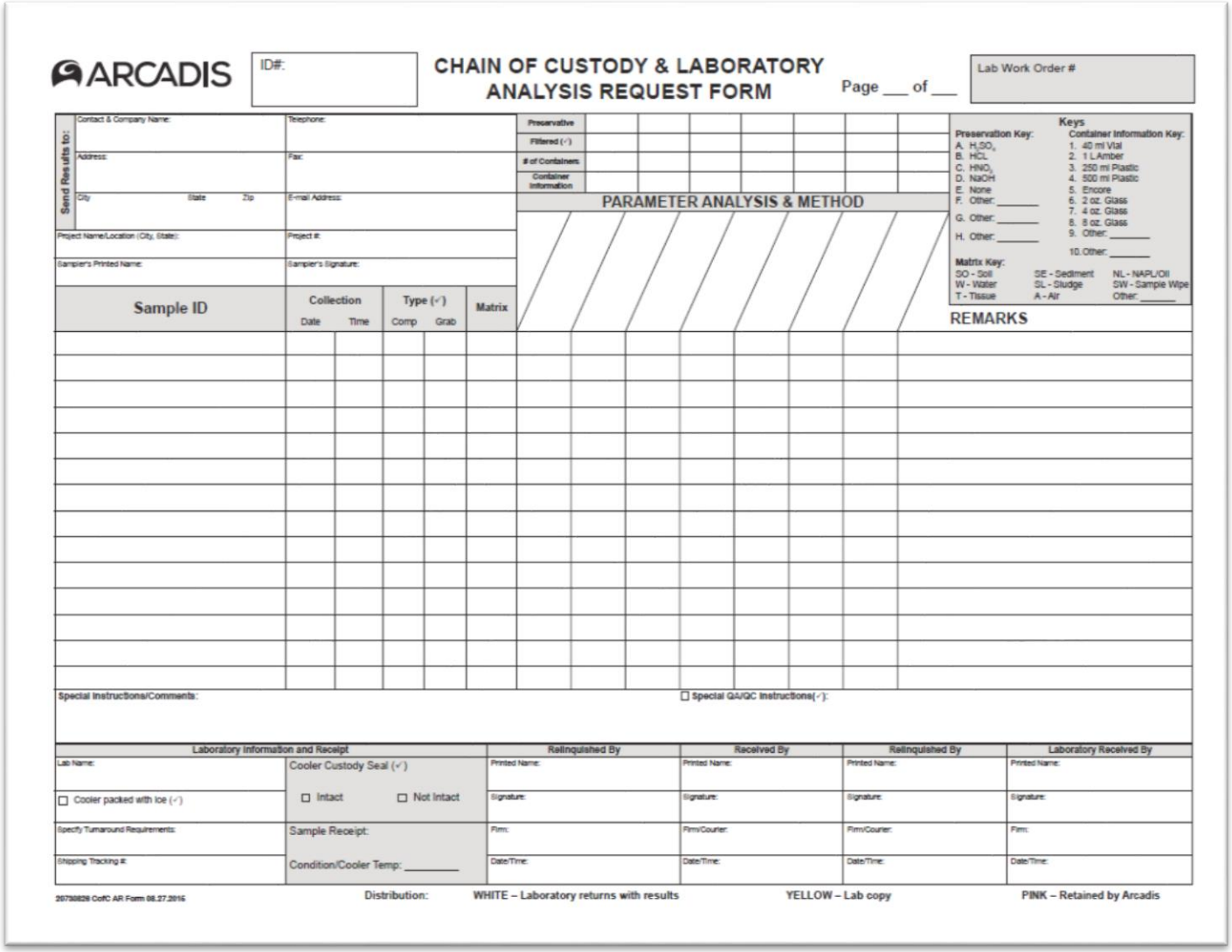
EPA Region I Office Environmental Measurement and Evaluation – *Standard Operating Procedures for Chain of Custody of Samples* revision 1 March 25, 2002

EPA Region IV Science and Ecosystem Support Division *Operating Procedure for Sample and Evidence Management* January 29, 2013

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APPENDIX A
Chain of Custody Form
[click image below to access form]



ARCADIS

ID#:

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:
Contact & Company Name:
Telephone:
Address:
Fax:
City State Zip
E-mail Address:
Project Name/Location (City, State):
Project #:
Sampler's Printed Name:
Sampler's Signature:

Sample ID	Collection Date	Collection Time	Type (✓) Comp	Type (✓) Grab	Matrix

Preservative
Filtered (✓)
of Containers
Container Information

PARAMETER ANALYSIS & METHOD

REMARKS

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: _____
G. Other: _____
H. Other: _____

Container Information Key:
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: _____
10. Other: _____

Matrix Key:
SO - Soil
W - Water
T - Tissue
SE - Sediment
SL - Sludge
A - Air
NL - NAPL/Oil
SW - Sample Wipe
Other: _____

Special Instructions/Comments:

☐ Special QA/QC Instructions(✓):

Laboratory Information and Receipt		Relinquished By	Received By	Relinquished By	Laboratory Received By
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with Ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: _____	Date/Time:	Date/Time:	Date/Time:	Date/Time:

20730829 CofC AR Form 08.27.2015

Distribution: WHITE – Laboratory returns with results YELLOW – Lab copy PINK – Retained by Arcadis

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Implementation Date	HS Standard NameUtility	SOP # P-03
13 December 2006	Location and Clearance	
Revision Date	HS Standard No.	Revision Number
17 March 2017	ARCHSFS019	16

EXECUTIVE SUMMARY

Damaging an underground or aboveground utility can result in serious injury and loss of life, disrupt essential services, and create significant liability to Arcadis, clients, and subcontractors. Therefore, it is Arcadis policy that the following steps be completed prior to beginning any subsurface intrusive work (i.e., any work or activity that breaks the plane of the ground surface):

- The presence of existing or known utilities will be investigated and cleared (to the extent feasible) by locating and marking before the start of any subsurface intrusive work and where appropriate, visually verifying through soft dig methods (referred to as potholing or daylighting) before the start of any subsurface intrusive activity.

- A minimum of **three (3) reliable lines** of evidence are required for an acceptable utility clearance. Each location of subsurface intrusive work must have at least 3 reliable lines of evidence. All lines of evidence used during the utility clearance procedure will be recorded on the Utility and Structures Checklist or equivalent client-provided checklist or permit. If a line of evidence is lost or not apparent, STOP WORK, and re-establish the line of evidence prior to resuming subsurface intrusive work.

- The lines of evidence used will be reasonable and appropriate for the conditions expected to be encountered (soil type, water table, etc.) and the type of utilities expected to be encountered (e.g., gas line versus an irrigation line).

- Contact the State One Call or equivalent service (Nationwide "811") as required by law. The State One Call or equivalent service (Nationwide "811") can only be used as a reliable line of evidence when working within the public right-of-way or easement.

- For point clearance (single intrusive point, used as 1 of the 3 required reliable lines of evidence), the borehole must be cleared to 110% of the diameter of the intrusive device (e.g., auger, drill head, etc.) or an additional 2 inches of overall diameter, whichever is greater.

- Utility clearance information will be documented on the Arcadis Utility and Structures Checklist (USC) or equivalent client-provided checklist or permit. The Utility Structures and Checklist is valid for 15 business days from the date of completion. A copy of the completed Utility and Structures Checklist will remain on-site during all subsurface intrusive work.

- Employees overseeing utility clearance activities will:

    - Be familiar with the contents of this standard and ARC HSFS-019 Supplement 2;
    - Have one year of field experience in the visual identification of utilities; and
    - If operating equipment, have training and six months of experience in the proper operation and results interpretation of any clearance equipment, including without limitation, magnetometers and ground penetrating radar.

- A utility strike is an unplanned contact of a utility during the course of work that results in damage requiring repairs, making a report to the utility owner, or requiring further assessment to evaluate the potential for damage. All utility strikes must be reported within 24 hours using the Utility Line Strike Investigation Form. **Do not enter the incident into 4-Sight until approved to do so by Corporate Legal. Refer to** ARC HSFS-019 Supplement 5**, Utility Strike Emergency Action Plan Guidelines.**

Report Utility Incident Now

1. POLICY

It is the practice of Arcadis and its affiliated companies to implement appropriate, reasonable, and practical standards within acceptable and customary industry practices to promote the health and safety of its employees and avoid and mitigate exposure of risk in the performance of their work. In furtherance of this policy, Arcadis promotes and encourages compliance by all employees with this policy and standards relating to work in the vicinity of subsurface, submerged, or aboveground utilities.

2. PURPOSE AND SCOPE

2.1 Purpose

This standard directs general safety standards and best practices associated with the identification and management of subsurface, submerged, and aboveground utilities on project sites. Utility location standard operating procedures (SOP) for submerged utilities can found in ARC HSFS-019 Supplement 6.

2.2 Scope

This standard assigns responsibilities and expectations for proper utility clearance by both Arcadis employees and Arcadis subcontractors at project sites.

3. DEFINITIONS

Definitions relating to Utility Clearance can be found in Exhibit 1.

4. RESPONSIBILITIES

4.1 Project Manager Responsibilities

For every project site having the potential to come into contact with utilities, Project Managers must ensure that:

- The requirements of this standard are followed.
- Local regulations governing utility clearance are followed. This includes ensuring local and**/**or state laws defining activities or depth of intrusive work/excavation requiring utility clearance are reviewed as they vary by location. For further information, refer to One Call and State Law Directory.
- Efforts are made to work with the client, project site representatives, public utility companies, and subcontractors to identify the nature of any utilities and to determine control processes that need to be implemented by Arcadis and the subcontractors to prevent damage to these utilities and to properly manage the effects in the event there is utility damage.
- Utility clearance activities are only delegated to a Task Manager or other individual meeting the requirements of Section 4.2 below, as appropriate. However, even if the Project Manager delegates certain responsibilities, the Project Manager maintains primary responsibility for a complete utility clearance.

For additional information on Project Manager responsibilities and best practices, refer to ARC HSFS-019 Supplement 1.

- Project Managers or designee must review the Utility and Structures Checklist with staff and Arcadis subcontractors conducting subsurface intrusive work (including "Sub-of-Subs" when conducting subsurface intrusive work) prior to staff beginning subsurface intrusive work. The Project Manager or designee review must be documented on the Utility and Structures Checklist prior to starting subsurface intrusive work.

4.2 Field Personnel Responsibilities

Arcadis field personnel conducting work on a project site having the potential to come into contact with utilities have the responsibility to:

- Read, understand, and follow this standard and ARC HSFS-019 Supplement 2 and complete the appropriate checklists during the on-site utility and structures locate and clearance process.

- Complete a minimum of one year of utility clearance-related experience before accepting responsibility for any utility clearance tasks. This requires on-site training led by another Arcadis employee with detailed knowledge and experience in identifying utilities and structures.

- Complete training and have 6 months of experience in operating and interpreting the results of remote sensing technologies, including without limitation, magnetometers and ground penetrating radar, before operating such technologies. Field staff should understand the technologies being utilized by a private utility locate contractor and how they are operating in comparison with the site conditions. Refer to ARC HSFS-019 Supplement 3 for more information.

- Prior to beginning subsurface intrusive work, the Utility and Structures Checklist must be completed and signed by the staff member completing or overseeing the clearance. Confirm that the Utility and Structures Checklist was reviewed by the Project Manager or designee as discussed in Section 4.1 above. Review the Utility and Structures Checklist daily prior to starting subsurface intrusive activities to ensure all utilities are identified and markings are present. A copy of the completed Utility and Structures Checklist will remain on-site during all subsurface intrusive work (i.e., any work or activity that breaks the plan of the ground surface).

- Use their STOP WORK Authority to eliminate any reasonable concern if utilities cannot be reasonably located and contact the Project Manager to review the STOP WORK situation and confirm the direction of action before moving forward.

- Ensure that Arcadis subcontractors conduct their own reasonable independent utility clearance efforts as required by Arcadis' standard subcontract and are aware of any Arcadis clearance standards used on-site.

- Be on-site and provide oversight during utility locate activities and any active subsurface intrusive work or activities involving contractor under contract to Arcadis.

- If a utility is damaged and repaired during the course of the field event, field staff must provide oversight and document that the repair appears competent and complete to prevent further damage to the site when the damaged utility is re-activated.

4.3 Arcadis Subcontractor Responsibilities

According to Arcadis' standard subcontract, subcontractors have agreed to take responsibility for any damages resulting from a utility impact caused by their work. Therefore, Arcadis subcontractors are expected to take reasonable time and diligence to conduct their own independent utility clearance using reasonable standards and processes. Subcontractors have the responsibility to stop their work if utility concerns are identified and will report those concerns to the Arcadis employee overseeing their work activities. Arcadis staff should reinforce these responsibilities with subcontractors during job safety briefings.

In jurisdictions where the actual contractor performing the subsurface intrusive work is required to perform utility clearance notifications, the contractor will perform the clearance notification and will provide evidence of the notification to Arcadis (ticket or ticket number, etc.). Refer to ARC HSFS-019 Supplement 4 for Best Practices for State One Call procedures.

- If overhead utilities are present in areas where heavy equipment will be operated, ensure adequate clearance is provided. For heavy equipment that is extendable or telescoping (e.g., excavators, dump trucks, extendable lift trucks), evaluate whether the use of a spotter is necessary prior to operating heavy equipment when in proximity to the overhead utility.

- If a utility is damaged and repaired during the course of the field event, the field subcontractor must verify that the repair is competent and complete to prevent further damage to the site when the damaged utility is re-activated.

5. PROCEDURE

5.1 General

Protocols to be followed during utility and structures location and clearance activities are outlined in:

- Best Practices for Project Managers (or Their Delegates) Concerning Utility Clearance (ARC HSFS-019 Supplement 1).

- Best Practices for Field Personnel Concerning Utility Clearance (ARC HSFS-019 Supplement 2).

- Use and Limitations of Common Underground Locating Technologies and Clearance Methods (ARC HSFS-019 Supplement 3).

- Best Practices for State One Call Procedures (ARC HSFS-019 Supplement 4).
- Emergency Action Plan guidelines for Utility Strikes (HSFS-019 Supplement 5).
- Utility Location Standard Operating Procedure for Aquatic Work Activities (ARC HSFS-019 Supplement 6).

5.2 Lines of Evidence

When locating underground utilities, three (3) reliable "lines of evidence" must be established to help determine where a subsurface utility may be located. A line of evidence may be a site drawing that shows where a utility is located, it could be anecdotal information obtained from owners or employees, it could be established using any number of non-intrusive geophysical methods [e.g., ground penetrating radar (GPR), electromagnetic survey (EM), radio-frequency methods (RF), etc.], or it could involve probing for or exposing the utility by soft dig technologies (i.e., daylighting or potholing). Some lines of evidence will identify utility locations with a high degree of certainty (e.g., direct connect radio-frequency technique, daylighting or potholing, sonde tracing, etc.). Other lines of evidence will identify utilities will less certainty (e.g., anecdotal reports, design drawings, etc.).

Effective utility locate practices must use multiple lines of evidence until there is a high degree of certainty that the underground services have been adequately located. Three (3) reliable lines of evidence are required for an appropriate utility clearance as defined in this standard. All reliable lines of evidence used during the utility clearance procedure will be recorded on the Utility and Structures Checklist or equivalent client-provided checklist or permit. If three (3) reliable lines of evidence have not established certainty in the location of a utility, STOP WORK and do not proceed. Additional reliable lines of evidence must be utilized until the presence or absence of the underground utility can be established. During work activities, if a line of evidence is lost or not apparent (e.g., paint markings have faded), STOP WORK, and re-establish the line of evidence prior to resuming subsurface intrusive work.

Generally, the following lines of evidence may be used to meet this minimum utility clearance requirement:

1. Contacting the State One Call or equivalent service (Nationwide "811") is REQUIRED BY LAW regardless if it will be used as a line of evidence. Contacting the State One Call or equivalent service (Nationwide "811") is an acceptable reliable line of evidence when working within the public right of way or easement. Note that the State One Call can provide valuable information regarding locations and types of utilities entering the private property.

   Note: For work on private property or in areas not served by State One Call or equivalent service, consider using a reputable private utility locating company to locate and mark the utilities. **Use of a reputable private utility locator is encouraged for all projects with subsurface or submerged utilities.** When working with a private locater, it is best practice to pre-plan clearance areas, review required clearance equipment and the re-clearing/confirmation of any public utility mark outs (State One Call or equivalent service Nationwide "811").

2. Use detailed, scaled site utility plans, preferably in the form of an "as-built" or "record" drawing, to identify and/or confirm utility locations. Document request and/or receipt of utility drawings from the property owner/client on the Utilities and Structures Checklist.

3. Interview(s) with knowledgeable site or client personnel. The following questions should be asked during the interview and answers documented on the Utility and Structures Checklist:

   - Employees(s) Name and Affiliation(s) with the site;
   - Types of utilities, including utility composition and location of utilities on-site;
   - Depths of known utilities; and
   - Any other pertinent information regarding utilities on the site.

View the Utilities and Structures Checklist

4. Conduct a detailed visual site inspection of areas around all planned subsurface intrusive work points or areas to identify and/or confirm utility locations. For underground utilities, conduct an inspection for structures that tend to indicate the presence and general location of such utilities, including, but not limited to manholes, vaults, valve covers, valve markers, telephone pedestals, transformer housings, fire hydrants, spigots, sprinkler heads, air relief valves, backflow preventers, meters, downspouts going into the subsurface, power poles with wiring going into the subsurface and line markers. Saw cut lines and concrete/asphalt repairs often yield valuable information regarding utility locations.

   Always discuss the presence of utilities with the site owner, operator, and/or occupant to identify any potential utilities that might not be readily identified by non-intrusive clearing methods or may be:

   - At depths > 5 feet below ground surface; or
   - At very shallow depths (< 2 feet below ground surface), such as communication lines, electrical conduits/wiring, irrigation lines, etc.

If one of the above lines of evidence cannot be utilized or if using the above lines of evidence does not adequately identify utilities with reasonable certainty, one or more additional lines of evidence must be utilized. Commonly used lines of evidence are listed on the Utility and Structures Checklist.

A discussion of use and limitations associated with common utility location and clearance methods is provided in ARC HSFS-019 Supplement 3.

Standard operating procedures for utility location in submerged settings are presented in ARC HSFS-019 Supplement 6.

The lines of evidence will be recorded on the Utility and Structures Checklist or equivalent client-provided checklist or permit.

Note: If a line of evidence is lost, utility markings are removed/worn, or area of previous clearance is not confirmed, STOP WORK and re-establish the

line(s) of evidence prior to resuming subsurface intrusive work. Each location of subsurface intrusive work must have 3 reliable lines of evidence. All lines of evidence used during the utility clearance procedure will be recorded on the Utility and Structures Checklist of equivalent client-provided checklist or permit. If a line of evidence is lost or not apparent, STOP WORK, and re-establish the line of evidence prior to resuming subsurface intrusive work. The Utility Structures and Checklist is valid for 15 business days from the date of completion.

If and when any line of evidence reveals that planned subsurface work will be located inside the 30-inch Tolerance Zone of known/marked/located/observed utilities, the project team must Stop Work and contact Corporate H&S as early as possible for pre-approval.

5.3 Color Codes used for Utility Markings

The following colors are used for marking utilities. Some government agencies or large industrial facilities may use additional colors not provided below. Arcadis policy is to assume any paint marking or pin flag color not provided below is a subsurface utility marking until proven otherwise.

If utilities or subsurface anomalies are identified but the utility type or anomalies are not classified, it is recommend that a pink (Temporary Survey Marking) marking be used. Once the type of utility is established, the pink marks should be repainted/remarked to represent the correct type of utility.

COLOR	Utility Line
WHITE	Proposed Excavation
PINK	Temporary Survey Markings
RED	Electrical Power Lines, Cables, Conduit and Lighting Cables
YELLOW	Gas, Oil, Steam, Petroleum or Gaseous Materials
ORANGE	Communication, Alarm or Signal Lines, Cables or Conduit
BLUE	Potable Water
PURPLE	Reclaimed Water, Irrigation and Slurry Lines
GREEN	Sewer and Drain Lines

APWA and ANSI standard Z-53.1

5.4 Locating Technologies

There are several types of locating technologies that can be used to identify and locate utilities in the subsurface. Project teams need to work closely with private utility locators (PUL) in order to best match locating technology with site conditions. To provide the best results, all possible locating technologies should be available for use and implementation at the project location. Any potential interferences should also be discussed up front and then at the project site during utility location activities. Potential interferences could be soil moisture, soil type, standing water on concrete/asphalt, rebar, fencing, and metal

structures that are in the subsurface. Employees overseeing locating technology activities should have an understanding of device operation and limitations. For further information, refer to ARC HSFS-019 Supplement 3, Use and Limitations of Common Utility Location Technologies and Clearance Methods.

5.5 Clearance Methods

In some cases, proposed subsurface intrusive locations may be pre-cleared using other intrusive methods. Determine the clearance or soft dig method based on-site conditions and utilize the least invasive method possible. The number of subsurface intrusive locations and soil type should be taken into consideration. The following clearance methods are listed from least invasive to most:

1. Vacuum Extraction/Potholing (air or water-based),
2. Air knifing,
3. Hydroknifing,
4. Probing,
5. Hand augering,
6. Hand digging, and
7. Posthole digging.

Single-Point clearance must be 110% of the proposed subsurface intrusive area or the diameter plus 2 inches, whichever is greater. Three-Point clearance must be installed in a triangular pattern around the proposed borehole and in a configuration not to allow for utilities to enter the borehole. Three-Point clearance must be 110% of the proposed intrusive area or the diameter of the intrusive area plus 2 inches, whichever is greater. Each method of clearance should be documented on the Utility and Structure Checklist.

Manual clearing methods, such as shoveling, using pick axes, digging bars and other hand tools, should be avoided completely or only used when absolutely necessary and used with caution. Excessive downward force, prying or use in poor/obstructed visibility conditions is prohibited as these tools can damage utilities.

Surface cover (e.g., asphalt) removal methods within the 30-inch Tolerance Zone that pose excessive downward force, such as jackhammering, should be used with extreme caution. Methods that only cut the surface cover (coring or saw cutting) present less risk due to the absence of the downward force, which could cause collateral damage to shallow subsurface utilities. Note that utilities are often present at the concrete or pavement/soil interface or encased within the concrete or pavement and are easily damaged during concrete coring or pavement removal. Always work slowly, methodically and frequently STOP WORK to evaluate conditions during these work activities.

For borings and excavations, if the utility is known to be at depths where hand clearing is not feasible or creates additional safety concerns, no work will be performed within the 30-inch Tolerance Zone vertically or horizontally of the utility unless manual clearing is performed under the oversight of an Excavation Competent Person as defined in ARC HSCS005 Arcadis Excavation and Trenching.

5.5.1 Temporary Backfilling of Pre-Cleared Boreholes

In some cases, it may be necessary to temporarily backfill a pre-cleared location until the remaining subsurface activities are performed. At these locations where subsurface intrusive work does not immediately follow pre-clearance, it is important to properly backfill and mark the pre-cleared location in order to relocate the pre-cleared location. In general, wooden stakes, survey markers, whiskers, paint marking or other surficial markings alone are inadequate because these markings can be easily removed, damaged or otherwise lost leading to uncertainty regarding the pre-cleared location. Although the specific steps for backfilling a pre-cleared location will depend on site-specific conditions, use the following additional steps to prevent loss of the pre-cleared location:

- Backfill a pre-cleared location with clean sand or other granular material that is significantly different than the surrounding subsurface native material. Native soil should not be used to backfill a pre-cleared location that may require further subsurface work.
- Backfill the top 2 feet of a pre-cleared location with dyed sand or gravel to facilitate re-location.
- Use hammered wooden stakes or delineators to mark locations as an additional measure, if practical.
- In the event that the pre-cleared borehole is located on asphalt or concrete and an asphalt cold patch is required, use white paint to mark the intrusive location with a circle over the asphalt cold patch.
- In some instances, such as projects potentially affected by unexploded ordinance (UXO), the pre-cleared borehole may require that a PVC of matching diameter pipe be inserted into the pre-cleared borehole, filled with clean sand and affixed with a matching cap. Contact the project manager to identify any client-specific requirements.
- Always use a physical subsurface marker such as described above to identify the pre-cleared borehole location. Never rely solely on field measurements or GPS coordinates.
- If a utility or anomaly/obstruction is encountered during the pre-clearing process, backfill the hole with the native soil and mark the location with a pink-painted X and/or NO.

In the event that a previously pre-cleared location cannot be located, the location must be re-cleared prior to performing subsurface intrusive work.

5.6 Clearance for Working in Vicinity of Subsurface Utilities

Prior to the start of subsurface intrusive activities (i.e., excavations, vertical drilling, installing grounding rod, and soil sampling), all utilities must be located and measures must be instituted to avoid subsurface utility hazards. See exemptions for subsurface intrusive work in Exhibit 1 (Definitions). Do not conduct subsurface work within 30 inches of a line marking in all directions. If the centerline of the utility is marked, the diameter of

the utility or utility bank (Exhibit 1) must be incorporated into the 30-inch Tolerance Zone, see Figure 1 located in Exhibit 2 for further instructions.

If and when any line of evidence reveals that planned subsurface work will be located inside the 30-inch Tolerance Zone of known/marked/located/observed utilities, the project team must Stop Work and contact Corporate H&S as early as possible for pre-approval.

If subsurface work must take place within the 30-inch Tolerance Zone of the line marking, the utility must be exposed (potholed) by soft dig/clearance methods prior to starting subsurface intrusive activities (see Section 5.5 for options); **no mechanized equipment is permitted for the exposing of the utility**.

Once the utility has been exposed, if mechanized equipment is planned for use within the 30-inch Tolerance Zone of the utility, such activity must receive pre-approval by Corporate H&S, as necessary, to mitigate or accept the risk associated with the planned work. Additional excavation safety procedures may have to be developed as part of the approval to proceed. It should be noted that any disturbance within the 30 inches or disruption of the bedding materials could affect the integrity of the utility.

For horizontal borings, to avoid striking a utility, damage from vibration, damage by pressure of the advancing boring, do not drill within 30 inches in all directions (3-Dimensional cylinder) of a line marking. Make sure to factor the diameter of the line or utility bank when computing 30-inch Tolerance Zone. When crossing a utility during horizontal drilling, it is recommend that the utility be exposed 30 inches in a 360°-direction. When exposing utilities for horizontal borings, the utility must be exposed (potholed) by soft dig/clearance methods. This recommendation applies even if the operating contractor has technology that places the location to within a few inches. Make sure to factor the diameter of the utility when determining the 30-inch Tolerance Zone. If subsurface work must take place within the 30-inch Tolerance Zone of the line marking, the utility must be exposed (potholed) by soft dig/clearance methods prior to starting subsurface intrusive work (see Section 5.5 for options); **no mechanized equipment is permitted for the exposing of the utility**. Once the utility has been exposed, if mechanized equipment is planned for use within the 30-inch Tolerance Zone of the utility, such activity must receive pre-approval by Corporate H&S, as necessary, to mitigate or accept the risk associated with the planned work. Additional excavation safety procedures may have to be developed as part of the approval to proceed. It should be noted that any disturbance within the 30 inches or disruption of the bedding materials could affect the integrity of the utility.

Additional cautions for horizontal borings include gravity utilities, such as sewers and storm drains, as the depth of these utilities will change (sometimes significantly) as they run across the project site. Always obtain the utility depth at the location where the boring will actually cross the line by collecting sewer depth inverts from identified manholes and interpolating those depths to the area of the subsurface intrusive work.

During well installations and well abandonment via mechanical equipment, the 30-inch Tolerance Zone rule applies outward from the outside edge of the largest diameter auger or tool to be used for installation and abandonment (over drilling). In cases where wells have been previously installed and the 30-inch rule has not been followed, work proposed using mechanized equipment to work within the 30-inch Tolerance Zone will

require approval from Corporate H&S. For more information, see Exhibit 2 for further instructions.

5.6.1 Aboveground Activities causing Subsurface Disturbance in the Vicinity of Underground Utilities

Aboveground activities can cause damage to shallow underground utilities or structures. Plan the intended path/mobilization/operation of Heavy Equipment is cleared to ensure that shallow utilities are not damaged. If Heavy Equipment must cross over shallow utilities, the utilities will be protected. Other subsurface disturbances may lead to damage such as clearing trees/shrubs/vegetation as roots may be entangled with underground piping or structures. For more information, see Best Practices for Field Personnel Concerning Utility Clearance (ARC HSFS-019 Supplement 2).

5.7 Acceptable Clearance for Working in Vicinity of Overhead Power Lines and Other Overhead Lines and Structures

No work will be performed by Arcadis or our subcontractor near overhead power lines where any Unqualified Person or equipment is within the limits specified below unless the power line has been properly covered or de-energized by the owner or operator of the power line. Qualified Person approach distances are defined in Exhibit 5A and 5B of ARC HSFS0006 Electrical Safety Standard.

Power Line Voltage Phase to phase (kV)	Minimum Safe Clearance (feet)
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	45

ANSI standard B30.5-1994, 5-3.4.5

5.7.1 Reducing Vehicle and Mechanical Equipment Clearance Requirements

Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 feet (305 centimeters (cm)) is maintained. If the voltage is higher than 50 kilovolts (kV), the clearance shall be increased 4 inches (10 cm) for every 10 kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

- If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 feet (122 cm). If the voltage is higher than 50 kV, the clearance shall be increased 4 inches (10 cm) for every 10 kV over that voltage.

- If insulating barriers are installed to prevent contact with the lines and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

- If the equipment is an aerial lift that is insulated for the voltage involved and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in OSHA 1910.333(c)(3)(ii)(C) Table S-5. Reference information from OSHA 1910.333 Table S-5 and NFPA 70E Table 130.4(C)(a) for alternating-current systems and 130.4(C)(b) for the distances associated with direct-current voltage systems is included as Exhibit 5 of ARC HSFS0006 Electrical Safety Standard.

Employees standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments unless:

- The employee is using protective equipment rated for the voltage; or

- The equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in this section of this standard.

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

When a machine is in contact with an overhead power line, do not allow anyone to come near or touch the machine. Stay away from the machine and summon outside assistance.

5.7.2 Acceptable Clearance for Working in Vicinity of Non-Electrical Overhead Utilities and Structures

Arcadis field personnel will identify non-electrical overhead utilities and structures and where possible, work is not be conducted within the 30-inch Tolerance Zone of these overhead utilities and structures. It is recommended that if work will be completed in the vicinity of non-electric overhead utilities, the overhead utilities should be labeled with warning signs, protective barricades, and/or flags. Non-electrical overhead utilities and structures may include, but is not limited to, pipe chases, water lines, ceilings in buildings, etc. Arcadis field personnel will notify its site workers

(employees, subcontractors, vendors, etc.) of known overhead utilities and structures during the tailgate safety meeting. See Exhibit 2 for additional details.

5.8 Reporting Utility Incidents

Arcadis field personnel involved with any subsurface, submerged, and aboveground utility strikes should immediately STOP WORK and contact the Project Manager to discuss the incident unless there are injuries, then call 911 or the available emergency services number for the area and then the Project Manager. The utility strike must be reported to Corporate Health and Safety and Legal Departments immediately and no later than 24 hours. Use the Utility Line Strike Investigation Form as part of the notification process.

Selected utility strike incidents may also utilize a conference call with operations management to review findings and lessons learned. The Business Line Health and Safety Director will make the determination concerning the need to have the incident review call and will arrange the call, if deemed necessary.

5.9 Relationship of this standard to the Project Specific HASP

With the exception of the Utility and Structures Checklist, this standard, including most supplements, are not designed to be printed off and attached to project HASPs. During project health and safety planning, this standard will be reviewed and applicable clearance technologies and methods will be documented on the Utility and Structures Checklist.

Additionally, emergency action standards specific to utility strikes should be addressed. ARC HSFS-019 Supplement 5 provides general guidelines for emergency response to utility strikes. Applicable information may be attached to the Utility and Structures Checklist to facilitate communication of response expectations.

5.10 Required Contract Terms and Conditions

Arcadis' standard client and subcontractor contracts contain required terms and conditions defining responsibility for utility clearance and the allocation of risk associated with an impacted utility. These terms and conditions have prescribed language concerning subsurface work that is presented in Arcadis client contracts and Arcadis' subcontractor contracts, which can be found on the Legal Source site. If such provisions cannot be agreed upon, the reasons are documented and other risk-management actions should be identified, such as limits of liability, add additional physical investigations, additional lines of evidence or utility location, assignment of risk to subcontractors, etc. In addition, any changes to these terms and conditions require approval by Legal Services.

6. TRAINING

Employees responsible for coordinating or conducting utility clearance activities will be familiar with the requirements of this standard. Arcadis in-house 8-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) refresher may provide awareness-level training regarding this utility location and clearance standard.

7. REFERENCES (regulation citation, technical links, publications, etc.)

- Utility and Structures Checklist
- Utility Line Strike Investigation Form
- ARC HSFS-019 Supplement 1, Best Practices for Project Managers (or Their Delegates) Concerning Utility Clearance
- ARC HSFS-019 Supplement 2, Best Practices for Field Personnel Concerning Utility Clearance
- ARC HSFS-019 Supplement 3, Use and Limitations Associated with Location Technologies and Common Utility Clearance Methods
- ARC HSFS-019 Supplement 4, Best Practices for State One Call Procedures and Notifications
- ARC HSFS-019 Supplement 5, Emergency Action Plan guidelines for Utility Strikes
- ARC HSFS-019 Supplement 6, Utility Location SOP for Aquatic Work Activities
- Figure 1 – 30-Inch Tolerance Zone
- ARC HSCS005 Excavation and Trenching
- ARC HSFS0006 Electrical Safety Standard
- One Call and State Law Directory

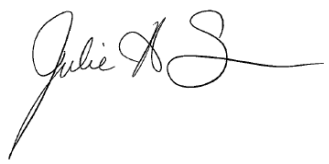
8. RECORDS - DATA RECORDING AND MANAGEMENT

8.1 Utility Clearance Records

All records (maps, checklists and documentation of communications) used to determine the location of utilities should be retained and kept in the project file.

9. APPROVALS AND HISTORY OF CHANGE

Approved By: Julie Santaniello, CSP – Corporate H&S, Manager of Technical Programs



Implementation Date 13 December 2006	HS Standard Name Utility Location and Clearance	SOP # P-03
Revision Date 17 March 2017	HS Standard No. ARCHSFS019	Revision Number 16

History of Change

Revision Date	Revision Number	Standard Developed/Reviewed By or Revised By	Reason for change
13 December 2006	01	Mike Thomas/Pat Vollertsen	Original document
26 March 2007	02	Mike Thomas/Pat Vollertsen	Put in new company format
15 May 2007	03	Mike Thomas/Pat Vollertsen	Added nation-wide 811 number
6 September 2007	04	Mike Thomas/Pat Vollertsen	Changing over to new template format
22 February 2008	05	Mija Coppola	Changing over to new template format
13 January 2009	06	Mija Coppola	Define lines of evidence
4 October 2010	07	Sam Moyers/Mija Coppola	Reformatting and addition of utility clearance information
13 February 2012	08	Sam Moyers/Mija Coppola	Modified link information for utility strike reporting, clarified local/state requirements in section 4.1 and 4.3
28 January 2013	09	Tony Tremblay	Utility and Structures Checklist revised; hyperlink updated
12 February 2013	10	Amanda Tine/Tony Tremblay	Clarified clearance boundaries for Unqualified staff in Section 5.7 and added information about vehicles and equipment being used near power lines in Section 5.7.1

Revision Date	Revision Number	Standard Developed/Reviewed By or Revised By	Reason for change
15 March 2013	11	Kurt Merkle, Rebecca Lindeman / Tony Tremblay	Added additional text to standard for recent lessons learned, added section 5.4 (Locating Technologies) and 5.5 (Clearance Methodologies), added additional details to section 5.6 when working in close proximity to subsurface utilities, and added Supplement 6 - Utility Location SOP for Aquatic Work Activities.
07 July 2013	12	Andrew McDonald/ Tony Tremblay	Removed HSFS-019 Supplement 1, Utility Definitions. Added hyperlink for One Call and State Law Directory. Segregated evidence of sewer or storm drains in USC list. Removed Sam Moyers and added Andrew McDonald as author.
26 September 2014	13	Andrew McDonald/Tony Tremblay	Added Exhibit 1. Definitions and 30 inch tolerance zone. Clarified use of 811 or state one call as a reliable line of evidence. Added best practice to cover backfilling of pre-cleared boreholes. Updated USC list to cover soft dig termination depths and PM review.
23 February 2015	14	Tony Tremblay	Page number correction

Revision Date	Revision Number	Standard Developed/Reviewed By or Revised By	Reason for change
10 May 2016	15	Denis Balcer/Sharon Lingle/Alec MacAdam/Andrew McDonald/Tony Tremblay/Julie Santaniello	ES and Section 4.2 - define subsurface intrusive work; clarify employees providing oversight of utility contractors, Arcadis requirements of operating and interpreting results of utility clearance equipment, and utility clearance before all subsurface intrusive work. Sections 1 and 5.8- changed submarine to submerged. Section 4.1 – added contacting public utility companies to help clear utilities. Section 4.2 – Clarified requirement to complete one year of utility clearance-related experience. Section 4.2 and 4.3 - Added discussion on aboveground activities causing subsurface disturbances. Added responsibility to clear overhead utilities when heavy equipment will be used and to evaluate use of a spotter. Added that repairs to damaged utilities need to be verified as competent and complete. Section 5.2 – Clarified reliable lines of evidence for each subsurface intrusive work point and degrees of certainty. Added all work within 30-inch Tolerance Zone needs Corp H&S preapproval. Section 5.6 and Exhibit 1- Clarify subsurface intrusive work and activity and exemptions for subsurface intrusive work. Section 5.6.1 – Add requirement to evaluate aboveground activities that may lead to subsurface disturbances that may cause damage to shallow underground utilities or structures.

Implementation Date 13 December 2006	HS Standard Name Utility Location and Clearance	SOP # P-03
Revision Date 17 March 2017	HS Standard No. ARCHSFS019	Revision Number 16

Revision Date	Revision Number	Standard Developed/Reviewed By or Revised By	Reason for change
10 May 2016	15	Denis Balcer/Sharon Lingle/Alec MacAdam/Andrew McDonald/Tony Tremblay/Julie Santaniello	Section 5.7.2 – added non-electric overhead utilities and structures other than power lines need to be identified and marked if working in that area. Section 9 – Changed reviewer from Tony Tremblay to Julie Santaniello. Exhibit 1 – added definitions of Utility Strike, Daylighting, Potholing, Subsurface Intrusive Work, Subsurface Intrusive Activities, and Utility Bank. Standard and Supplements placed on new Arcadis headers. Updated Supplement revision numbers to be consistent with standard. Supplement 2 revised. Utility Clearance and Structures Checklist and Utility Strike Investigation Form revised.
17 March 2017	16	Alec MacAdam/Julie Santaniello	Hyperlink updates; minor formatting; Utility Clearance and Structures Checklist revised.

EXHIBIT 1 – DEFINITIONS

Aboveground Utilities - For the purpose of this procedure, aboveground utilities include, but are not limited to: any aboveground line, pipe, conduit, system, or facility used for producing, storing, conveying, transmitting or distributing communication or telecommunications signals, electricity, gas, liquid, petroleum and petroleum products, coal slurry, hazardous liquids or gases, water under pressure, steam, sanitary sewage, storm water, or other materials, liquids, or gases.

Daylighting – exposing underground utilities or structures through soft dig technology/clearance prior to completing subsurface intrusive activities.

Excavation - Any man-made cut, cavity, trench, or depression, in an earth surface formed by earth removal into which a person can bodily enter.

Overhead Utilities and Structures – Overhead water lines, overhead pipe chases, ceilings in buildings.

Potholing – exposing underground utilities or structures through soft dig technology/clearance prior to completing subsurface intrusive activities.

Subsurface Intrusive Activities – For the purposes of this procedure, subsurface intrusive activities include, but are not limited to: excavations, vertical drilling, installing grounding rod, soil sampling, etc,

Subsurface Intrusive Work – Is any work or activity that breaks the plane of the ground surface. Exemptions include soil sampling using a non-conductive sampling tool to a depth of 6 inches below ground surface (bgs), placement of survey flagging to a depth of 6 inches bgs, and placement of non-conductive survey stake(s) to a depth of 6 inches bgs).

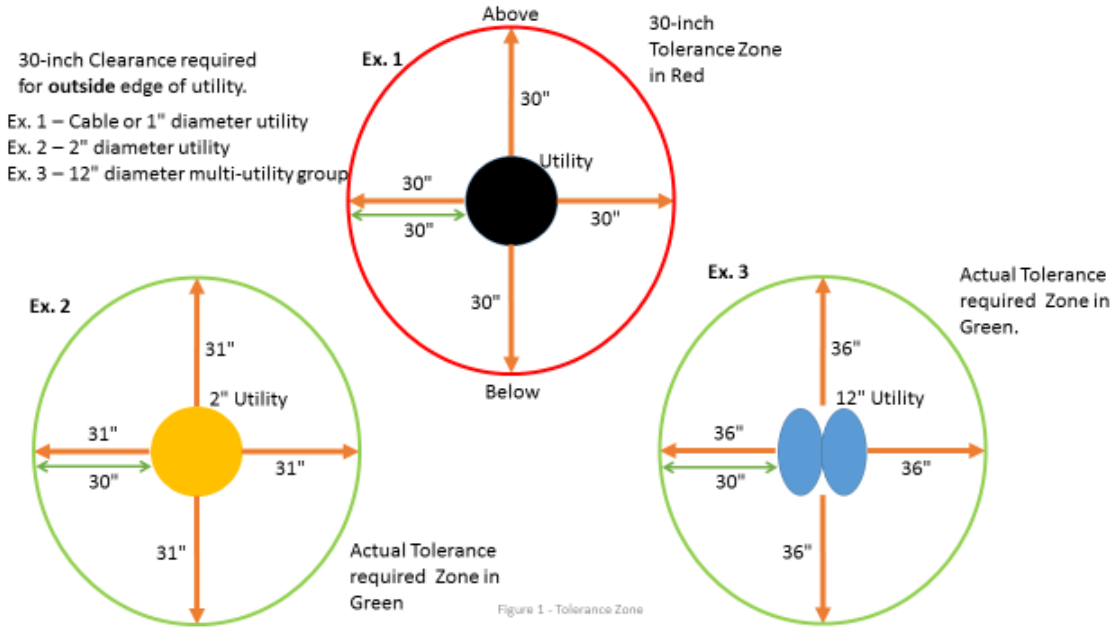
Subsurface Utilities - For the purposes of this procedure, subsurface utilities include, but are not limited to: any underground line, pipe, conduit, system, or facility used for producing, storing, conveying, transmitting or distributing communication or telecommunications signals, electricity, gas, liquid, petroleum and petroleum products, coal slurry, hazardous liquids or gases, water under pressure, steam, storm water, or sanitary sewage; underground storage tanks; tunnels and cisterns; and septic tanks and lines.

Tolerance Zone – The area within 30 inches in all directions from the outside diameter of a located/marked utility in which special care is to be taken. If the centerline of the utility is marked, the diameter of the utility or utility bank/trench must be incorporated into the 30 inches. This area must be hand cleared with non-mechanized equipment. Once the utility has been exposed, if mechanized equipment is planned for use within the 30-inch Tolerance Zone of the utility, such activity must receive pre-approval by Corporate H&S, to mitigate or accept the risk associated with the planned work. See Figure 1 – 30-inch Tolerance Zone.

Utility Bank – a structure containing two or more conduits. A conduit is a single enclosure containing one or more facilities.

Utility Strike – An unplanned contact of a utility (i.e., overhead and structures, aboveground, underground or submerged) during the course of work that results in damage requiring repairs, making a report to the utility owner or requiring further assessment to evaluate the potential for damage

EXHIBIT 2 – FIGURE 1 – TOLERANCE ZONE



ENV Quality Procedure - SOP # P-04	
TOPIC: **CALIBRATION AND CONTROL OF MEASURING AND TEST EQUIPMENT**	
Revision Date: November 2016 **Revision Letter: C**	**QP#: 3.07**

STATEMENT OF POLICY:

The Arcadis Environment Business Line (ENV) uses measuring and test equipment in the course of its activities. Equipment used by ENV and their subcontractors must be in the condition required for the performance of specified activities. A procedure for performing and documenting calibration and for the preventive maintenance of measuring and test equipment will be followed to provide necessary controls.

1. Purpose

The objective of this Quality Procedure (QP) is to provide a standard procedure for the calibration and control of measuring and test equipment, including establishing the correct equipment type, range, accuracy, and precision to meet data collection needs. Equipment must be uniquely identified, calibrated against recognized standards that are clearly identified and documented, and maintained to provide reliable performance and to meet ENV quality requirements.

2. Responsibilities

Certified Project Manager – responsible for implementation of this procedure.

Field Supervisor – responsible for field equipment and for communicating calibration and maintenance procedures for equipment used by ENV staff. Similar requirements for field equipment calibration and maintenance should also be communicated to subcontractors using field equipment. Subcontractors are responsible for following those requirements and are subject to performance audits.

Quality Consultant – responsible for providing quality assurance and quality control guidance to the CPM in implementing this procedure.

Project Team Members – project team members are responsible for verifying calibration status prior to using the equipment, and for operating equipment by approved procedures, documenting information, and reporting equipment malfunctions.

3. Terms and Definitions

Accuracy – a qualitative evaluation of the agreement between an individual value (or the central tendency of a set of values) and the correct value or the accepted reference value.

Calibration – the process of evaluating and standardizing an instrument by determining the deviation from a known standard.

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Measuring and Test Equipment – devices or systems used to calibrate, measure, gauge, test, or inspect in order to acquire data.

Precision – a qualitative evaluation of measurement data used to describe the dispersion of a set of numbers with respect to its central tendency.

4. Related Forms

Not applicable.

DESCRIPTION OF PROCEDURE:

Measuring and test equipment will be controlled by a calibration and preventive maintenance program. Instruments that measure a quantity or whose performance must meet stated criteria will be subject to calibration. Calibration of equipment may be performed internally using reference equipment and standards, or externally by agencies or manufacturers. Two types of calibration are presented in this procedure:

- Operational calibration, which is routinely performed as part of instrument usage.
- Periodic calibration, which is performed at prescribed intervals for equipment such as water-level indicators, pressure recording devices, and thermometers. In general, equipment that can be calibrated periodically is relatively stable in performance.

Preventive maintenance is an organized and documented program of equipment cleaning, lubricating, reconditioning, adjusting, and/or testing intended to maintain proper performance, prevent equipment from failing during use, and maintain reliability.

1. Calibration Procedures

Documented procedures must be used for calibrating measuring and test equipment and reference equipment. Procedures such as those published by ASTM International (formerly known as the American Society for Testing and Materials), U.S. Environmental Protection Agency (USEPA), or procedures provided by manufacturers will be used whenever possible.

Where pre-established procedures are not available, procedures will be developed. Factors such as the type of equipment, stability characteristics of the equipment, required accuracy and precision, and the effect of error on the quantities measured must be taken into account. Calibration procedures must include:

- Type of equipment to be calibrated
- Reference equipment and standards to be used
- Calibration method and specific procedure

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- Acceptance tolerances
- Frequency of calibration
- Data recording form.

2. Equipment Identification

Measuring and test equipment owned by Arcadis must be uniquely identified using the manufacturer's serial number, a calibration system identification number, or an inventory control tag number. This identification must be attached to the equipment. In addition to the identification number, equipment requiring periodic calibration must bear a label indicating when the next calibration is due. Equipment that is rented or leased for the purposes of measuring and testing must also be uniquely identified.

Personnel are responsible for verifying calibration status from due date labels or instrument records prior to using the equipment. Measuring and test equipment that is not properly calibrated must not be used.

3. Calibration Frequency

Measuring and test equipment and reference equipment will be calibrated at prescribed intervals and/or as part of operational use. The calibration frequency will depend on the type of equipment, inherent stability, manufacturer's recommendations, intended use, effect of error on the measurement process, and experience. Calibration frequencies may be defined in project-specific plans or in calibration procedures. The CPM or Field Supervisor is responsible for specifying the procedures to be followed to meet project data quality objectives.

Scheduled periodic calibration may not be performed for infrequently used equipment; such equipment will be calibrated on an "as needed" basis prior to use, and then at the required frequencies for the duration of its use.

Field equipment will require an operational check per the applicable procedure and or the equipment manual prior to use, and then again at the end of the working day. Pre-use calibration should be completed under conditions of anticipated use (e.g., temperature, humidity, and atmospheric pressure) if these parameters may influence results.

4. Reference Equipment and Standards

Whenever possible, equipment must be calibrated using reference equipment (i.e., physical standards) and chemical and radioactive standards having known relationships to nationally recognized standards (e.g., National Institute of Standards and Technology [NIST]) or accepted values of natural physical constants. If national standards or constants do not exist, the basis for the calibration must be documented.

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Physical standards may include calibration weights, certified thermometers, standard measurement tapes, gauge blocks, and reference gauges. These are generally used for periodic calibrations. Physical standards must be used only for calibration.

Chemical and radioactive standards may include reagents, solvents, and gases. These may be Standard Reference Materials (SRM) provided by NIST or USEPA, or they may be vendor-certified materials traceable to NIST or USEPA SRMs. Chemical and radioactive standards will primarily be used for operational calibrations.

The date of receipt and expiration date must be clearly labeled on the container of each standard. If calibration standards are transferred to additional containers, these containers must be labeled with the name of the standard, the lot number, and the shelf life. Calibration standards that exceed shelf life must not be used and must be discarded.

If equipment is sent to the manufacturer or calibration laboratory for calibration, adequate documentation must be maintained to establish the calibration method, reference standard source, or traceability to recognized standards.

5. Calibration Failure

Equipment failing calibration or becoming inoperable during use will be removed from service and segregated to prevent inadvertent use, or tagged to indicate it is out of service. The equipment must be repaired and properly recalibrated; equipment that cannot be repaired will be replaced.

The results of activities involving equipment that has failed recalibration will be evaluated by the CPM. If the results are adversely affected, the findings of the evaluation will be documented and appropriate personnel will be notified.

Periodic calibration of measuring and test equipment does not replace the user's responsibility for verifying proper function of equipment. If an equipment malfunction is suspected, the device must be tagged or removed from service, and recalibrated. If it fails recalibration, it must be repaired or replaced.

6. Documentation of Calibration

Records must be maintained for each piece of calibrated measuring and test equipment and each piece of reference equipment. The records must indicate that established calibration procedures have been followed, and that the accuracy of reference chemical and radioactive standards has been verified.

Records for periodically calibrated equipment must include the following minimum information:

- Type and identification number of equipment
- Calibration frequency and acceptance tolerances

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- Calibration dates
- Name of individual and organization performing the calibration
- Reference equipment and/or standards used for calibration
- Calibration data
- Certificates or statements of calibration provided by manufacturers and external organizations
- Documentation of calibration acceptance or failure, and of repair of failed equipment.

For equipment requiring calibration, information should be maintained in a project or equipment database regarding the calibration and maintenance history for that equipment. Equipment that does not have a calibration sticker or that has an expired calibration sticker should be tagged inoperable and sent for calibration. The equipment information file should contain periodic calibration files, as well as equipment calibration and maintenance records, calibration data forms, and/or certification of calibration provided by manufacturers or external organizations, and notice of equipment calibration failure.

Measuring and test equipment used for field investigations will typically be calibrated as part of operational use. For this equipment, records of the calibrations or checks will be documented as part of the test data (e.g., in the field notebook or on a Field Activity Log). Equipment-specific forms may also be developed. These records should include information similar to that required for periodically calibrated equipment. Documentation related to malfunctioning equipment or equipment that fails calibration should also be included in the individual equipment file.

Calibration files for equipment requiring periodic calibration should be sent with equipment that is transferred to allow a continuously updated record to be maintained. Recalibration of sensitive equipment should be performed following the transfer.

When measuring and test equipment is rented or leased, procurement documents must specify that a current certificate of calibration must accompany the equipment. This certificate must be maintained with the project documentation calibration records.

7. Operational Checks

Certain equipment may require periodic operability tests or checks to verify that operating systems are within the allowed range. These tests are in addition to formal calibration. Like calibrations, these tests will be performed at specified frequencies, or as part of operational use using reference equipment and standards.

If an instrument fails an operability test, and corrective action cannot bring the instrument into tolerance, it must be removed from service and segregated to prevent inadvertent use, or tagged to indicate it is out of service. Such equipment will be repaired and/or recalibrated.

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Operability tests will generally be performed in conjunction with data acquisition. Information recorded must include:

- Type and identification number of equipment (e.g., model and serial numbers)
- Test date
- Name of individual and organization performing the test
- Reference equipment and standards used
- Test data
- Documentation of acceptance or failure.

Documentation may be in the field notebook or on a Field Activity Log.

8. Preventive Maintenance

Preventive maintenance is an organized program of equipment cleaning, lubricating, reconditioning, adjusting, and/or testing intended to maintain proper performance, prevent equipment from failing during use, and maintain reliability. Specific maintenance details may be supplied in project-specific plans. A typical preventive maintenance program includes:

- A listing of the equipment that is included in the program
- The frequency of maintenance (manufacturer's recommendations or previous experience with the equipment)
- Service contracts
- Identification of spare parts
- Items to be checked and specific protocols to be followed
- Documentation of maintenance.

Maintenance records of measuring and test equipment must be maintained at the location that is the host for the equipment. Documentation of subcontractor and Arcadis equipment that is used for an individual project will be included in the project files. Records for multi-project equipment will be maintained by the location that controls the equipment.

Measuring and test equipment must be controlled through the use of sign-out/sign-in records or other suitable method. Equipment that is returned from field use must be free of contamination, packaged in a manner suitable for storage, and returned to its designated area. Support personnel should be notified of performance problems with equipment.

— END OF PROCEDURE —

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ENV Quality Procedure - SOP # P-05	
TOPIC: FIELD SAMPLING, MEASUREMENT, AND OBSERVATIONS	
Revision Date: October 2017 Revision Letter: D	QP#: 3.08

STATEMENT OF POLICY:

It is Arcadis Environment Business Line (ENV) policy that field sampling, measurements, and observations must be conducted and documented to facilitate later data interpretation, provide an evidentiary record and to demonstrate that field activities have been performed consistently and in accordance with approved site-specific project planning documents. Site-specific documents describing field sampling activities may include, but are not limited to, work plans, the Project Quality Plan (PQP), Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), applicable Standard Operating Procedures (SOPs) and Technical Guidance Instructions (TGIs), Quality Procedures (QPs), Health and Safety Plan (HASP), and/or other appropriate project documents associated with the sampling program.

1. Purpose

The objective of this Quality Procedure (QP) is to provide a consistent process for the execution of activities associated with field sampling, measurements, and observations. This QP, while focused on field sampling activities, should be performed in conjunction with QP 3.06 Field Activities Documentation.

2. Responsibilities

Certified Project Manager (CPM) – is responsible for implementation of this QP, including verification that site-specific project planning documents are followed (including approved deviation decisions, if necessary). Although a Field Supervisor may lead the sampling activities, the CPM is ultimately responsible for staff's adherence to this QP.

Quality Consultant – responsible for providing quality assurance and quality control (QA/QC) guidance to the CPM in implementing this procedure. Note that for Federal projects there are specific requirements for the QA officer assigned to a project.

Project Team Members – project participants who are involved in sampling activities are responsible for compliance with this procedure. Individuals involved in the sampling program will read and adhere to the site-specific project planning documents that direct their field activities.

3. Terms and Definitions

Work Plan – a document that describes proposed project activities.

Quality Assurance Project Plan (QAPP) – a document that prescribes the quality assurance/quality control procedures to be followed. Uniform Federal Policy (UFP)-QAPPs are now frequently required for environmental projects by most federal regulatory agencies. UFP-QAPP includes Worksheets used to document the entire project plan developed following the systematic planning process. For more details on the UFP-QAPP see: http://www.epa.gov/fedfac/documents/qualityassurance.htm. Note that if the project QAPP is written following the

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Uniform Federal Policy (UFP) that it will also contain a description of the sampling rationale and sampling locations as well as quality assurance/quality control requirements. The UFP-QAPP format is designed to capture the entire systematic planning process. If a UFP-QAPP is written for a project, a separate FSP may not be required unless specified by the particular regulatory agency, client or contract.

Field Sampling Plan (FSP) – a document that describes the procedures and protocols necessary to complete field sampling and data collection activities.

Health and Safety Plan (HASP) – a document that describes the hazards of planned activities and the controls to be implemented to protect site personnel.

Data Quality Objective (DQO) – a statement that specifies the quality of data required to support the purposes and intent of the sampling and analysis activity. DQOs are based on the intended use of the data; as such, different data uses and needs may require different levels of data quality.

Standard Operating Procedures (SOP) and Technical Guidance Instruction (TGI) – Documents that describe a procedure and/or protocol necessary to conduct a specific field activity. SOPs/TGIs may also be created or revised on a program or project specific basis. An SOP/TGI library is available on The Source.

4. Related Forms

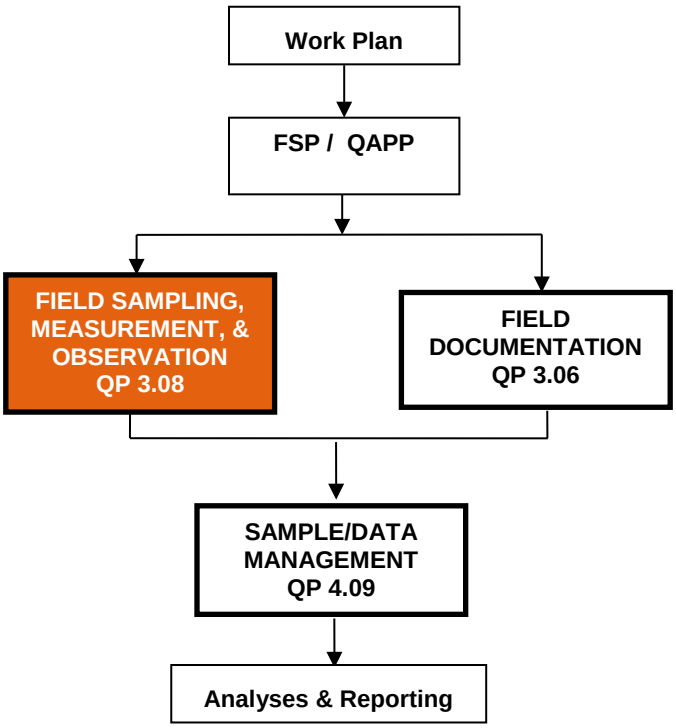
Forms such as purge logs, soil boring logs appropriate for the field sampling activity and observations.

DESCRIPTION OF PROCEDURE:

Sampling and data quality directly affect overall project success because sampling and other field activities are a critical and fundamental component of projects. Errors, mistakes, missed communications, or out-of-scope or out-of-compliance actions may have an adverse effect on a project. Because field conditions cannot be anticipated absolutely, procedures for a particular sampling program must include a formal process for making decisions and obtaining appropriate approvals for deviations necessitated by conditions. Within this context, the basic procedures and requirements for sampling and other field measurements and observations are outlined in the project documents (FSP, QAAP or Work Plan) and the associated procedures. Sample collection, data collection, and drilling locations should be documented (i.e., tape measurements with respect to site features, GPS measurements, and or survey by a licensed land surveyor). It is also recommended taking to the field site maps showing pre-existing and proposed sampling, drilling, data collection, and well locations. It is also recommended the field staff be aware of previous data measurements so field staff can note and communicate any significant changes.

The following flow chart provides the major components of a typical field characterization program and highlights where field sampling activities fit in.

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1. Field Sampling, Measurement, and Observation Activities

Field operations are conducted to provide reliable information, data, and/or samples that meet the project and data quality objectives. It is essential that field sampling, measurement, and observation activities begin with the field team having a detailed familiarity with appropriate site-specific project planning documents, most notably the FSP. Time should be scheduled and budgeted for the field team members to review the plan(s) and ask questions. With a good understanding of what samples or data are to be collected, as well as where and why they are to be collected, field personnel will perform the following activities during the implementation of field characterization activities.

1.1 Briefing and Preparation

Before field activity begins, a kick-off meeting should be held to ensure that the project team understands the project objectives and the procedures that will be followed. The CPM and appropriate project office and field personnel (e.g., Field Supervisor, Crew Leader, or entire crew) should engage in a briefing via telephone discussion or in person to review (in summary fashion) the following:

- Project objectives and project plans
- DQOs
- Sampling locations
- SOPs/TGIs

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- Chain of command
- HASP
- Provisions for addressing deviations
- Other special circumstances or information critical to the success of the sampling event and integrity of the data and documentation.

When possible, the CPM and/or Field Supervisor should perform a reconnaissance site visit prior to initiation of the sampling or other field activities to review sample locations and consider health and safety or other logistical challenges the site may present. The CPM must also ensure that any utility clearance requirements have been met. Finally, the CPM and/or Field Supervisor must verify that the necessary subcontracts, notifications, and approvals are in place, including coordination with client personnel, agency oversight personnel, access to private or public property (i.e., legal), and coordination with utility companies/agencies regarding the potential of buried, overhead, or other sensitive infrastructure that may affect project implementation and/or health and safety.

1.2 Standard Operating Procedures and Technical Guidance Instructions

Applicable SOPs and TGIs must be followed to ensure consistency and quality in method and resulting data. An SOP/TGI library is available on The Source. SOPs and TGIs may also be created or revised on a program or project specific basis. Deviation from established procedure(s) during a data collection activity must be documented. Where plans and SOPs allow discretion (do A or B) or choice (exact sampling location) these decisions should be documented in the field notebook. In cases where the integrity of the data being collected may be jeopardized, field personnel must consider stopping associated work activities until the CPM or other project authority can be consulted as to what corrective action is warranted before work can recommence. Follow the hierarchy of regulatory, client, ENV in selecting and modifying methods and procedures.

1.3 Equipment and Instrumentation

The site-specific project planning documents will be reviewed to identify the types of equipment, instrumentation, and supplies that are needed for the sampling, measurement, observation, or other data collection activities. The selected equipment and instrumentation will meet the requirements of the specifications, methods, and procedures provided in the FSP, QAPP, HASP, or other planning document(s). Further, the Field Supervisor/Crew Leader is responsible for verifying that the equipment and instrumentation are in good working order, clean and, if necessary, properly calibrated and maintained before, during, and after use in the field. (See QP 3.07 Calibration and Control of Measuring and Test Equipment).

1.4 Physical Sample Management

It is extremely important that proper procedures be followed in the sample identification system employed for collected samples, the chain-of-custody procedures, and the manner in which the samples are tracked from collection point, through handling and shipment, and to receipt by the laboratory (including sampling techniques, sample volumes, holding times, preservation, packaging, and shipping procedures). Field personnel are

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responsible for obtaining the proper number and type of quality control samples, including but not necessarily limited to trip blanks, duplicates, matrix spikes, matrix spike duplicates, and equipment rinse blanks (these requirements should be specified in the site-specific project planning documents and reviewed prior to commencing the field program). These procedures are specified in the Work Plans, FSP, QAPP, and or HASP, or other project planning documents and shall be reviewed by field personnel prior to initiation of field activities. Deviation from established procedures could impact the integrity of the sample or activity; and must be justified, approved by the CPM, and be appropriately documented.

1.5 Qualitative Data Management

Based on requirements specified in site-specific project planning documents, field activities should adhere to applicable SOPs and WTGIs and be carried out in a consistent manner that is well documented in accordance with QP 3.06 Field Activities Documentation. This includes care in making and recording accurate and precise measurements and observations in a timely manner.

1.6 Decontamination

Field personnel will review and be familiar with required decontamination procedures, including those for cleaning field equipment, proper storage of cleaned field equipment, and for properly disposing of waste generated from decontamination procedures. If decontamination is conducted on site, the activities will be performed in a designated, controlled location that will not impact collected samples. Decontamination activities will be appropriately documented in the field notes, following the protocols specified in the FSP/QAPP or SOP/TGI and QP 3.06 Field Activities Documentation. Wastes generated in the field will be collected, stored, and properly disposed in accordance with FSP/QAPP protocols.

It is important to note that decontamination includes personal protective equipment as well as vehicles and equipment. It is critical that equipment used in one area not serve as a source of contamination of another. This may include weeds or affected soil/water (e.g., carried-in tires or equipment) that could be transported outside the designated work area. In particular, work in surface waters potentially supporting amphibians and other ecological resources may require specific decontamination procedures between sampling events even if no pollutants are anticipated in the waters.

1.7 Corrective Action

The CPM and field personnel will be familiar with site-specific project planning procedures designed to address deficiencies or deviations quickly and efficiently, so as not to unnecessarily hold up progress or compromise the integrity of the field effort. Based on the procedures established in the site-specific project planning documents, specific steps are taken as soon as a potential problem is identified. At a minimum, deficiencies or deviations must be reported to the CPM (through pre-established chain of command) and then fully documented to include the nature of the problem, the corrective action taken, and the person(s) responsible for correcting or otherwise

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addressing the problem. Site-specific project planning documents should contain site-specific corrective action procedures.

— END OF PROCEDURE —

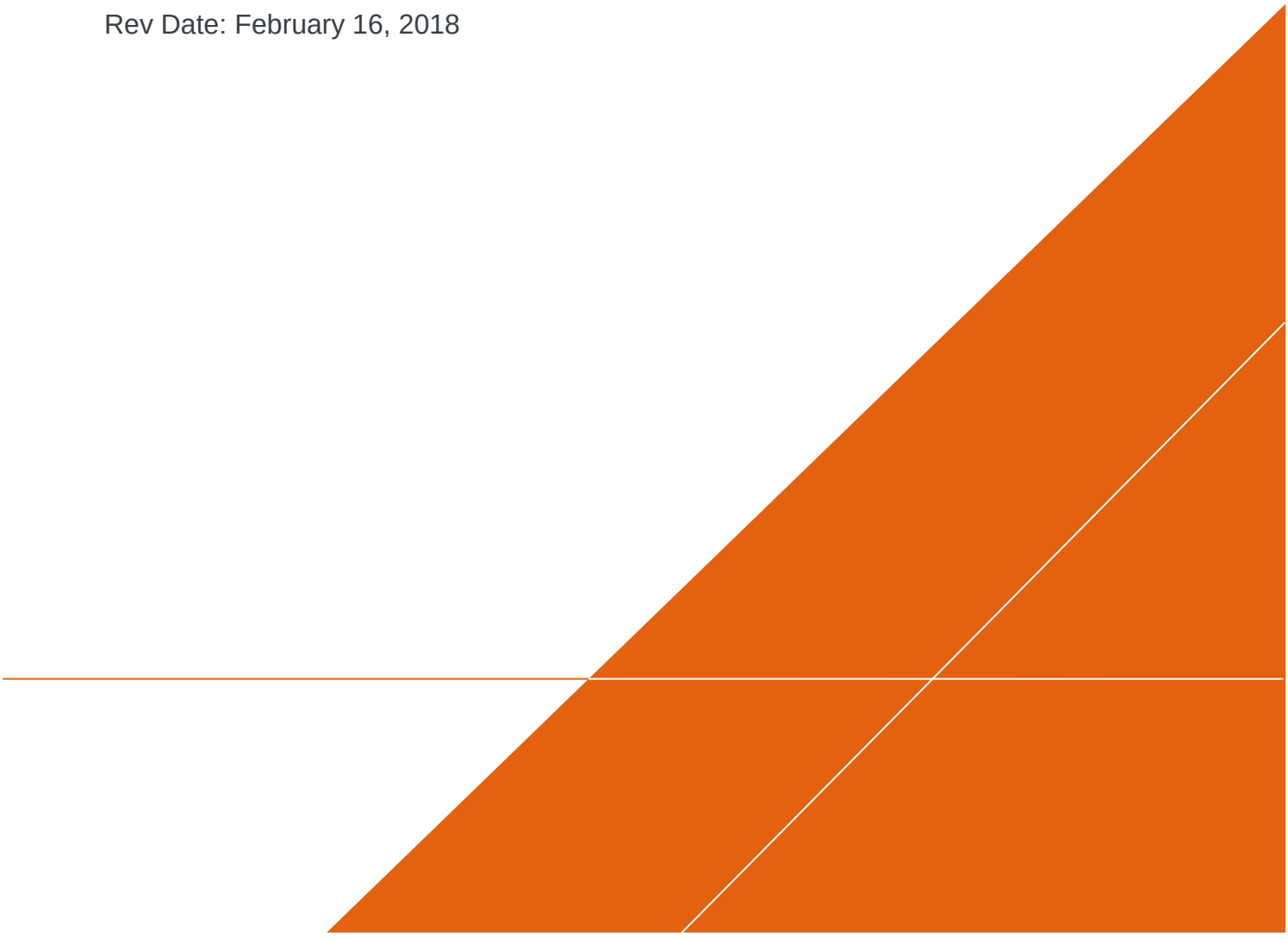
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SOP # P-06

TGI - SOIL DESCRIPTION

Rev: #2

Rev Date: February 16, 2018



SOP # P-06

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	May 20, 2008	17	Original SOP	Joe Quinnan Joel Hunt
1	September 2016	15	Updated to TGI	Nick Welty Patrick Curry
2	February 16, 2018	15	Updated descriptions, attachments and references in text	Nick Welty Patrick Curry

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APPROVAL SIGNATURES

Prepared by:		June 30, 2017
	Patrick Curry, PG	Date:
Technical Expert Reviewed by:		June 30, 2017
	Nicklaus Welty, PG	Date:

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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Arcadis Technical Guidance Instruction (TGI) describes proper soil description procedures. This TGI should be followed for unconsolidated material unless there is an established client-required specific procedure or regulatory-required specific procedure. In cases where there is a required specific procedure, it should be followed and should be referenced and/or provided as an appendix to reports that include soil classifications and/or boring logs. When following a required non-Arcadis procedure, additional information required by this TGI should be included in field notes with client approval.

This TGI has been developed to emphasize field observation and documentation of details required to:

- make hydrostratigraphic interpretations guided by depositional environment/geologic settings;
- provide information needed to understand the distribution of constituents of concern; properly design wells, piezometers, and/or additional field investigations; and develop appropriate remedial strategies.

This TGI incorporates elements from various standard systems such as ASTM D2488-06, Unified Soil Classification System, Burmister and Wentworth. However, none of these standard systems focus specifically on contaminant hydrogeology and remedial design. Therefore, although each of these

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systems contain valuable guidance and information related to correct descriptions, strict application of these systems can omit information critical to our clients and the projects that we perform.

This TGI does not address details of health and safety; drilling method selection; boring log preparation; sample collection; or laboratory analysis. Refer to other Arcadis procedure, guidance, and instructional documents, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan (HASP), as appropriate.

3 PERSONNEL QUALIFICATIONS

Soil descriptions should only be performed by Arcadis personnel or authorized sub-contractors with a degree in geology or a geology-related discipline. Field personnel will complete training on the Arcadis soil description TGI in the office and/or in the field under the guidance of an experienced field geologist with at least 2 years of prior experience applying the Arcadis soil description method.

4 EQUIPMENT LIST

The following equipment should be taken to the field to facilitate soil descriptions:

- field book, field forms or PDA to record soil descriptions;
- field book for supplemental notes;
- this TGI for Soil Descriptions and any project-specific procedure, guidance, and/or instructional documents (if required);
- field card showing Wentworth scale;
- Munsell® soil color chart;
- tape measure divided into tenths of a foot;
- stainless steel knife or spatula;
- hand lens;
- water squirt bottle;
- jar with lid;
- personal protective equipment (PPE), as required by the HASP; and
- digital camera

5 CAUTIONS

Drilling and drilling-related hazards including subsurface utilities are discussed in other procedure documents and site-specific HASPs and are not discussed herein.

Soil samples may contain hazardous substances that can result in exposure to persons describing soils. Routes for exposure may include dermal contact, inhalation and ingestion. Refer to the project specific HASP for guidance in these situations.

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6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with soil sampling and description will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Know what hazardous substances may be present in the soil and understand their hazards. Always avoid the temptation to touch soils with bare hands, detect odors by placing soils close to your nose, or tasting soils.

7 PROCEDURE

1. Select the appropriate sampling method to obtain representative samples in accordance with the selected sub-surface exploration method, e.g. split-spoon or Shelby sample for hollow-stem drilling, acetate sleeves for direct push, bagged core for sonic drilling, etc.
2. Proceed with field activities in required sequence. Although completion of soil descriptions is often not the first activity after opening sampler, identification of stratigraphic changes is often necessary to select appropriate intervals for selection of laboratory samples.
3. Set up boring log field sheet.
    - Drillers in both the US and Canada generally work in feet due to equipment specifications. Use the Arcadis standard boring log form (**Attachment A**).
    - The preferred boring log includes a graphic log of the principal soil component to support quick visual evaluation of grain size. The purpose of the graphic log is to quickly assess relative soil permeability. Note, for poorly sorted soils (e.g. glacial till), the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability. For example, for a dense sand/silt/clay till, the graphic log would reflect the silt/clay, rather than sand.
    - Record depths along the left-hand side at a standard scale to aid in the use of this tool. See an example completed boring log (**Attachment B**).
4. Examine each soil core (this is different than examining each sample selected for laboratory analysis), and record the following for each stratum:
    - depth interval;
    - principal component with descriptors, as appropriate;
    - amount and identification of minor component(s) with descriptors as appropriate;
    - moisture;
    - consistency/density;
    - color; and
    - additional description or comments (recorded as notes).
5. At the end of the boring, record the amount of drilling fluid used (if applicable) and the total depth logged.

The above is described more fully below.

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DEPTH

To measure and record the depth below ground surface (bgs) of top and bottom of each stratum, the following information should be recorded.

1. Measured depth to the top and bottom of sampled interval. Use starting depth of sample based upon measured tool length information and the length of sample interval.
2. Length of sample recovered, not including slough (material that has fallen into hole from previous interval), expressed as fraction with length of recovered sample as numerator over length of sampled interval as denominator (e.g. 14/24 for 14 inches recovered from 24-inch sampling interval that had 2 inches of slough discarded).
3. Thickness of each stratum measured sequentially from the top of recovery to the bottom of recovery.
4. Any observations of sample condition or drilling activity that would help identify whether there was loss from the top of the sampling interval, loss from the bottom of the sampling interval, or compression of the sampling interval. Examples: 14/24, gravel in nose of spoon; or 10/18 bottom 6 inches of spoon empty.

DETERMINATION OF COMPONENTS

Obtain a representative sample of soil from a single stratum. If multiple strata are present in a single sample interval, each stratum should be described separately. More specifically, if the sample is from a 2-foot long split-spoon where strata of coarse sand, fine sand and clay are present, then the resultant description should be of the three individual strata unless a combined description can clearly describe the interbedded nature of the three strata. Example: Fine Sand with interbedded lenses of Silt and Clay, ranging between 1 and 3 inches thick.

Identify principal component and express volume estimates for minor components on logs using the following standard modifiers.

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

Determination of components is based on using the Udden-Wentworth particle size classification (see below) and measurement of the average grain size diameter. Each size grade or class differs from the next larger grade or class by a constant ratio of ½. Due to visual limitations, the finer classifications of Wentworth's scale cannot be distinguished in the field and the subgroups are not included. Visual determinations in the field should be made carefully by comparing the sample to the Soil Description Field Guide (**Attachment C**) that shows Udden-Wentworth scale or by measuring with a ruler. Use of field sieves is encouraged to assist in estimating percentage of coarse grain sizes. Settling test or wash method (Appendix X4 of ASTM D2488) is encouraged for determining presence and estimating percentage of clay and silt. Note that "gravel" is not an Udden-Wentworth size class.

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Udden-Wenworth Scale Modified Arcadis, 2008			
Size Class	Millimeters	Inches	Standard Sieve #
Boulder	256 – 4096	10.08+	
Large cobble	128 - 256	5.04 -10.08	
Small cobble	64 - 128	2.52 – 5.04	
Very large pebble	32 – 64	0.16 - 2.52	
Large pebble	16 – 32	0.63 – 1.26	
Medium pebble	8 – 16	0.31 – 0.63	
Small pebble	4 – 8	0.16 – 0.31	No. 5 +
Granule	2 – 4	0.08 – 0.16	No.5 – No.10
Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
Clay (subgroups not included	1/2048 – 1/256	.00002 – 0.0002	

Identify components as follows. Remove particles greater than very large pebbles (64-mm diameter) from the soil sample. Record the volume estimate of the greater than very large pebbles. Examine the sample fraction of very large pebbles and smaller particles and estimate the volume percentage of the pebbles, granules, sand, silt and clay. Use the jar method, visual method, and/or wash method (Appendix X4 of ASTM D2488) to estimate the volume percentages of each category.

Determination of actual dry weight of each Udden-Wentworth fraction requires laboratory grain-size analysis using sieve sizes corresponding to Udden-Wentworth fractions and is highly recommended to determine grain-size distributions for each hydrostratigraphic unit.

Lab or field sieve analysis is advisable to characterize the variability and facies trends within each hydrostratigraphic unit. Field sieve-analysis can be performed on selected samples to estimate dry weight fraction of each category using ASTM D2488 Standard Practice for Classification of Soils for Engineering Purposes as guidance, but replace required sieve sizes with the following Udden-Wentworth set: U.S. Standard sieve mesh sizes 6; 12; 20; 40; 70; 140; and 270 to retain pebbles; granules; very coarse sand; coarse sand; medium sand; fine sand; and very fine sand, respectively.

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PRINCIPAL COMPONENT

The principal component is the size fraction or range of size fractions containing the majority of the volume. Examples: the principal component in a sample that contained 55% pebbles would be “Pebbles”; or the principal component in a sample that was 20% fine sand, 30% medium sand and 25% coarse sand would be “Sand, fine to coarse” or for a sample that was 40% silt and 45% clay the principal component would be “Clay and Silt”. Shade the boxes on the graphic log (**Attachment A**) up to and including the box with the principal component. The purpose of the graphical log is to provide a relative estimate of permeability. As noted above, for poorly sorted soils such as glacial till, the principal component may not correlate to permeability of the sample. In this case, the geologist should use best judgement to graph overall soil type consistent with relative soil permeability.

Include appropriate descriptors with the principal component. These descriptors vary for different particle sizes as follows.

Angularity – Describe the angularity for very coarse sand and larger particles in accordance with the table below (ASTM D-2488-06). Figures showing examples of angularity are available in ASTM D-2488-06 and the Arcadis Soil Description Field Guide.

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Sub-angular	Particles are similar to angular description but have rounded edges.
Sub-rounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

Plasticity – Describe the plasticity for silt and clay based on observations made during the following test method (ASTM D-2488-06).

- As in the dilatancy test below, select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
- Shape the test specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation. Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble when the soil is near the plastic limit.

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Description	Criteria
Non-plastic	A 1/8-inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Dilatancy – Describe the dilatancy for silt and silt-sand mixtures using the following field test method (ASTM D-2488-06).

- From the specimen select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material adding water if necessary, until it has a soft, but not sticky, consistency.
- Smooth the ball in the palm of one hand with a small spatula.
- Shake horizontally, striking the side of the hand vigorously with the other hand several times.
- Note the reaction of water appearing on the surface of the soil.
- Squeeze the sample by closing the hand or pinching the soil between the fingers, and not the reaction as none, slow, or rapid in accordance with the table below. The reaction is the speed with which water appears while shaking and disappears while squeezing.

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

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Note that silt and silt-sand mixtures will be non-plastic and display dilatancy. Clay mixtures will have some degree of plasticity but do not typically react to dilatancy testing. Therefore, the tests outlined above can be used to differentiate between silt dominated and clay dominated soils.

MINOR COMPONENT(S)

The minor component(s) are the size fraction(s) containing less than 50% volume. Example: the identified components are estimated to be 60% medium sand to granules, 25% silt and clay; 15 % pebbles – there are two identified minor components: silt and clay; and pebbles.

Include a standard modifier to indicate percentage of minor components (see Table on Page 6) and the same descriptors that would be used for a principal component. Plasticity should be provided as a descriptor for clay and clay mixtures. Dilatancy should be provided for silt and silt mixtures. Angularity should be provided as a descriptor for pebbles and coarse sand. For the example above, the minor constituents with modifiers could be: some silt and clay, low plasticity; little medium to large pebbles, sub-round.

SORTING

Sorting is the opposite of grading, which is a commonly used term in the USCS or ASTM methods to describe the uniformity of the particle size distribution in a sample. Well-sorted samples are poorly graded and poorly sorted samples are well graded. Arcadis prefers the use of sorting for particle size distributions and grading to describe particle size distribution trends in the vertical profile of a sample or hydrostratigraphic unit because of the relationship between sorting and the energy of the depositional process. For soils with sand-sized or larger particles, sorting should be determined as follows:

Well sorted – the range of particle sizes is limited (e.g. the sample is comprised of predominantly one or two grain sizes).

Poorly sorted – a wide range of particle sizes are present.

You can also use sieve analysis to estimate sorting from a sedimentological perspective; sorting is the statistical equivalent of standard deviation. Smaller standard deviations correspond to higher degree of sorting (see Remediation Hydraulics, 2008).

MOISTURE

Moisture content should be described for every sample since increases or decreases in water content is critical information. Moisture should be described in accordance with the table below (percentages should not be used unless determined in the laboratory).

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet (Saturated)	Visible free water, soil is usually below the water table.

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CONSISTENCY or DENSITY

This can be determined by standard penetration test (SPT) blow counts (ASTM D-1586) or field tests in accordance with the tables below. When drilling with hollow-stem augers and split-spoon sampling, the SPT blow counts and N-value is used to estimate density. The N-value is the blows per foot for the 6" to 18" interval. Example: for 24-inch spoon, recorded blows per 6-inch interval are: 4/6/9/22. Since the second interval is 6" to12", the third interval is 12" to 18", the N value is 6+9, or 15. Fifty blow counts for less than 6 inches is considered refusal. In recent years, more common drilling methods include rotary-sonic or direct push. When blow counts are not available, density is determined using a thumb test. Note however, the thumb test only applies to fine-grained soils.

Fine-grained soil – Consistency

Description	Criteria
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated one inch by thumb.
Medium stiff	N-value 9-15 or indented about ¼ inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty

Coarse-grained soil – Density

Description	Criteria
Very loose	N-value 1- 4
Loose	N-value 5-10
Medium dense	N-value 11-30
Dense	N-value 31- 50
Very dense	N-value >50

COLOR

Color should be described using simple basic terminology and modifiers based on the Munsell system. Munsell alpha-numeric codes are required for all samples. If the sample contains layers or patches of varying colors this should be noted and all representative colors should be described. The colors should be described for moist samples. If the sample is dry it should be wetted prior to comparing the sample to the Munsell chart.

ADDITIONAL COMMENTS (NOTES)

Additional comments should be made where observed and should be presented as notes with reference to a specific depth interval(s) to which they apply. Some of the significant information that may be observed includes the following.

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- Odor - You should not make an effort to smell samples by placing near your nose since this can result in unnecessary exposure to hazardous materials. However, odors should be noted if they are detected during the normal sampling procedures. Odors should be based upon descriptors such as those used in NIOSH “Pocket Guide to Chemical Hazards”, e.g. “pungent” or “sweet” and should not indicate specific chemicals such as “phenol-like” odor or “BTEX” odor.
- Structure
- Bedding planes (laminated, banded, geologic contacts).
- Presence of roots, root holes, organic material, man-made materials, minerals, etc.
- Mineralogy
- Cementation
- NAPL presence/characteristics, including sheen (based on client-specific guidance).
- Reaction with HCl - typically only used for special soil conditions, such as caliche environments.
- Origin, if known (Lacustrine; Fill; etc.).

EXAMPLE DESCRIPTIONS



51.4 to 54.0’ CLAY, some silt, medium to high plasticity; trace small to large pebbles, sub-round to sub-angular up to 2” diameter; moist, stiff, dark grayish brown (10 YR 4/2) NOTE: Lacustrine; laminated 0.1 to 0.2” thick, laminations brownish yellow (10 YR 4/3).



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32.5 to 38.0' SAND, medium to very coarse, sub-round to sub-angular; little granule and pebble, trace silt; poorly sorted, wet, grayish brown (10 YR 5/2).

Unlike the first example where a density of cohesive soils could be estimated, this rotary-sonic sand and pebble sample was disturbed during drilling (due to vibrations in a loose sand and pebble matrix) so no density description could be provided. Neither sample had noticeable odor so odor comments were not included.

The standard generic description order is presented below.

- Depth
- Principal Components
  - Angularity for very coarse sand and larger particles
  - Plasticity for silt and clay
  - Dilatancy for silt and silt-sand mixtures
- Minor Components
- Sorting
- Moisture
- Consistency or Density
- Color
- Additional Comments

8 WASTE MANAGEMENT

Project-specific requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

9 DATA RECORDING AND MANAGEMENT

Upon collection of soil samples, the soil sample should be logged on a standard boring log and/or in the field log book depending on Data Quality Objectives (DQOs) for the task/project. The preferred standard boring log is presented below and is included as **Attachment A**.

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The general scheme for soil logging entries is presented above; however, depending on task/project DQOs, specific logging entries that are not applicable to task/project goals may be omitted at the project manager's discretion. In any case, use of a consistent logging procedure is required.

Completed logs and/or logbook will be maintained in the task/project field records file. Digital photographs of typical soil types observed at the site and any unusual features should be obtained whenever possible. All photographs should include a ruler or common object for scale. Photo location, depth and orientation must be recorded in the daily log or log book and a label showing this information in the photo is useful.

10 QUALITY ASSURANCE

Soil descriptions should be completed only by appropriately trained personnel. Descriptions should be reviewed by an experienced field geologist for content, format and consistency. Edited boring logs should be reviewed by the original author to assure that content has not changed.

11 REFERENCES

Arcadis Soil Description Field Guide, 2008.

Munsell® Color Chart – available from Forestry Suppliers, Inc.- Item 77341 "Munsell® Color Soil Color Charts.

Field Gauge Card that Shows Udden-Wentworth scale – available from Forestry Suppliers, Inc. – Item 77332 "Sand Grain Sizing Folder."

ASTM D-1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM D-2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

United States Bureau of Reclamation. Engineering Geology Field Manual. United States Department of Interior, Bureau of Reclamation. http://www.usbr.gov/pmts/geology/fieldmap.htm.

Petrology of Sedimentary Rocks, Robert L. Folk, 1980, p. 1-48.

NIOSH Pocket Guide to Chemical Hazards.

Remediation Hydraulics, Fred C. Payne, Joseph A. Quinnan, and Scott T. Potter, 2008, p 59-63.

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ATTACHMENT A

Arcadis Standard Soil Boring Log Form

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SOIL BORING LOG

Boring/Well _____ Project _____ Page ___ of ___

Site Location _____ Drilling Started _____

Total Depth Drilled _____ Feet Hole Diameter _____ inches Drilling Completed _____

Type of Sample or Coring Device _____ Length and Diameter of Coring Device _____ Sampling Interval _____ feet

Drilling Method _____ Drilling Fluid Used _____

Drilling Contractor _____ Driller _____

Prepared By _____ Helper _____

Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	MUD		SAND					GRAVEL				**Udden-Wentworth Description:** principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, additional comments
			clay	silt	very fine	fine	medium	coarse	very coarse	granular	pebble	cobble	boulder	

SOP # P-06

SOIL BORING LOG (CONT'D)

Boring/Well _____ Prepared By _____ Page ____ of ____

Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	MUD		SAND					GRAVEL				Udden-Wentworth Description: principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, addtl. Comments
			clay	silt	very fine	fine	medium	coarse	very coarse	granular	pebble	cobble	boulder	

SOP # P-06

ATTACHMENT B

Example of Completed Arcadis Soil Boring Log

ARCADIS Design & Consultancy for natural and built assets

SOIL BORING LOG

Boring/Well SB-01 Project Example Page 1 of 1

Site Location Anytown, North America Drilling Started 6/26/17

Total Depth Drilled 20 Feet Hole Diameter 4.5 inches Drilling Completed 6/26/17

Type of Sample or Coring Device Continuous Length and Diameter of Coring Device 5', 2.25" macrocore Sampling Interval 5 feet

Drilling Method Geoprobe Drilling Fluid Used NA

Drilling Contractor Fibertec Driller Ryan Brown

Prepared By A. DeGrandis Helper Grant Berger

Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	MUD: clay	MUD: silt	SAND: very fine	SAND: fine	SAND: medium	SAND: coarse	SAND: very coarse	GRAVEL: granular	GRAVEL: pebble	GRAVEL: cobble	GRAVEL: boulder	Udden-Wentworth Description: principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, additional comments
	0.3	1	X	X	X	X	X							(0.0-4.0) SAND, fine to medium, sub-rounded; little granules to small pebbles, sub-rounded to sub-angular; trace silt; poorly sorted, dry to moist, dark grayish brown (10YR 4/2).
60" (HA)	0.1	2	X	X	X	X	X							
	0.0	3	X	X	X	X	X							
	0.0	4	X	X	X	X	X							
↓	1.4	5	X	X										NOTE: Ablation till.
	1.7	6	X	X										
	0.9	7	X	X										(4.0-10.0) SILT, non-plastic, rapid dilatancy; dry to moist, soft to medium stiff, gray (10YR 5/1).
52"	1.2	8	X	X										
	0.6	9	X	X										
↓	0.2	10	X	X										
	0.0	11	X	X	X	X	X							(10.0-15.5) SAND, fine, sub-rounded; trace silt; well sorted, moist to wet, pale brown (10YR 6/3).
	0.0	12	X	X	X	X	X							
60"	0.1	13	X	X	X	X	X							
	0.0	14	X	X	X	X	X							
↓	0.0	15	X	X	X	X	X							NOTE: wet at 12.0'
	0.2	16	X	X	X	X	X							
	0.0	17	X	X										(15.5-20.0) CLAY, high plasticity, no dilatancy; little silt; moist, soft to medium stiff, light gray (10YR 7/1) to dark gray (10YR 4/1).
58"	0.0	18	X	X										
	0.0	19	X	X										
↓	0.0	20	X	X										NOTE: Lacustrine, minor 0.1-0.25" lamination.
														End of boring - 20.0'

SOP # P-06

ATTACHMENT C

Arcadis Soil Description Field Guide

ON THE ORIGINAL DRAWING.
USE TO VERIFY FIGURE
REPRODUCTION SCALE

SOIL DESCRIPTION FIELD GUIDE (JUNE 30, 2017; REV. 2.0)

SOP # P-06

ARCADIS

FINE-GRAINED SOILS

Description	Criteria
	Descriptor - Plasticity
Nonplastic	A 1/8-inch (3mm) thread cannot be rolled at any moisture content.
Low	Thread can barely be rolled, and lump cannot be formed when drier than plastic limit.
Medium	Takes considerable time and rolling to reach plastic limit. Thread cannot be rolled after reaching plastic limit. Lump crumbles when drier than plastic limit.
High	Thread is easy to roll and quickly reaches plastic limit. Thread can be rerolled several times after reaching plastic limit. Lump can be formed without crumbling when drier than plastic limit.
	Descriptor - Dilatancy
No Dilatancy	No visible change when shaken or squeezed.
Slow	Water appears slowly on the surface of soil during shaking and does not disappear or disappears slowly when squeezed.
Rapid	Water appears quickly on surface of soil during shaking and disappears quickly when squeezed.
Minor Components with Descriptors	
	Moisture
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
	Consistency
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated 1 inch by thumb.
Medium stiff	N-value 5-8 or indented about 1/2 inch by thumb with great effort.
Stiff	N-value 9-15 or indented about 1/4 inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty.
Color using Munsell	
Geologic Origin (if known)	
Other	

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

10-15 feet CLAY, medium to high plasticity; trace silt; trace small to very large pebbles, subround to subangular up to 2" diameter; moist, stiff, dark grayish brown (10YR 4/2). NOTE: Lacustrine; laminated 0.1 to 0.2" thick, laminations brownish yellow (10YR 4/3).



DESCRIPTION ORDER

Depth Interval
Principal Components with Descriptors
Minor Components with Descriptors
Sorting
Field Moisture Condition
Density/Consistency
Color using Munsell
Geologic Origin (if known)
Other descriptions as NOTES:
- Odor
- Stratigraphy
- Structure
- Sphericity
- Cementation
- Reaction to acid

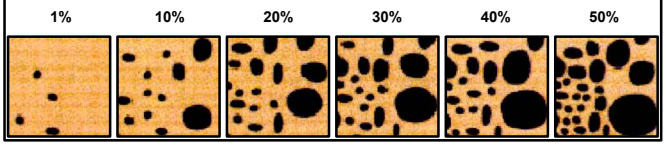
MINOR COMPONENTS % MODIFIERS

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

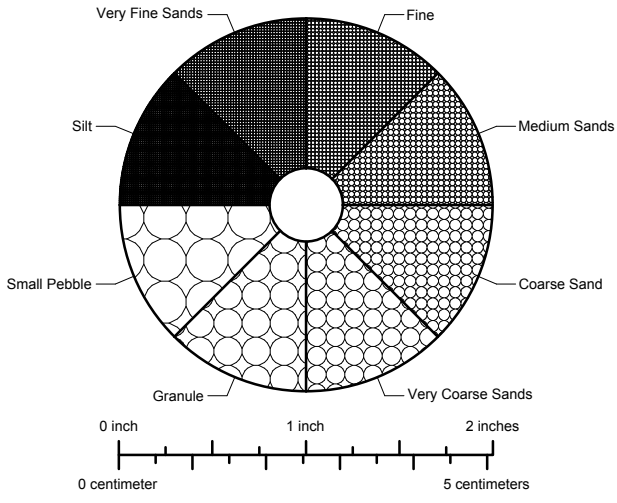
UDDEN-WENTWORTH SCALE

Fraction	Sieve Size	Grain Size	Approximate Scale
Boulder		256 - 4096 mm	Larger than volleyball
Large Cobble		128 - 256 mm	Softball to volleyball
Small Cobble		64 - 128 mm	Pool ball to softball
Very Large Pebble		32 - 64 mm	Pinball to pool ball
Large Pebble		16 - 32 mm	Dime size to pinball
Medium Pebble		8 - 16 mm	Pencil eraser to dime size
Small Pebble	No. 5+	4 - 8 mm	Pea size to pencil eraser
Granule	No. 10 - 5	2 - 4 mm	Rock salt to pea size
Very Coarse Sand	No. 18 - 10	1 - 2 mm	See field gauge card
Coarse Sand	No. 35 -18	0.5 - 1 mm	See field gauge card
Medium Sand	No. 60 - 35	0.25 - 0.5 mm	See field gauge card
Fine Sand	No. 120 - 60	0.125 - 0.25 mm	See field gauge card
Very Fine Sand	No. 230 - 120	0.0625 - 0.125 mm	See field gauge card
Silt and Clay. See SOP for description of fines	Not Applicable	<0.0625 mm	Analyze by pipette or hydrometer

PARTICLE PERCENT COMPOSITION ESTIMATION



GRAPH FOR DETERMINING SIZE OF PARTICLES



FOR COARSE-GRAINED SOILS

Description	Criteria
	Descriptor - Angularity
Angular	Particles have sharp edges and relatively planar sides withunpolished surfaces.
Subangular	Particles are similar to angular but have rounded edges.
Subround	Particles have nearly planar sides but have well-roundedcorners and edges.
Round	Particles have smoothly curved sides and no edges.
Minor Components with Descriptors	
	Sorting Cu= d60/d10
Well Sorted	Near uniform grain-size distribution Cu= 1 to 3.
Poorly Sorted	Wide range of grain size Cu= 4 to 6.
	Moisture
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet	Visible free water; soil is usually below the water table. (Saturated)
	Density
Very loose	N-value 1 - 4
Loose	N-value 5 - 10
Medium Dense	N-value 11 - 30
Dense	N-value 31 - 50
Very dense	N-value >50
Color using Munsell	
Geologic Origin (if known)	
Other	
	Cementation
Weak Cementation	Crumbles or breaks with handling or little finger pressure.
Moderate Cementation	Crumbles or breaks with considerable finger pressure.
Strong Cementation	Will not crumble with finger pressure.
	Reaction with Dilute HCl Solution (10%)
No Reaction	No visible reaction.
Weak Reaction	Some reaction, with bubbles forming slowly.
Strong Reaction	Violent reaction, with bubbles forming immediately.

EXAMPLE OF SOIL DESCRIPTION AND PHOTO

10 -15 feet SAND, medium to very coarse; little granules to medium pebbles, subround to subangular; trace silt; poorly sorted, wet, grayish brown (10YR5/2).



SOP # P-06 ARCADIS

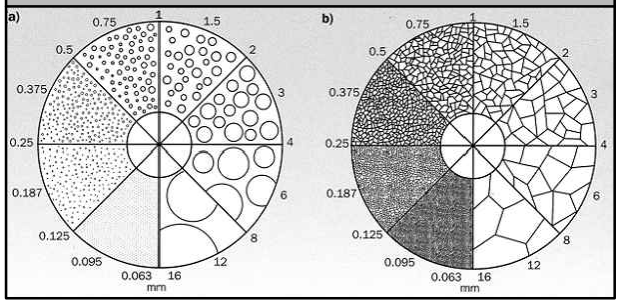
VARIATIONS IN SOIL STRATIGRAPHY

Term	Thickness of Configuration
Parting	0 - to 1/16-inch thickness.
Seam	1/16 - to 1/2-inch thickness.
Layer	1/2 - to 12-inch thickness.
Stratum	> 12-inch thickness.
Pocket	Small erratic deposit, usually less than 1 foot in size.
Varved Clay	Alternating seams or layers of sand, silt, and clay (laminated).
Occasional	≤ 1 foot thick.
Frequent	> 1 foot thick.

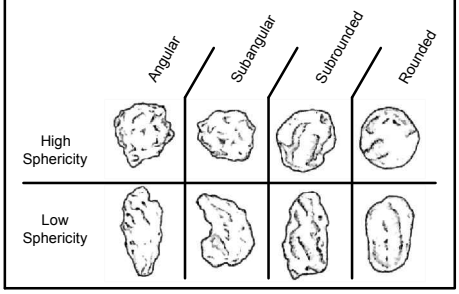
SOIL STRUCTURE DESCRIPTIONS

Term	Description
Homogeneous	Same color and appearance throughout.
Laminated	Alternating layers < 1/4 inch thick.
Stratified	Alternating layers ≥ 1/4 inch thick.
Lensed	Inclusions of small pockets of different materials, such as lenses of sand scattered through a mass of clay; note thickness.
Blocky	Cohesive soil can be broken down into small angular lumps, which resist further breakdown.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear to be polished or glossy, sometimes striated.

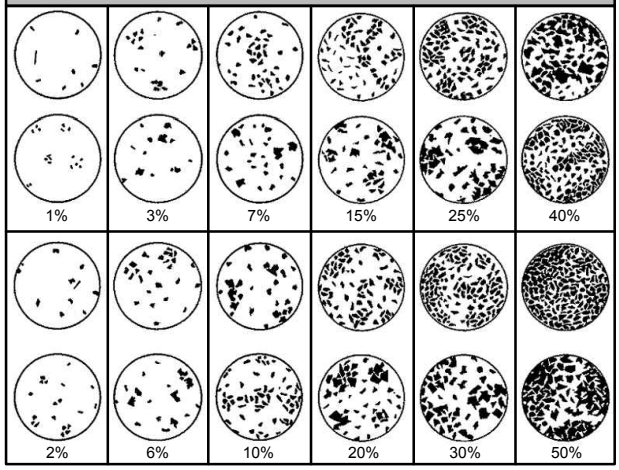
GRAPH FOR DETERMINING SIZE OF PARTICLES



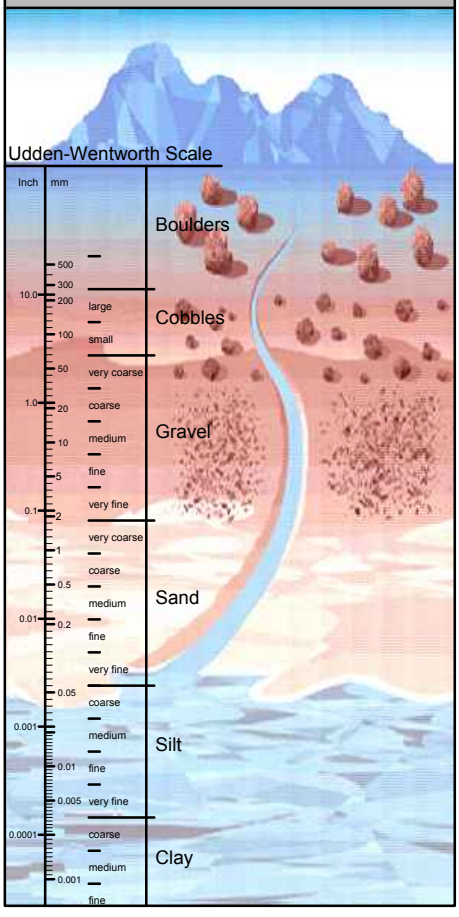
ANGULARITY CHART



PARTICLE PERCENT COMPOSITION ESTIMATION



SORTING



SETTLING TABLE (SILT/CLAY)

Diameter of Particle (mm)	<0.625	<0.031	<0.016	<0.008	<0.004	<0.002	<0.0005
Depth of Withdrawal (cm)	10	10	10	10	5	5	3
Time of Withdrawal	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec	hr:min:sec
Temperature (Celsius)							
20	00:00:29	00:01:55	00:07:40	00:30:40	00:61:19	04:05:00	37:21:00
21	00:00:28	00:01:52	00:07:29	00:29:58	00:59:50	04:00:00	
22	00:00:27	00:01:50	00:07:18	00:29:13	00:58:22	03:54:00	
23	00:00:27	00:01:47	00:07:08	00:28:34	00:57:05	03:48:00	
24	00:00:26	00:01:45	00:06:58	00:27:52	00:55:41	03:43:00	33:56:00
25	00:00:25	00:01:42	00:06:48	00:27:14	00:54:25	03:38:00	
26	00:00:25	00:01:40	00:06:39	00:26:38	00:53:12	03:33:00	
27	00:00:24	00:01:38	00:06:31	00:26:02	00:52:02	03:28:00	
28	00:00:24	00:01:35	00:06:22	00:25:28	00:50:52	03:24:00	31:00:00
29	00:00:23	00:01:33	00:06:13	00:24:53	00:49:42	03:10:00	
30	00:00:23	00:01:31	00:06:06	00:24:22	00:48:42	03:05:00	

10 inches
9 inches
8 inches
7 inches
6 inches
5 inches
4 inches
3 inches
2 inches
1 inch
1/10in

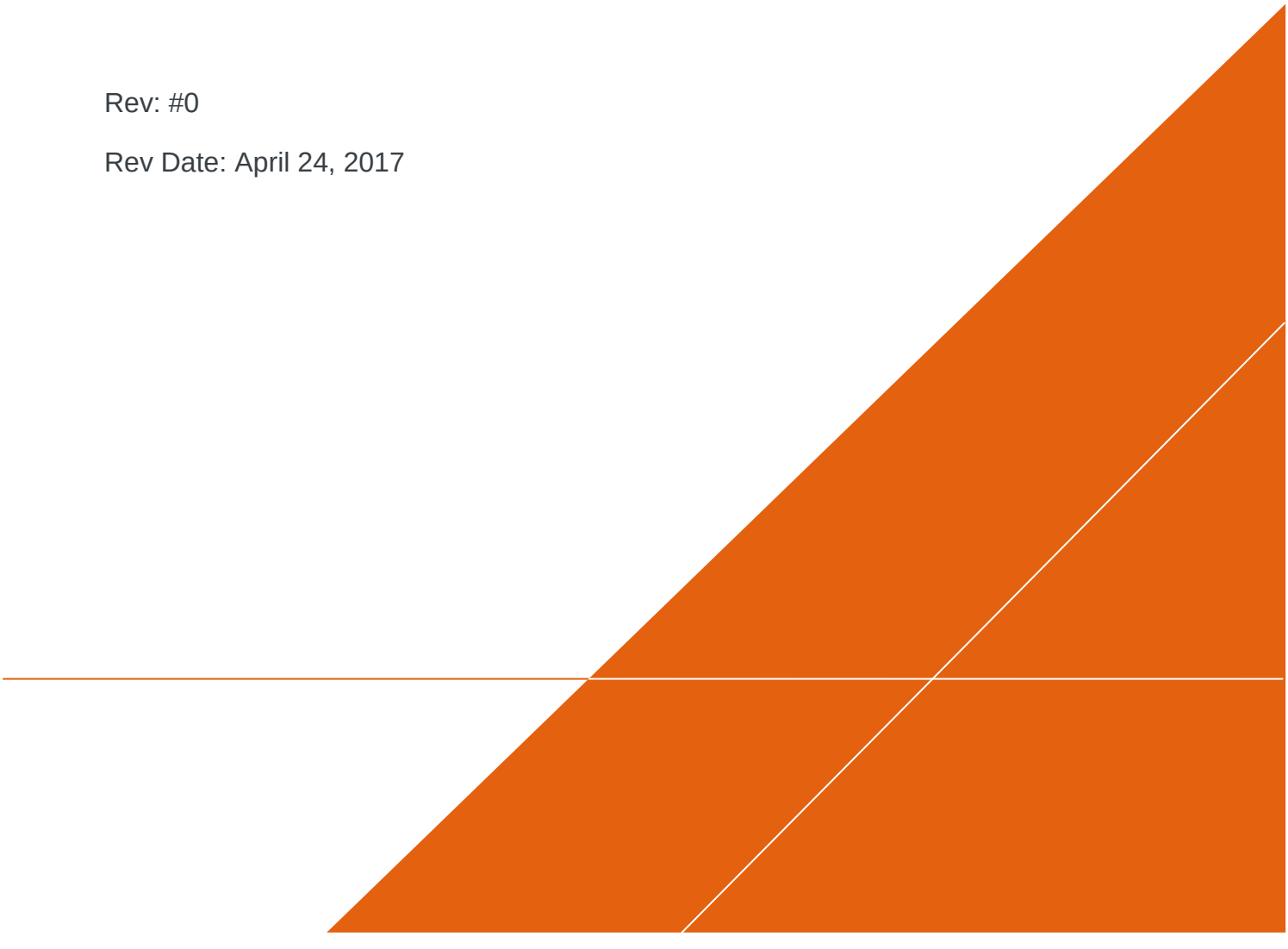
0 mm
10 mm
20 mm
30 mm
40 mm
50 mm
60 mm
70 mm
80 mm
90 mm
100 mm
110 mm
120 mm
130 mm
140 mm
150 mm
160 mm
170 mm
180 mm
190 mm
200 mm
210 mm
220 mm
230 mm
240 mm
250 mm

SOP # P-07

TECHNICAL GUIDANCE INSTRUCTION - MONITORING WELL DEVELOPMENT

Rev: #0

Rev Date: April 24, 2017



SOP # P-07

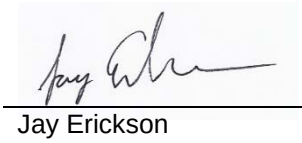
VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as TGI	Marc Killingstad

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SOP # P-07

APPROVAL SIGNATURES

Prepared by:		4/24/2017
	Jay Erickson	Date:
Technical Expert Reviewed by:		4/24/2017
	Marc Killingstad	Date:

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SOP # P-07

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) covers the development of screened wells used for obtaining representative groundwater information and samples from granular aquifers (i.e., monitoring wells). Note that this TGI only applies to monitoring well development and not remediation (injection/extraction) well development.

The purposes of Monitoring Well Development are:

1. Repair damage to the borehole wall from drilling that can include clogging, smearing or compaction of aquifer materials;
2. Remove fine grained sediment from the formation and filter pack that may result in high turbidity levels in groundwater samples;
3. To re-sort formation and filter pack material adjacent to the well screen;

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4. To recover any drilling fluids (if used) that may affect the permeability of the formation and filter pack or alter the water quality around the well; and
5. To optimize the well efficiency and hydraulic communication between the well screen and the formation.

Successful monitoring well development is dependent on the following:

1. Hydrostratigraphy – Permeable formations containing primarily sand and gravel are more easily developed due to lower percentages of silt and clay material. Water in permeable formations can be moved in and out of the screen and/or through the formation easier than in less permeable deposits
2. Well Diameter – Development tooling including brushes, surge blocks, pumps and jetting tools are more readily available for wells 4 inches in diameter and greater.
3. Well Design – Wells with filter packs and screens designed to match the formation through the analysis of formation sieve samples are easier to develop. An important aspect to well design is to minimize the size of the annular space between the formation and well screen. Adequate room must be allowed for the proper installation of well materials, but not too large as to prevent/reduce communication with the surrounding formation.
4. Drilling Methods – Different drilling methods result in varying amount of borehole damage and, therefore, impact the degree to which development will be successful.

Well development methods for monitoring wells include the following:

1. Bailing – use of a bailer to remove water and sediment from the well casing. This technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen.
2. Pumping/overpumping – use of a pump to remove water and sediment from the well casing, overpumping involves pumping the well at a rate that exceeds the design capacity of the well. Similar to bailing, this technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen. Small diameter monitoring wells have the additional constraint on pump size and flow rates.
3. Backwashing (rawhiding) – consists of starting and stopping a pump intermittently to produce rapid pressure changes in a well. This method can produce better results than pumping alone since the procedure involves movement of the water in and out of the screen and formation. However, in many cases the surging action is not rigorous enough to fully develop the well.
4. Surging/swabbing – use of a mechanical surge block or swabbing tool to operate like a piston with an up and down motion. The downstroke causes a backwash action that breaks up bridged sediment and the upstroke pulls the dislodged sediment into the well. This method works well for small and large diameter wells. Care should be taken on the downstroke so as not to force fines back into the formation, frequent pumping/purging during surging help to keep fines out of the well. Double surge blocks are recommended.
5. Jetting – use of a tool fitted with nozzles that direct streams of water horizontally into well screens at high velocity. Due to the size of the tooling, this method is better suited for wells 4 inch in diameter and larger. The method is also more effective with wire-wrapped/continuous slot screens due to the

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increased open area. Jetting requires specialized equipment and concurrent pumping to prevent reintroducing fines into the filter pack. Additionally, jetting requires subsequent surging to remove fines dislodged in the filter pack and formation.

For most situations, gentle surging coupled with bailing or pumping to remove dislodged materials is recommended.

Well development for properly designed and constructed monitoring wells may begin after the annular seal materials have been installed and allowed to cure, since these wells are designed to retain 90-99% of the filter pack material. This cure time is typically at least 24 to 48 hours after the sealing materials have been installed.

This TGI is meant to provide a general guide for proper monitoring well development. A site-specific field implementation plan for well installation and development detailing the specific methods and tools should be developed to provide site-specific instruction and guidance.

3 PERSONNEL QUALIFICATIONS

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

4 EQUIPMENT LIST

Required equipment depends on the selected method and should be detailed in the site-specific field implementation plan. However, the following are typically required.

- Health and safety equipment, as required by the site Health and Safety Plan (HASP):
- Cleaning equipment
- Field notebook and/or personal digital assistant (PDA)
- Monitoring well keys
- Water level indicator
- Field parameter meter (YSI)
- Well Development Logs
- Well construction logs/diagrams
- Weighted tape (measure depth)
- Turbidity meter
- Camera
- Watch/timing device.

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5 CAUTIONS

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

In some cases, it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Certified Project Manager (CPM) and/or Project Hydrogeologist must be notified and the CPM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the CPM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

As indicated above, for most monitoring wells, gentle surging coupled with bailing or pumping to remove dislodged sediment is recommended.

1 Ensure sufficient time has passed to allow for proper curing of the well seal.

2 Don appropriate PPE (as required by the site-specific HASP).

3 Place plastic sheeting around the well.

4 Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.

5 Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

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6 Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book. It is recommended to use a weighted tape for the total well depth measurement.

7 The depth to the bottom of the well should be sounded and then compared to the completion form or construction diagram for the well. Any discrepancies should be reported immediately to the CPM and/or Project Hydrogeologist. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the CPM and/or Project Hydrogeologist and obtain approval to continue or cease well development activities.

8 Lower a double surge block into the screened portion of the well. Starting from the bottom of the screen using 2 foot throws, gently raise and lower the surge block to force water in and out of the screen slots and sand pack. Continue surging for 15 to 30 minutes.

9 Lower a bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well and gently bounce on the bottom of the well to collect/remove accumulated sediment, if any. Remove and empty the bailer, if used. Repeat until the bailed/pumped water is free of excessive sediment and contact at the bottom of the well feels solid. Alternatively, measurement of the well depth with a weighted tape can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.

10 After surging the well for a minimum of two cycles and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

11 Remove formation water by pumping/bailing. Where pumping is used, measure and record the pre-pumping water level. Operate the pump at a relatively constant rate. Measure the pumping rate using a calibrated container and stop watch, and record the pumping rate in the field log book. Measure and record the water level in the well at least once every 5 minutes during pumping. Note any relevant observations in terms of water color, visual level of turbidity, sheen, odors, etc. Pump or bail until termination criteria specified in the Site-Specific Field Implementation plan are reached. Note: the project-specific field implementation plan may also specify a maximum turbidity requirement for completion of development. Unless otherwise specified the maximum turbidity should be 50 NTUs or less. Record the total volume of water purged from the well.

12 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Log.

13 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Log.

14 While developing, water is also periodically collected directly from the well or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified), the extracted water is clear and free

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of fine sediment and most importantly, when acceptable volume of water has been removed and/or a sufficient amount of surging has been performed.

15 In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete when minimal amounts of fine-grained sediments are recovered and acceptable volume of water has been removed.

16 If the well goes dry, stop pumping or bailing. Note the time that the well went dry. After allowing the well to recover, note the time and depth to water. Resume pumping or bailing when sufficient water has recharged the well.

17 Contain all development water in appropriate containers.

18 When complete, secure the lid back on the well.

19 Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer

8 WASTE MANAGEMENT

Materials generated during monitoring well installation and development will be placed in appropriate labeled containers and disposed of as described in the Work Plan/Field Implementation Plan or Field Sampling Plan.

9 DATA RECORDING AND MANAGEMENT

All well development activities should be documented on appropriate log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before, during, and after pumping.

10 QUALITY ASSURANCE

All reused, non-disposable, downhole well development equipment should be cleaned in accordance with the procedures outlined in the project documents.

11 REFERENCES

American Society for Testing Materials (ASTM), Designation D5521-05. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

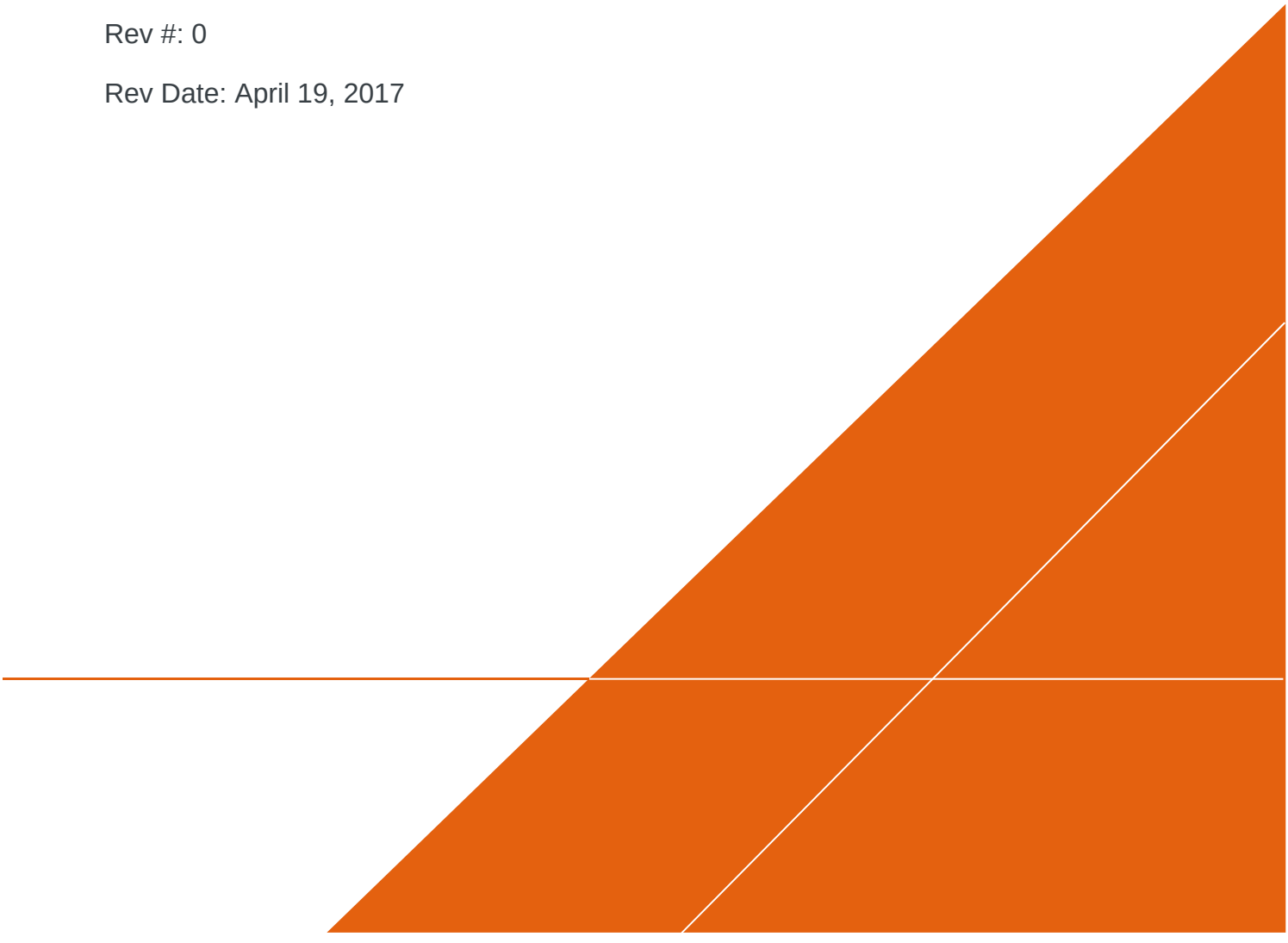
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SOP # P-08

TGI – MONITORING WELL INTEGRITY SURVEY

Rev #: 0

Rev Date: April 19, 2017



SOP # P-08

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/19/2017	All	Re-written as a TGI	Matthew McCaughey

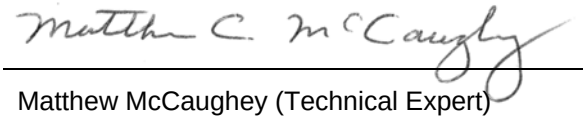
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SOP # P-08

APPROVAL SIGNATURES

Prepared by:  4/19/2017

Patrick J. Nolan Date:

Technical Expert Reviewed by:  4/19/2017

Matthew McCaughey (Technical Expert) Date:

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SOP # P-08

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) specifies the procedures for performing inspections/inventories of existing monitoring wells. This TGI also applies to piezometers that are constructed analogous to monitoring wells. For simplicity, such piezometers are also referred to as monitoring wells for the remainder of this document. For all other types of wells (e.g., remediation wells such as injection, extraction, sparge, etc.), please refer to the appropriate guidance document regarding procedures for conducting inspections on those specific wells.

Monitoring well inventories are periodically conducted to assess the integrity of existing monitoring wells and to identify the need for repairs, replacement of parts, or replacement of wells that are determined to no longer be usable. A well inventory involves an inspection of the overall condition of the well, comparison of measurable quantities (e.g., riser stickup relative to grade and total depth), general verification of survey coordinates and elevation, and measurement of depth to water in the well.

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3 PERSONNEL QUALIFICATIONS

All personnel shall meet the requirements of the site-specific Health and Safety Plan (HASP).

The CPM is responsible for ensuring that the activities described herein are conducted in accordance with this TGI and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Field Manager is responsible for periodic observation of field activities and review of field generated documentation associated with this TGI. The Field Manager is also responsible for implementation of corrective action if well conditions necessitate them.

4 EQUIPMENT LIST

The following materials will be available, as required, during performance of a monitoring well inventory:

- Health and safety equipment (as required by the site-specific Health and Safety Plan)
- Ruler or tape measure
- Water level indicator and/or interface probe
- Bailer
- Metal detector
- Indelible ink pen
- Paint pen
- Well keys
- Wrenches or ratchet set for accessing flush-mount well covers
- Cleaning equipment
- Well construction information (e.g., construction log, as-built, summary table, etc.)
- Digital camera (or phone with camera)
- Field notebook or Personal Digital Assistant (PDA)
- Appropriate field form(s) (see Attachment A)

If feasible, a supply of typical replacement parts (e.g., locks, bolts, well caps) should be available to enable immediate usage as necessary.

5 CAUTIONS

It is important to confirm the correct identity of wells, particularly when they are installed in a cluster. In these cases, however, the wells usually differ significantly in terms of depth below grade. During the well integrity survey, verify that all wells are properly labeled by comparing their measured depth to the reported depth as installed. If the well identity is incorrectly labeled or not labeled, provide a clear, correct

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label using an indelible ink pen on the inside of the steel protective cover for the well, or on the outside of the steel protective cover using a paint pen. Take photos to document as necessary.

One of the routine challenges encountered in performing this task is actually locating monitoring wells in the field. Oftentimes, field teams create an electronic file for new sites that will include a photo of the well head and a map image (e.g., Google Earth image) showing the well location. If such files exist, ensure that they are used as part of this task. Note that the Well Integrity Assessment Form (Attachment A) includes a sketch area to help locate wells in future surveys.

If present, remove standing water from the curb box using a bailer before opening the monitoring well. Refer to project waste management plan for proper disposal of water.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Care should be taken using tools to access flush-mount curb boxes. Wells in or near roadways must not be accessed without proper traffic cones and flagging. Access to wells containing chemicals of concern may pose a chemical exposure and biological hazard.

7 PROCEDURE

The typical procedure for assessing the integrity of a monitoring well is outlined below.

Step 1. Prior to mobilizing in the field, obtain a list of wells/piezometers to be inventoried and available information concerning their location and physical characteristics.

Step 2. Identify site and well identification number on the Well Integrity Assessment Form **(Attachment A).** Record all observations on this form, supplemented by notes in the field notebook if necessary.

Step 3. Locate the monitoring well using site maps and, if needed, a metal detector.

Step 4. Examine the well for the presence of an identification label. If absent, label the well with the appropriate well number after measuring the total depth of the well to verify that the depth matches the well number (see Step 8 below). If the well identity is incorrectly labeled or not labeled, provide a clear, correct label using an indelible ink pen on the inside of the steel protective cover for the well, and on the outside of the steel protective cover using a paint pen.

Step 5. Examine the surface condition of the well. Record the type of well (i.e., flush mount or above-grade stickup), condition of the well cover and surface seal. Confirm the protective casing is not bent or rusted through, the PVC casing is not broken or chipped, there is no evidence of frost heaving or subsidence.

Step 6. Unlock and open the well. Record the type (e.g., PVC or stainless steel), dimensions (i.e., casing diameter and riser stickup relative to grade), condition of the well casing, and type of

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well cap. Record any observations of recent modifications of the well casing. If the well cap is missing, replace with available parts or record the type of cap required.

Step 7. Measure the above-grade portion of the well riser stickup and compare to the known length of the stickup measured during well installation (surveyed top of inner casing elevation minus ground surface elevation). If the difference between the observed stickup length and the known stickup length is greater than 0.1 foot, the monitoring well location and elevation should be re-surveyed.

Step 8. Locate the marked measuring point along the top of the well casing. If no mark is visible, add a mark at the highest point of the casing using an indelible ink pen.

Step 9. Measure the depth to water, total depth of the well and any non-aqueous phase liquids (NAPL) thicknesses. For total depth measurements, account for any difference in calibration of the measuring tape on the probe (i.e., distance from part of probe that measures depth to water and the physical bottom of the probe that will measure total depth of the well). Record any obstructions encountered and a description of the feel of the well bottom (i.e., soft due to sediment or hard).

Step 10. Compare all observations concerning the measured dimensions of the well with the listed values. Based on these results as well as other observations concerning the condition of the well, record any appropriate recommendations on the Monitoring Well Integrity Assessment form **(Attachment A).** Perform any recommended maintenance activities that can be accomplished with available equipment.

Step 11. Remove all equipment from the well. If no additional maintenance activities are to be performed, close the well and collect all personal protection equipment (PPE) and other wastes generated for disposal (see Section 8 below).

Depending on the results of the well inventory, several additional activities may be warranted prior to future usage of the well. Typical follow-up activities include replacement of missing parts, removal of sediment from the base of the well, re-surveying of the well, or complete replacement if the well is determined to be unusable.

As stated above, a supply of locks, bolts, and well caps should be available for immediate usage during performance of the well inventories. However, it may not be feasible to maintain a supply of all potential replacement parts due to the variety of well types in use. Therefore, a list of required replacement parts should be compiled during the performance of a well inventory event. At the conclusion of the event, the necessary replacement parts for all wells should be obtained and installed.

8 WASTE MANAGEMENT

Materials generated during well inventory activities, including disposable equipment, will be disposed in appropriate containers.

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9 DATA RECORDING AND MANAGEMENT

Field observations will be recorded on the Well Integrity Assessment Form (Attachment A), and/or in an appropriate Field Notebook or PDA. Well integrity inventory results will be retained in the project file.

10 QUALITY ASSURANCE

To verify accurate measurements of well stickup, depth to bottom, depth to groundwater, etc., measurements must be double-checked periodically (e.g., at least one of these measurements per well should be repeated to verify accuracy).

11 REFERENCES

No references apply to this TGI.

12 ATTACHMENTS

A. Well Integrity Assessment Form

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Monitoring Well Integrity Assessment Form

(For each item, check appropriate response or fill in the blank)

Date _____

Well ID _____ ID Clearly Marked? _____ Project Name _____

Photo filename _____ Project Number _____

Weather _____ Field Personnel _____

General Description of Surroundings _____

Well Condition:

Damaged? ☐ Abandoned? ☐
(Describe Below)

Stick Up ☐ Flush Mount ☐

Lockable cover? _____

Lock present? _____

Key number: _____

Stick up height _____

Casing material _____

Well diameter _____

Protective casing material: _____

Protective casing diameter: _____

Cap present? Type? _____

Vented? If so, how? _____

Measuring point clearly marked? _____

Total depth reported: _____

Total depth measured: _____

DTW: _____

Well obstructed? If so, depth? _____

Well bottom soft (sediment) or firm? _____

Flush Mount Wells Only

Gasket present? _____

Bolts present? _____

Teflon washers present?

Surface Condition:

Damaged? ☐
(Describe Below)

Pad/cement intact? _____

Curb box/well cover present? _____

Intact? _____

Seal condition _____

All bolts present? _____

Ground surface slopes away from well? _____

Location Sketch

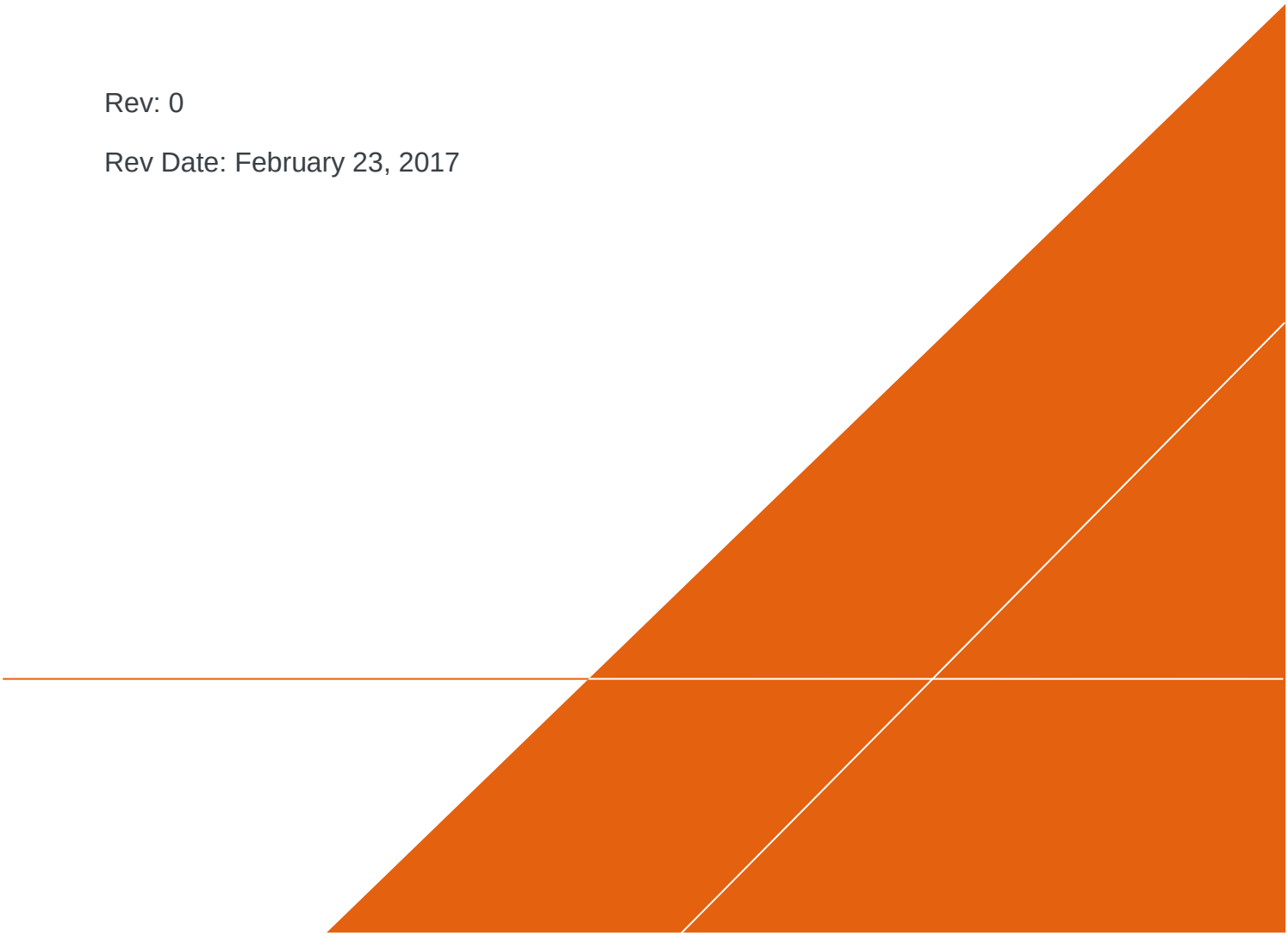
Comments/Recommendations:

SOP # P-09

TGI – GROUNDWATER AND SOIL SAMPLING EQUIPMENT DECONTAMINATION

Rev: 0

Rev Date: February 23, 2017



SOP # P-09

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Cassandra McCloud / Pete Frederick

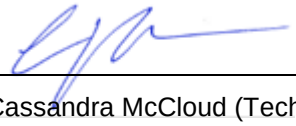
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SOP # P-09

APPROVAL SIGNATURES

Prepared by:  Date: 02/23/2017

Derrick Maurer

Technical Expert Reviewed by:  Date: 02/23/2017

Cassandra McCloud (Technical Expert)

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SOP # P-09

1 INTRODUCTION

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2 SCOPE AND APPLICATION

Decontamination is performed on sampling equipment prior to sample collection to ensure that the sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that could interfere with laboratory analysis for analytes of interest. Sampling equipment must be appropriately cleaned prior to use for sampling or coming into contact with environmental media to be sampled, and following completion of the sampling event prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The sampling equipment cleaning procedures described herein includes pre-field, in the field, and post-field cleaning of sampling equipment which may be conducted at an established equipment decontamination area (EDA) on site, as appropriate and necessary. Sampling equipment that may require decontamination at a given site includes: soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between each

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sample collected, and prior to placing sampling equipment in protective cases, or containers for transport. Cleaning procedures for sampling equipment should be monitored by collecting equipment blank samples as required in project work plans, field sampling plans, quality assurance project plans (QAPP), or other pertinent project documents. Dedicated and/or single-use (i.e., not to be re-used) sampling equipment will not require decontamination.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

4 EQUIPMENT LIST

The equipment required for equipment decontamination is presented below:

- Health and safety equipment, including appropriate PPE, as required in the site Health and Safety Plan (HASP)
- Deionized water that meets that analytical criteria for deionized water with no detectable constituents above the reporting limits for the methods to be used and analytes being analyzed for. Deionized water is used for inorganics, and organic-free water for VOCs, SVOCs, pesticides, etc.
- Non-phosphate detergent such as Alconox or, if sampling for phosphorus or phosphorus-containing compounds, Liquinox (or equivalent).
- Tap water
- Rinsate collection plastic containers
- DOT-approved waste shipping container(s), as specified in the work plan, field sampling plan, or regulatory requirements if decontamination waste is to be shipped for disposal
- Brushes
- Large heavy-duty garbage bags
- Spray bottles
- (Optional) – Isopropyl alcohol (free of ketones) or methanol. These can be wipes or diluted with water (usually 1part isopropyl/methanol to 10 parts water) if a spray is needed.
- Airtight, sealable plastic baggies, such as Ziploc-type
- Plastic sheeting

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SOP # P-09

5 CAUTIONS

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry. Ensure all rinsate materials do not adversely affect sample collection efficiency or analytical results.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts. Properly containerize equipment to ensure cross-contamination doesn't happen from other uncontaminated surfaces or equipment.

If equipment is damaged to the extent that decontamination is uncertain due to cracks, gouges, crevices, or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination regarding hazardous materials will be performed by a DOT-trained individual for cleaning materials shipped by Arcadis.

Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock.

6 HEALTH AND SAFETY CONSIDERATIONS

Review the safety data sheets (SDS) for the cleaning agents and materials used in decontamination. If solvent is used during decontamination, use appropriate PPE and work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers and bystanders. Follow health and safety procedures outlined in the HASP.

7 PROCEDURE

A designated area will be established to clean sampling equipment in the field prior to and following sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location that expose equipment to contamination (i.e. exposed to combustion engine exhaust). Detergent solutions will be prepared in clean containers for use in equipment decontamination. Decontaminated equipment should be handled by workers wearing clean gloves, properly changed to prevent cross-contamination.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.
2. Wash with detergent solution (Alconox, Liquinox or equivalent) to remove all visible particulate matter and any residual oils or grease.
3. If equipment is very dirty, precleaning gross debris with a brush and tap water may be necessary.
4. If non-aqueous phase liquids are present, the use of isopropyl alcohol (free of ketones) or methanol is recommended. Cloth wipes or diluted solution can be used to remove the non-aqueous phase liquids that are hard to remove with detergent solution in step 2. Consult with project manager if

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non-aqueous phase liquids are present onsite and design an appropriate decontamination procedure that includes step 4.

5. Rinse with deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps must be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another container filled with potable water. The pump should be flushed with deionized water as the last step prior to use. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Disconnect the pump from the power source before handling. The pump and hose should be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

8 WASTE MANAGEMENT

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

9 DATA RECORDING AND MANAGEMENT

Equipment cleaning and decontamination will be noted in the field notebook for project documentation. Information will include the type of equipment cleaned, the decontamination location, specific procedures utilized, solvents and/or cleaning agents used, source of water, and deviations or omissions from this TGI.

Unusual field conditions should be noted if there is potential to impact the efficacy of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the project documentation. Records will be maintained for solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

10 QUALITY ASSURANCE

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water (or organic-free water, for organic analyses) over the clean and dry tools and collecting the water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned as specified in the sampling and analysis plan. Equipment blanks are collected per equipment set, which represents all of the tools needed to collect a specific sample.

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11 REFERENCES

USEPA Region 9 - Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1 - Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

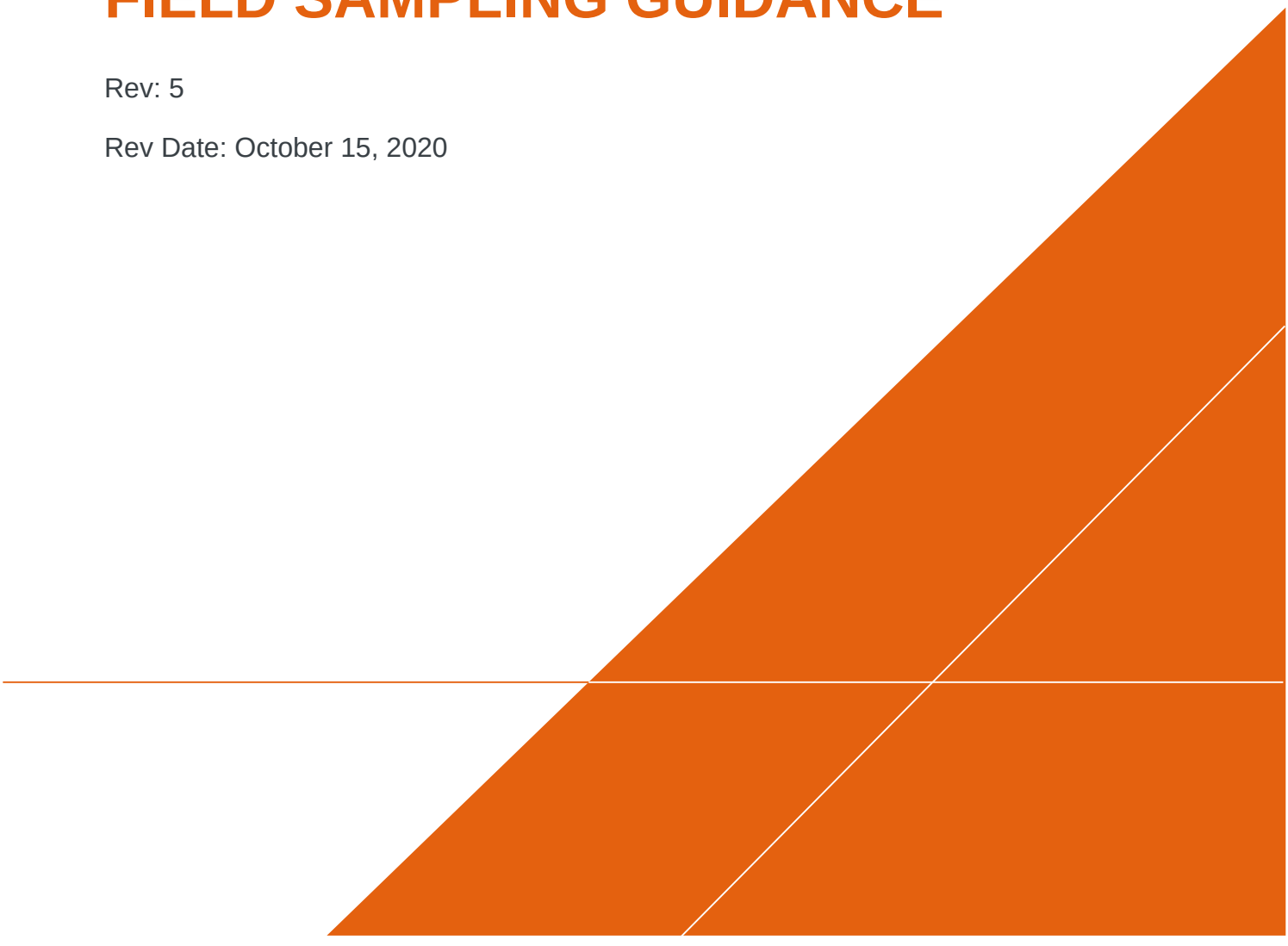
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SOP # P-10

POLY- AND PERFLUORINATED ALKYL SUBSTANCES (PFAS) FIELD SAMPLING GUIDANCE

Rev: 5

Rev Date: October 15, 2020



SOP # P-10

VERSION CONTROL

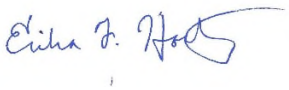
Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 27, 2017	All	Initial Release	Erica Kalve Erika Houtz Sue Tauro
1	June 19, 2018	1 through 4 and 17	Updated Information on Sampling Materials	Erica Kalve Erika Houtz
2	October 15, 2018	6 to 16	Minor updates on laboratory elements, updates to decontamination procedures, and clarification on equipment and reagent blank collection	Erika Houtz Erica Kalve
3	December 17, 2018	4, 6, 17	Removed Sharpies from acceptable field writing implements; Changed language in Section 3.2 and Section 10.5 to provide stricter guidance for DoD projects.	Erika Houtz, Erica Kalve
4	March 26, 2019	4,5	Removed Citranox from acceptable Decon solutions in Table 1a, added all fluoropolymer containing materials to prohibited items in Table 1b. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox.	Erika Houtz
5	October 16, 2020	14	Added Air Force preference to sample surface water at surface for Air Force investigations.	Erika Houtz

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SOP # P-10

APPROVAL SIGNATURES

Prepared by:



10/19/2020

Erika F. Houtz, PhD, PE
Environmental Engineer and PFAS Analytical Lead

Date:

Reviewed by:



12/17/2018

Erica Kalve, PG-CA
Emerging Contaminants Focus Group Leader

Date:

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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The purpose of this Technical Guidance Instructions (TGI) is to provide guidance on field sampling to be used for poly-and perfluorinated alkyl substances (PFASs). This protocol was adapted from various sources including Arcadis Australia, Transport Canada, and the U.S Army Corp of Engineers (USACE) Omaha. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. **Table 1a** provides a summary of materials that have been approved for site investigation; this list is expected to grow longer as industry experience increases. **Table 1b** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection; for materials that are suspected of containing PFASs and/or to retain PFASs, these recommendations are considered preliminary and subject to change.

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Table 1a: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Investigations

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to investigation	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to investigation	DER 2016
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

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Table 1b: Summary of Sampling Equipment and Materials Not Recommended for PFAS Site Investigations.

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016

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Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Decontamination				
[Some] detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are advised to err on the side of caution by strictly following these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate the potential for false detections of PFASs. A summary of other specific items related to field sampling for PFASs are discussed in the sections below.

This TGI applies to all Arcadis and subcontractor personnel involved in field sampling for PFAS.

3 PERSONNEL QUALIFICATIONS

3.1 Sampling Personnel

Field personnel must have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, and site-specific training, as needed. In addition, field personnel will be versed in the other relevant SOPs (e.g., low flow sampling) and will possess the skills and experience necessary to successfully complete the desired field work. The site Health and Safety Plan (HASP) and other documents will identify any other training requirements such as site-specific safety training or access control requirements.

3.2 Laboratories

These laboratories are example laboratories that could be used to analyze environmental media for PFASs, pending project approval:

- United States: TestAmerica, SGS, Vista, ALS, and Eurofins
- Canada: Axys-SGS and Maxxam Laboratories

Other laboratories may be used if they are appropriately accredited for PFAS analysis according to any project requirements. It is recommended that a laboratory is Environmental Laboratory Accreditation Program (ELAP)-accredited for PFAS analysis in accordance with the Department of Defense (DoD) Quality Systems Manual (QSM) 5.1 Table B-15 or any subsequent updates. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.1 or later.**

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4 EQUIPMENT LIST

The following equipment and materials must be available for sampling:

- Site plan of sampling locations, relevant work plan (or equivalent), and this TGI;
- Appropriate health and safety equipment, as specified in the site HASP;
- Dedicated plastic sheeting (preferably high-density polyethylene [HDPE]) or other clean surface to prevent sample contact with the ground;
- Conductivity/temperature/pH meter;
- Dissolved oxygen meter, oxidation reduction potential meter, and turbidity meter;
- Depth to water meter;
- If using low-flow groundwater sampling techniques, peristaltic pump (groundwater sampling)/bladder pump (with PFAS free bladder/ HDPE bladder), flow through cell, and accompanying HDPE and silicone tubing;
- Hydrasleeves, if using Hydrasleeves for groundwater sampling;
- Metal trowel for soil samples; specialized soil/sediment sampling equipment as required;
- Brushes for scrubbing sampling equipment;
- Pens, pencils, and/or Sharpies for writing;
- Clipboards, field binders, and field note pages that are not waterproof;
- Labeled sample bottles:
    - Water: HDPE bottles fitted with polypropylene screw cap only; some types of PFAS samples (primarily drinking water) may require preservative, which will be indicated by the laboratory conducting the analysis. The laboratory will specify the sample bottle volume.
    - Soil and sediment: HDPE bottles fitted with polypropylene screw cap only; no preservatives. The laboratory will specify the sample bottle volume.
- If high concentrations of PFASs related to class B firefighting foams are expected, bring additional small vials to conduct field-based shaker tests for foaming;
- Ziploc® bags to hold ice and samples;
- Bottles containing “PFAS-free” water used for reagent blanks;
- Labeled coolers for samples with ice; Blue ice is not permitted;
- Deionized or distilled water for initial decontamination rinsing;
- “PFAS-free” water provided by the laboratory for final decontamination rinsing;
- Methanol, isopropanol, or acetone if able to be brought safely to field site; especially important for decontamination during soil sampling;
- Alconox or Liquinox®;

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- Packing and shipping materials;
- Groundwater Sampling Log; and
- Chain-of-Custody (COC) Forms.

5 CAUTIONS

5.1 Food Packaging

Some food packaging may be treated with PFAS-containing chemicals to prevent permeation of oil and water in the food outside of the packaging. To avoid potential food packaging-related PFAS contact:

- Do not bring any food outside of the field vehicles onsite and eat snacks and meals offsite.
- Wash hands after eating.
- Remove any field garments or outer layers prior to eating. Do not put them back on until done eating and hands are washed.

5.2 Field Gear

5.2.1 Clothing

Many types of clothing are treated with PFASs for stain and water resistance, in particular outdoor performance wear under brand names such as Gore-Tex®. To avoid potential clothing-related PFAS contact:

- Do not wear any outdoor performance wear that is water or stain resistant, or appears to be. Err on the side of caution.
- Wear pre-laundered (multiple washings, i.e. 6+) clothing that is not stain resistant or water proof.
- Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water and stain resistant.
- Most importantly, avoid contacting your clothing with sampling equipment, bottles, and samples.

5.2.2 Personal Protective Equipment

Safety Footwear

Some safety footwear has been treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFASs. For the health and safety of field personnel, footwear must be protected at all times to avoid potential PFAS contamination. To do this:

- Do not contact your footwear with equipment, bottles, or samples in any way.
- Do not allow gloves used for sampling to come in contact with safety footwear.

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Nitrile Gloves

Wear disposable nitrile gloves at all times. Don a new pair of nitrile gloves **before** the following activities at each sample location:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or "PFAS-free" water bottles;
- Insertion of anything into the sample ports (e.g., HDPE tubing); and
- Handling of any quality assurance/quality control (QA/QC) samples including field blanks and equipment blanks.

Don a new pair of nitrile gloves **after** the following activities:

- Handling of any non-dedicated sampling equipment;
- Contact with contaminated surfaces; or
- When judged necessary by field personnel.

5.3 Personal Hygiene

- Shower at night.
- Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary.
- Use sunscreen and insect repellent ONLY if necessary for health and safety. If they are necessary, apply sunscreen and repellant prior to initiating field sampling. If sunscreen and/or repellant need to be reapplied, ensure a safe distance away from the sampling locations and equipment (i.e., more than 10 meters (m) away). Wash hands after application.

5.4 Visitors

Visitors to the site are asked to remain at least 10 m from sampling areas.

5.5 Rain Events

Special care should be taken when rain is falling at the project site:

- Do not perform field sampling when rain fall is persistent at a consistent rate that saturates the ground (i.e., formation of puddles) because rain gear is not permitted while sampling. Intermittent showers or fog are acceptable conditions to proceed. If rain showers occur; field gear must be removed from the monitoring well location until the rain subsides.
- If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next site.

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6 HEALTH AND SAFETY CONSIDERATIONS

- The ability to safely access the surface water sampling locations must be verified before sampling.
- Field activities must be performed in accordance with the site HASP, a copy of which will be present onsite during such activities.
- Safety hazards associated with sampling surface water include fast-moving water, deep water, and steep slopes close to sampling sites. Use extreme caution when approaching sampling sites.
- If thunder or lighting is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting.
- Use caution when removing well caps as well may be under pressure, cap can dislodge forcefully and cause injury.

7 PROCEDURE

7.1 Field Equipment Cleaning

Reusable field sampling equipment will require cleaning between uses. For groundwater sampling, between uses, decontaminate the flow-through cell and any non-dedicated equipment (i.e., interface probe of depth to water meter) that comes into contact with well water. Trowels and other materials used to sample soil samples will also require decontamination, although dedicated, single use equipment such as liners should be used where possible.

After donning a new pair of nitrile gloves:

- Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a plastic brush if needed;
- Rinse two times with distilled water or deionized water;
- Rinse one time with “PFAS-free” water or once with methanol/isopropanol/acetone, if it is available, and once with “PFAS-free” water; organic solvents are especially useful for decontaminating soil sampling equipment. If organic cleaning solvents cannot be brought to site, scrub equipment a second time after a single distilled or deionized water rinse, then rinse two times with distilled or deionized water and once with “PFAS-free” water (i.e., two scrubbings and four water rinsings total).
- Collect all rinsate in a sealed pail for disposal. Do not reuse decontamination solutions between sampling locations.

7.2 Borehole/Monitoring Well Development

If a drill rig is being used to drill for soil cores or to install monitoring wells, wear clean nitrile gloves before collecting each continuous soil sample. Additional requirements include the following:

- Verify in writing with the manufacturer that single-use liners used to collect each sample are made of a material that does not contain PFASs;

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- Collect soil samples in laboratory-supplied HDPE bottles.
- Store the sample bottles in coolers and keep at a temperature of 0 to 6ºC until transported to the laboratory.

7.2.1 Well Condition Survey/ Water Level Monitoring

Using equipment that has been thoroughly decontaminated according to the procedures in Section 7.1, conduct the well condition surveys and water level monitoring:

- Conduct monitoring well inspections and record water levels.
- Use an interface probe to evaluate presence/absence of non-aqueous phase liquid (NAPL).
- Measure the depth to water from the top of the polyvinyl chloride (PVC) riser and the total depth of the well.
- Record information in the field notes.

7.2.2 Monitoring Well Development and Purging

Follow these requirements for monitoring well development and purging:

- Do not use Teflon™ tubing for purging or sample collection. HDPE tubing is acceptable.
- Do not re-use materials between wells. Upon completion of use, remove all disposable materials (such as HDPE and/or silicone tubing) and place in heavy duty garbage bags for disposal.
- During development of the well, create sufficient energy to agitate the water column and create flow reversals in the well screen, filter pack and formation to loosen fine-grained materials and draw them into the well. The pumping or bailing action should then draw all drilling fluids and fine-grained material out of the borehole and adjacent formation and then out of the well. Review the Arcadis Monitoring Well Development guidance (Arcadis 2010) for more detailed information.
- Follow the low-flow purge and sampling techniques per the U.S. Protection Agency's (EPA's) guidance document titled *Low Stress (Low Flow) purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells* (2010) and ASTM's standard titled *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations* (2002). Also available for review is the Arcadis Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Arcadis 2011).
- To purge the well, if using HDPE tubing and a peristaltic pump, insert the end of the tubing to the approximate depth of the midpoint of the screened section of the monitoring wells. Measure the length of HDPE tubing to be inserted into each monitoring well and pre-cut it to approximate lengths (such as the previously measured arm span of a field technician) to avoid contact with any materials other than the monitoring well and peristaltic pump. Flow rates should be as low as can be reasonably achieved. Collect and appropriately dispose of purge water.
- Silicone tubing should direct the purge water through a flow-through cell for field parameter measurements of pH, conductivity, temperature, dissolved oxygen, and turbidity. Calibrate the

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instrument in the field prior to use. Decontaminate the instrument and flow-through cell at each monitoring well location before purging.

- Record field parameters in intervals (generally of 3-minute duration) to ensure purge water has cycled through the flow-through cell. Sample the wells after field parameter measurements indicate stabilization, which allows collection of representative formation water (generally acceptable standards are three consecutive pH readings to within ±0.1 units, and three consecutive conductivity, temperature and dissolved oxygen measurements to within 3%). Turbidity must be monitored, but does not need to be used as a stabilization indicator of purge completion. Record field parameter measurements at each well. Drawdown should be monitored throughout the purge.
- If wells are suspected to be dewatering throughout the purge (i.e., reduced flow rate/difficulty pumping water or bubbles begin to come through the flow through cell), turn off the pump and allow the water level to recover for ½ hour, followed by sample collection. Document these activities in the field notes.

7.3 Sample Collection

Different laboratories may supply sample collection bottles of varying sizes depending on the type of media to be sampled.

7.3.1 Sample Containers

- Collect samples in HDPE bottles fitted with an unlined (no Teflon™), polypropylene screw cap.
- Complete bottle labels after the caps have been placed back on each bottle.
- Do not use glass bottles due to potential loss of analyte through adsorption. This is particularly important for aqueous samples.
- Review with analytical lab the sample size, sample container, etc. depending upon the type of PFAS analysis that is being requested.

7.3.2 Soil Sampling

Before Sample Collection

- Place plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Trowels or drilling equipment that will come into contact with a sample should be decontaminated prior to sample collection, preferably with methanol/isopropanol/acetone;
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Collect soil samples using a clean stainless steel trowel or with single-use PFAS-free liners;

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- Place soil samples in labeled HDPE bottles supplied by the laboratory.
- Note the time on the sample label.
- Collect any necessary duplicates/co-located samples and matrix spikes – verify with laboratory whether they need to be collected in separate sample bottles.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place soil sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.
- Place soil sample bottles in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. Do not use blue ice.

7.3.3 Groundwater Sampling

Before Sample Collection

- Place plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the labeled HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.
- Measure depth to water and field parameters. Turbidity and the physical appearance of the purged water should be noted on the Groundwater Sampling Log.

During Sample Collection

- Start groundwater sample collection upon stabilization of field parameters.
- If low-flow groundwater sampling techniques are being used, disconnect the silicone tubing from the flow-through cell, enabling collection of groundwater samples prior to passing through the cell.
- Hydrasleeves are also considered acceptable for sampling of PFAS in groundwater – consult the project manager to determine which technique should be used. In general, low flow sampling is preferable.
- Collect groundwater samples (to the neck of the bottle, some headspace is acceptable) from the dedicated sampling ports at the center of the well screen. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler, until replaced on the bottle.

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- To mitigate cross contamination, collect groundwater samples in a pre-determined order from least impacted to greater impacted based on previous analytical data or knowledge about past activities at the site. If no analytical data are available, samples are to be collected in the following order:
  1. First sample the upgradient well(s).
  2. Next, sample the well located furthest downgradient of the interpreted or known source.
  3. The remaining wells should be progressively sampled in order from downgradient to upgradient, such that the wells closest to the interpreted or known source are sampled last.
- NOTE: If high concentrations of PFASs related to class B firefighting foams are expected in a groundwater sample, conduct a Shaker test by collecting and shaking a small portion of the sample (~10 to 25 mL) on site in a small disposable vial. If foaming is noted within the sample, document the foaming when samples are submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically.
- After collecting the sample, tightly screw on the polypropylene cap (snug, but not too tight). This will minimize leaking or cross contamination of the sample. Most PFASs, including all analytes measured by USEPA Method 537, are not volatile at environmental pH.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.
- Do not rinse PFAS sample bottles during sampling. Do not filter samples.

After Sample Collection

- Place groundwater sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes and COC. Note ‘shake test’ results if appropriate.
- Place groundwater samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

  Treat all disposable sampling materials as single use and dispose of them appropriately after sampling at each monitoring well.

7.3.4 Sediment Sampling

Before Sample Collection

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- Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.
- Collect sediment samples either manually using a stainless steel trowel or using a petite ponar grab sampler, depending on field conditions at each sampling location during sampling program.
- Collect sediment samples from the upper 10 cm of sediment.
- For a sample to be acceptable overlying, low turbidity water must be present.
- Decant the overlying water and use a stainless steel trowel to collect only the upper 5 centimeters (cm) of sediment.
- Collect sediment samples directly into laboratory-supplied bottles that are suitable in both material and size.
- Do not overfill the sample bottle.
- Make sure that the sample does not contain vegetation, that the sediment is undisturbed, and that the sampler shows no signs of winnowing or leaking.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample label.
- Collect any necessary duplicates and matrix spikes.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.

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- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and total dissolved solids (TDS) at each location **after** both surface water and sediment sampling is completed.

7.3.5 Surface Water Sampling

Before Sample Collection

- Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
- Don a new set of nitrile gloves. Do not use gloved hands to subsequently handle papers, pens, clothes, etc., before collecting samples.
- Use the HDPE bottles that are supplied by the laboratory. Make sure that the caps remain on the bottle until immediately prior to sample collection.

During Sample Collection

- Avoid sampling the surface, in general.
- However, for Air Force investigations, collect samples from the water surface.
- Where surface water samples and sediment samples are collected at the same location, collect surface water samples first to minimize siltation.
- Collect surface water samples directly into laboratory-supplied bottles; wide-mouth bottles may be preferable to narrow mouth bottles for ease of surface water collection.
- Make sure bottle caps remain in the gloved hand of the sampler until sampling is complete and caps are replaced on the bottle.
- Note the time on the sample bottle.
- Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
- Collect any necessary equipment blanks. The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.
- Collect any necessary field reagent blanks. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

After Sample Collection

- Place sample bottles in a sealed Ziploc© bag (optional).
- Record the label information and time of sampling in the field notes.

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- Place samples in coolers that are durable in transportation and keep the temperature between 0 and 6ºC until transported to the laboratory. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Measure surface water pH, conductivity, temperature, and TDS at each location **after** both surface water and sediment sampling.

7.4 Shipping

- If samples cannot be shipped the same day as collected, arrange an appropriate means of keeping the samples cool overnight and maintain the temperature between 0 and 10°C for the first 48 hours after collection, and then between 0 and 6°C thereafter.
- Store samples in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**
- Complete the appropriate procedures for COC, handling, packing, and shipping.
- Fill out and check COC Forms against the labels on the sample bottles progressively after each sample is collected.
- Place all disposable sampling materials (such as plastic sheeting, and health and safety equipment) in appropriate containers.
- Ship samples via courier service with priority overnight delivery. Tracking numbers for all shipments should be provided and recorded after they have been sent out to ensure their timely delivery.
- Do not ship samples via Fed Ex for Saturday delivery.

8 WASTE MANAGEMENT

All rinsate should be collected in a sealed pail for disposal. Drill cuttings and purge water will be managed as specified in the Field Sampling Plan (FSP) or Work Plan, and according to state and/or federal requirements. PPE and decontaminated fluids will be contained separately and staged at the sampling location. Containers must be labeled at the time of collection. Labels will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, groundwater, PPE). General guidelines for investigation derived waste (IDW) handling and storage are set forth in a separate IDW guidance document (Arcadis 2009).

Typical waste characterization procedures include collection of a composite sample of the drill cutting material and a composite sample of the purge water for laboratory analysis. Samples are typically analyzed for disposal toxicity characteristic leaching procedure (TCLP) analysis for metals and VOCs. For PFASs, a simple leach test with neutral pH water may be more indicative of actual risk. Additionally, generators of waste are required to include analysis of other constituents that are reasonably believed to be present including (in this case) PFASs.

Emerging contaminants pose a unique challenge for disposal because acceptance of such waste will be based on the local facility and their permit restrictions. Project teams will be required to identify appropriate facilities based on the facility's legal ability to accept the waste and the team should confirm that the facility

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is meeting the regulatory requirements for accepting waste containing PFASs. In general, facilities that provide solidification and/or incineration will be likely to meet the necessary requirements to accept PFAS-containing waste. The facility will then provide the definitive laboratory analysis requirements needed to meet their permit requirements for waste classification.

9 DATA RECORDING AND MANAGEMENT

9.1 Field Notes

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Pens, pencils, and Sharpies may be used.
- Keep field notes and writing implements away from samples and sampling materials.
- One person should conduct sampling while another records field notes.
- Do not write on sampling bottles unless they are closed.

9.2 Other Project Documentation

- Complete Groundwater Sampling Logs.
- Make sure COC Forms are properly completed. Verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list, etc.) are required for analysis and note on the COC.

10 QUALITY CONTROL

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and
- Samples must be stored in appropriate transport bottles (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

10.1 Equipment Blanks (if relevant)

QA/QC sampling typically includes daily collection of equipment blanks using the laboratory-supplied "PFAS-free" water. For peristaltic pump tubing, laboratory supplied "PFAS-free" water should be poured into a clean HDPE sample bottle and then pumped through new HDPE tubing using the peristaltic pump (with new silicone tubing). The best timing to collect equipment blanks is immediately after the collection of

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a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

10.2 Field Duplicates

QA/QC sampling typically includes the collection of one field duplicate for every 10 or 20 samples collected. Each duplicate sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-provided sample bottle. Do not indicate to the laboratory which sample the duplicate replicates, i.e. it should be given a blind reference on the COC and sample name such as "duplicate".

10.3 Field Reagent Blanks

QA/QC sampling for PFASs typically includes the submission of one laboratory supplied field reagent blank per day. The field reagent blank sample is brought to the site in a laboratory-supplied sample bottle. Field staff transfer the laboratory-supplied reagent blank to an empty sample bottle. This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel and should be placed in the same cooler as the other PFAS samples.

10.4 Matrix Spikes (optional in some cases)

QA/QC sampling includes submitting a sample to be used as a matrix spike if the project requires it. If a separate sample bottle is required, an additional sample will be collected immediately after the initial sample of which it is a duplicate into a separate laboratory-supplied sample bottle.

10.5 Laboratory Analytical QA/QC

- Arcadis recommends that any request for PFAS analysis in groundwater or soil should be conducted by an ELAP-accredited method compliant with QSM 5.1 Table B-15. Requirements laid out in Table B-15 strictly govern acceptable laboratory data quality for PFAS analysis in environmental samples. **For all data collection efforts at DoD sites, PFAS data must be obtained using a method that is DoD ELAP-accredited under QSM 5.1 or later.**
- Laboratory QA/QC should consist of one laboratory blank and one laboratory control sample (or blank spike) per batch of samples, and additional QA/QCs as indicated by the laboratory QA/QC procedures.
- Isotope dilution should be used for quantification with isotope-labeled surrogate standards, as available, according to the guidelines of QSM 5.1 Table B-15. USEPA Method 537 does not allow for isotope dilution in their PFAS drinking water method.
- For drinking water, groundwater, and surface water samples, laboratories must extract the entire sample and include a solvent rinse of the bottle for analysis. Aqueous samples should generally not be sub-sampled prior to analysis, unless they are high concentration and require serial dilution (US DoD 2017).
- Soil samples should be analyzed in their entirety or thoroughly homogenized before extraction and analysis.

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- As part of the internal QA/QC of laboratory results, relative percent difference (RPD) should be calculated between samples and corresponding field or laboratory duplicates. The laboratory quality assurance portion of the laboratory certificates should be reviewed to verify that all calculations/recoveries were within acceptable limits as established by the laboratory method and guidelines in Table B-15 of QSM 5.1 or later (USDoD 2017).

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PFAS SAMPLING PROCEDURES AND LOW-FLOW GROUNDWATER PURGING FOR MONITORING WELLS

Rev. # 0

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SOP # P-11

PFAS SAMPLING PROCEDURES AND LOW-FLOW GROUNDWATER PURGING FOR MONITORING WELLS

REV. # 0

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PFAS SAMPLING PROCEDURES AND LOW-FLOW GROUNDWATER PURGING FOR MONITORING WELLS

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1 SCOPE AND APPLICATION

The protocol presented in this methods and procedures document describes the procedures recommended to purge monitoring wells and collect groundwater samples for per- and polyfluoroalkyl substances (PFASs) using low flow sampling with a peristaltic pump. Samples will be analyzed for a specified list of PFASs using a modified version of United States (U.S.) Environmental Protection Agency (USEPA) method 537 following the U.S. Department of Defense and U.S. Department of Energy Quality Systems Manual 5.1 methods and procedures set forth in Table B-15.

This protocol has been developed in accordance with the USEPA Region I Low Stress (Low-Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells (EQASOP-GW4; September 19, 2017). PFAS sampling guidelines are incorporated from various guidance documents including the United States Army Corps of Engineers (2016), Department of Environment Regulation, Western Australia (2016), New Hampshire Department of Environmental Services (2016), and Massachusetts Department of Environmental Protection (2017). Staff should also review the Arcadis Technical Guidance Instruction (TGI) titled, Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018).

The project team should determine the last time the wells were developed and if additional development is necessary prior to sample collection. Groundwater samples should not be collected within one week following well development.

2 PERSONNEL QUALIFICATIONS

Arcadis personnel providing assistance to groundwater sample collection and associated activities should have a minimum of six months of related experience or an advanced degree in environmental sciences, engineering, hydrogeology, or geology. The supervisor of the groundwater sampling team should have at least one year of previous supervised groundwater sampling experience, preferably with PFAS related experience. Prior to mobilizing to the field, the groundwater sampling team should review and be thoroughly familiar with relevant site-specific documents including but not limited to the site work plan, field sampling plan, Health and Safety Plan (HASP), historical information, and site relevant documents. Additionally, the groundwater sampling team should review and be thoroughly familiar with documentation provided by equipment manufacturers for all equipment that will be used in the field prior to mobilization, in particular to confirm the sample materials that will be in contact with the water sample are compatibile with PFAS sample collection**.**

3 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) should be available:

- Health and safety documents and equipment (as identified in the Programmatic Accident Prevention Plan and Site Safety and Health Plan)
- Site Plan, well construction records, prior groundwater sampling records (if available)

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- Peristaltic pump (e.g., ISCO Model 150) or bladder pump (e.g., Geotech PFC-Free Portable Bladder Pumps)
- A power supply for the peristaltic pump; peristaltic pumps require electric power from either a generator or a deep cell battery.
- High Density Polyethylene (HDPE) tubing and/or silicon tubing of an appropriate size for the pump being used. When collecting samples for PFASs, Teflon® or polytetrafluoroethylene-containing or coated components or tubing are prohibited.
- HDPE bailers (if necessary)
- Water-level probe with fluorine-free materials (e.g., Geotech ET 3/8" with Delrin tip and Buna-N O-ring)
- Water-quality (temperature/pH/specific conductivity/oxidation reduction potential [ORP]/turbidity/dissolved oxygen [DO]) meter, flow-through measurement cell, and appropriate calibration standards. Several brands may be used, including:
    - YSI 6-Series Multi-Parameter Instrument
    - Horiba U-22 Multi-Parameter Instrument
    - Hydrolab Series 3 or Series 4a Multiprobe and Display
- Supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020). Turbidity measurements collected with multi-parameter meters have sometimes been shown to be unreliable due to fouling of the optic lens of the turbidity meter within the flow-through cell. A supplemental turbidity meter should be used to verify turbidity data during purging if such fouling is suspected. An in-line tee and valve should allow for collection of water for turbidity measurements before the pump discharge enters the flow-through cell. Note that industry improvements may eliminate the need for these supplemental measurements in the future.
- HDPE water sample containers (supplied by the laboratory) fitted with an unlined (no Teflon™), polypropylene screw cap. Sample bottles for standard groundwater sampling should not contain Trizma® preservative. If sample bottles with Trizma® are provided by the laboratory, request new sample bottles prior to sample collection.
- Appropriate blanks (field reagent blanks supplied by the laboratory)
- Fluorine-free cleaning equipment
- Groundwater sampling log
- Dedicated plastic sheeting (preferably HDPE) or other clean surface to prevent sample contact with the ground
- Clipboards, field binders, and field note pages that are not waterproof and are fluorine-free
- If high concentrations of PFAS related to class B firefighting foams are expected, bring 'shaker test' vials
- Ziploc® bags to hold ice and samples

- Appropriate blanks (field reagent blanks supplied by the laboratory)
- Appropriate transport containers (coolers) with ice and appropriate labeling, no blue ice should be used
- "PFAS-free" water provided by the laboratory for decontamination rinsing
- Alconox® or Liquinox®; note that Alconox® is known to contain trace levels of 1,4-dioxane
- Packing and shipping materials
- Chain-of-Custody (COC) Forms

Note the specific make/model of the equipment used during each sampling event on the groundwater sampling log. The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, calibration, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment should be serviced by a qualified technician.

4 CAUTIONS

- Do not perform field sampling when rain fall is persistent at a consistent rate that saturates the ground (i.e., formation of puddles) because rain gear is not permitted while sampling. Intermittent showers or fog are acceptable conditions to proceed. If rain showers occur; field gear must be removed from the monitoring well location until the rain subsides. If project timelines are tight, consider the use of a gazebo tent that can be erected over the top of the monitoring well to provide shelter from the rain. The canopy material is possibly a PFAS-treated surface and should be managed as such; therefore, wear gloves when moving the tent, change them immediately after moving the tent, and avoid further contact with the tent until all sampling activities have been finished and the team is ready to move on to the next sample location. Ensure that the canopy will not leak into the sampling area prior to use.
- Do not wear any outdoor performance wear that is water or stain resistant or appears to be. Performance wear such as Gore-Tex® or eVent™ are examples of clothing brands to avoid. Natural fabrics such as cotton are preferred. Synthetic fabrics may also be acceptable if there is no indication on the label that the fabric is water and stain resistant. Avoid contacting clothing with sampling equipment, bottles, and samples.
- Waterproof field books must not be used for field notes. Use loose paper on Masonite, plastic, or aluminum clip boards. Pens, pencils, and Sharpies may be used but should be kept away from sampling materials. One person should conduct the sampling while another records the field notes.
- To avoid potential food packaging-related PFAS contact, do not bring any food outside of the field vehicles onsite. Wash your hands after eating and remove any field garments or outer layers prior to eating.
- Safety footwear is often treated to provide a degree of waterproofing and increased durability and may represent a source of trace PFAS. For the health and safety of field personnel, footwear must be protected at all times to avoid potential PFAS contamination. To do this, do not touch your safety footwear in the immediate vicinity of the sampling location and do not allow gloves used for sampling to come in contact with safety footwear.

- Wear disposable nitrile gloves at all times.
  - Don a new pair of nitrile gloves before the following activities at each sample location:
    - Decontamination of re-usable sampling equipment;
    - Contact with sample bottles or “PFAS-free” water bottles;
    - Insertion of anything into the sample ports (e.g., HDPE tubing); and
    - Handling of any quality assurance/quality control samples including field blanks and equipment blanks.
  - Don a new pair of nitrile gloves after the following activities:
    - Handling of any non-dedicated sampling equipment;
    - Contact with contaminated surfaces; or
    - When judged necessary by field personnel.
- Shower at night. Do not use personal care products after showering such as lotions, makeup, and perfumes, UNLESS medically necessary.
- Use sunscreen and insect repellent ONLY if necessary for health and safety. If they are necessary, apply sunscreen and repellant prior to initiating field sampling. If sunscreen and/or repellant need to be reapplied, ensure a safe distance away from the sampling locations and equipment (i.e., more than 10 meters away). Wash hands after application. Don a new pair of gloves as noted above.
- Visitors are asked to remain at least 30 feet from sampling areas.

5 HEALTH AND SAFETY CONSIDERATIONS

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work. The HASP and JSA documents should be present onsite during all field activities. Generators and cord and plug equipment should employ an overcurrent protection device such as an integrated ground fault circuit interrupter cord. If thunder or lighting is present, discontinue sampling and take cover until 30 minutes have passed after the last occurrence of thunder or lighting. Use caution when removing well caps as the well may be under pressure and the cap can dislodge forcefully and cause injury.

6 PROCEDURE

If a round of water level measurements for all site monitoring wells are planned as part of the project scope, the site-wide water level measurements should be collected in such a manner to avoid potential cross-contamination between the wells. Follow appropriate decontamination procedures for collection of water level measurements.

Peristaltic pumps are preferred when sampling for PFASs to minimize potential cross-contamination. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet), a PFAS-free bladder pump is acceptable. Purge water should be collected and containerized according to the direction of the project team.

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1. Calibrate field instruments according to manufacturer procedures for calibration and document.
2. Place plastic sheeting (preferably HDPE) adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
3. If required in the HASP, use a photoionization detector (PID) to measure the headspace before sampling. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. Insert the PID probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
4. Measure the initial depth to groundwater prior to placing the HDPE tubing.
5. Prepare and install the pump in the well: when using a peristaltic pump, slowly lower the HDPE sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Any dedicated tubing in the well should be replaced with new HDPE tubing. The sampling tube must be kept at least 2 feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well. If using a weight on the tubing ensure the material is PFAS free and has been deconned according to the procedures described in this document.
6. Measure the water level again with the pump in the well before starting the pump to ensure that it has stabilized. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at a lower site-specific rate if specified). Adjust the pump rate to cause little or no water level drawdown in the well (less than 0.3 foot below the initial static depth to water measurement), and the water level should stabilize; however, this is not always possible. If the recovery rate is less than 50 mL per minute, 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. Contact the project manager or other appropriate personnel to discuss.

   The water level should be monitored every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping if the well diameter is of sufficient size to allow such monitoring. Do not break pump suction or cause entrainment of air in the sample. Record pumping rate adjustments and depths to water. If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters. Maintain a steady flow rate to the extent practicable. Review groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for the well in order to more efficiently reach a stabilized pumping condition.

   If the recharge rate of the well is very low, use approved alternative purging techniques, which will vary based on the well construction and screen position. For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples. For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 foot) is maintained and monitoring for stabilization of field indicator parameters can commence. If a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen. Sampling may

commence after one well volume has been removed and the well has recovered sufficiently to permit collection of samples.

During purging, monitor the field indicator parameters (e.g., turbidity, temperature, specific conductance, pH, ORP, and DO) every 3 to 5 minutes (or after each volume of the flow-through cell has been purged). Measure field indicator parameters using a flow-through analytical cell or a clean container such as a glass beaker. Record field indicator parameters on the groundwater sampling log. The well is considered stabilized and ready for sample collection when turbidity values remain within 10% (or within 1 nephelometric turbidity unit [NTU] if the turbidity reading is less than 5 NTU), the specific conductance and temperature values remain within 3%, ORP readings remain within ± 10 mV, DO values remain within 10%, and pH remains within 0.1 unit for three consecutive readings collected at 3- to 5-minute intervals (or other appropriate interval, alternate stabilization goals may exist in different geographic regions, consult the site-specific Work Plan for stabilization criteria). If the field indicator parameters do not stabilize within 1 hour of the start of purging, but the groundwater turbidity is below the goal of 10 NTU and the values for all other parameters are within 10%, the well can be sampled. If the parameters have stabilized but the turbidity is not in the range of the 5 NTU goal, the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible.

DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); care should be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater then again check for and remove air bubbles on the probe before re-measuring. If the DO value is 0.00 or less, then the meter should be serviced and re-calibrated. If the DO values are above possible results, then the meter should be serviced and re-calibrated.

During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) should be documented in the field notes. If other field conditions preclude stabilization of certain parameters, an explanation of why the parameters did not stabilize should also be documented on the groundwater sampling log.

7. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell should be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection. Under no circumstances should analytical samples be collected from the discharge of the flow-through cell.
8. Make sure the sample bottle caps have remained on the bottle until immediately prior to sample collection.
9. Don a new set of nitrile gloves prior to sample collection. While collecting the sample, make sure the bottle cap remains in the other hand of the sampler until replaced on the bottle. When the container is full (fill to the neck of the bottle, some headspace is acceptable), firmly screw on the cap (snug but

not too tight so that the screw cap is stripped). Do not use gloved hands to subsequently handle papers, pens, clothes, etc. before collecting the sample.

10. Collect any necessary duplicates and matrix spikes. As the laboratory should be analyzing the entire aqueous sample rather than sub-sampling, separate bottles will be required for these samples.
11. Do not rinse PFAS sample bottles during sampling. Do not filter samples.
12. Complete and attach the sample label(s) after sample collection and after the caps have been placed back on each container. Pre-printed labels are preferred, but pens and Sharpies® may be used.
13. Place sample bottles in a sealed Ziploc® bag. Place samples in coolers that are durable in transportation and keep the temperature between 0 and 4ºC until transported to the laboratory.
14. Record the sample name and time of sampling on the sample bottle label, in the field notes and note observations (e.g., physical appearance and the presence or lack of odors or sheens), and record on the COC form.
15. NOTE: If high concentrations of PFAS related to class B firefighting foams are expected in a groundwater sample, collect and shake a small portion of the sample (~10 to 25 mL) on site. If foaming is noted within the sample, document the foaming when samples are submitted for analysis; the 'shaker test' vial can then be disposed. This shaker test provides information about how each of the samples should be handled analytically. Therefore, note ‘shake test’ results on the COC form if appropriate.
16. Turn off the pump. Slowly remove the tubing from the well. If the tubing will be dedicated, store the tubing in an appropriate storage container. Do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
17. Complete the procedures for packaging, shipping, and handling with the associated COC.
18. Between uses, complete decontamination procedures for flow-through analytical cell and water level meter, and any equipment that comes into contact with well water (see decontamination procedures described in Section 9 below).
19. At the end of the day, perform a calibration check of field instruments.
20. The general procedures listed in this document can be used for collection of samples from groundwater treatment systems or other similar sampling of water. In order to collect samples from a sampling port on a groundwater treatment system or for a similar situation follow the safety and quality procedures listed in this document. As a general note on sampling ports, ensure that there is no indication of Teflon™ tape or other Teflon™ containing material.

7 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment, should be placed in appropriate containers. PFAS containing waste requires special considerations and containerized waste will be stored onsite for future management by the responsible party.

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8 DATA RECORDING AND MANAGEMENT

Initial field logs and COC records should be transmitted to the Arcadis Project Manager at the end of each day unless otherwise directed. The groundwater team leader retains copies of the groundwater sampling logs until they are relinquished to the project file.

9 QUALITY ASSURANCE

In addition to the quality control samples to be collected in accordance with these methods and procedures, the following quality control procedures should be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available. If no analytical data are available, collect samples in order of upgradient, then furthest downgradient to source area locations.
- Bottle caps must remain in the hand of the sampler until replaced on the bottle.
- Labels must be completed after the caps have been placed back on each bottle.
- Equipment blanks should be collected from various sampling equipment including the pump, water level meter (following decontamination procedures), disposable tubing, and nitrile gloves.
- Collect equipment blanks using laboratory supplied “PFAS-free” water after wells with higher concentrations (if known) have been sampled.
- Field duplicates, matrix spike, and matrix spike duplicates will be collected at a frequency in accordance with the QAPP and applicable QAPP Addenda.
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc© bags for use as ice containers) with appropriate labeling. Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples. Samples should be maintained at temperatures between 0 and 4°C until transported to the laboratory.
- Operate all monitoring instrumentation in accordance with manufacturer’s instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities on calibration log sheets.
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for PFAS equipment decontamination noted below. Clean all field equipment used at locations that are suspected of containing class B firefighting foam (i.e., those that foam during shaking or are known to be near a class B firefighting foam source zone) using each of the below steps repeated twice.
- The steps for PFAS equipment decontamination are as follows:
    - Donning a new pair of nitrile gloves;
    - Rinse sampling equipment with Alconox or Liquinox® cleaning solution; Scrub equipment with a plastic brush if needed;
    - Rinse two times with distilled water or deionized water;

- Rinse one time with “PFAS-free” water; and
- Collect all rinsate in a sealed pail for disposal. Do not reuse decontamination solutions between sampling locations

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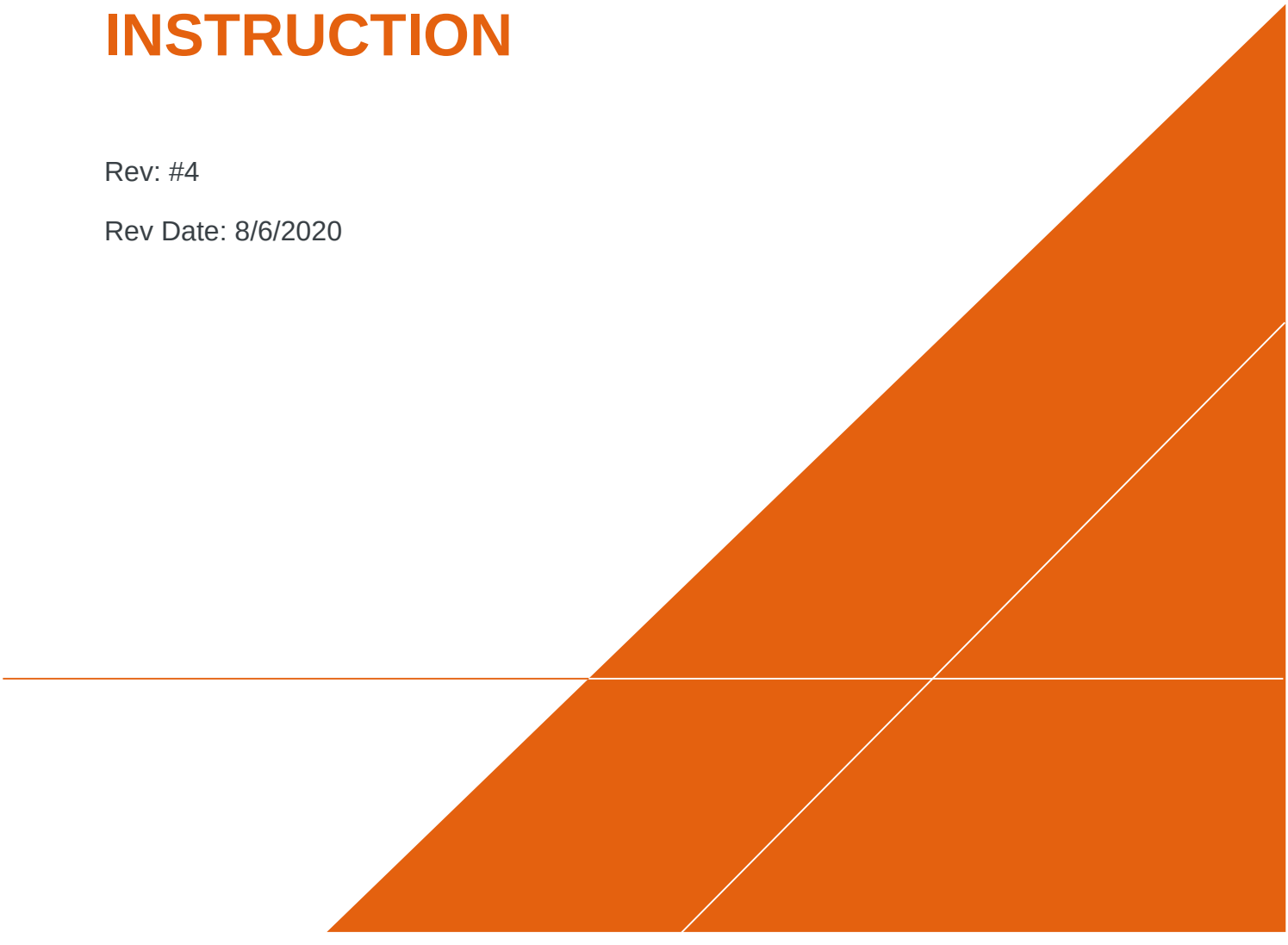
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SOP # P-12

PFAS-SPECIFIC DRILLING AND MONITORING WELL INSTALLATION TECHNICAL GUIDANCE INSTRUCTION

Rev: #4

Rev Date: 8/6/2020



SOP # P-12

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	10/12/2018	All	Generated from generic Well Installation TGI (Rev 0, April 24, 2017). Revised to be PFAS-specific, provide more instruction on soil sample collection, and only include DPT and Sonic methods	Ankit Gupta
1	3/26/2019	Attachments	Added a restriction against all fluoropolymer materials in Table 2 for sampling; Removed Citranox as an appropriate decon solution in Table 1. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox.	Erika Houtz
2	12/19/2019	5-7, 9-10, 13-15, 18-19, 22-28	Updated equipment list. Added procedures for single-interval groundwater sampling during drilling activities. Added procedures for hollow stem auger drilling.	Joseph Quinnan
3	4/15/2020	28-34	Added procedures for air rotary drilling	Eric Killenbeck
4	8/6/2020	30	Revised the procedure for single-interval groundwater sampling via air rotary drilling	Joseph Quinnan

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APPROVAL SIGNATURES

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SOP # P-12

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes methods for the following at sites impacted by per- and polyfluoroalkyl substances (PFASs):

- Advance soil borings via direct push technology (DPT), rotosonic, hollow stem auger, or air rotary drilling techniques
- Collect single or multiple depth-discrete dry and/or saturated soil samples
- Collect single-interval grab groundwater samples
- Install groundwater monitoring wells in unconsolidated aquifers (as necessary).

This TGI covers specific considerations relevant for PFASs due to their unique chemical and physical properties, low detection limits, and low regulatory standards. A more detailed discussion of general PFAS sampling procedures is provided in PFAS Field Sampling Guidance TGI (Arcadis 2020).

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If monitoring wells are to be installed upon completion of borehole drilling and soil sampling, it is assumed that the monitoring well has been designed consistent with the approach and methods presented in the American Society of Testing and Materials (ASTM) D5092 – *Standard Practice for Design and Installation of Groundwater Monitoring Wells* (ASTM D5092). This includes sizing of the filter pack and screen slot size, the length of the screen, total depth of the well, material strength and compatibility and surface completion. Typical monitoring wells are constructed of manufactured screen and engineered filter pack and are generally suitable for formations with granular materials having a grain size distribution with up to 50% passing a #200 sieve and up to 20% clay-sized material. Monitoring wells installed in formations finer than this may not be able to produce turbidity free water.

The procedures set out herein are designed to produce standard groundwater monitoring wells suitable for: (1) groundwater sampling; (2) water level measurement; and (3) hydraulic conductivity testing of formation sediments immediately adjacent to the open interval of the well (e.g., slug testing).

This TGI will focus specifically on four drilling methods most likely to be utilized during drilling and soil sampling activities: DPT, rotosonic, hollow stem auger, and air rotary techniques. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, site or regional geologic knowledge, type of sampling to be conducted, project objectives, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No polyvinyl chloride (PVC) glue/cement will be used in constructing or retrofitting monitoring wells that will be used for water-quality monitoring. No coated bentonite pellets will be used in the well drilling or construction process. Specifications of materials to be installed in the borehole will be obtained prior to mobilizing onsite; these materials generally include:

- Well casing (length, material, and diameter);
- Well screen (length, material, diameter, and slot size);
- Bentonite (type, as applicable, chips, non-coated and granular bentonite are acceptable);
- Filter pack (filter pack type and fine sand seal type, as applicable); and
- Grout (type, as applicable).

Well materials will be inspected and, if needed, cleaned or replaced prior to installation.

3 PERSONNEL QUALIFICATIONS

Drilling and soil sampling activities will be performed by persons who have been trained in proper procedures under the guidance of an experienced field geologist, engineer, or technician, with particular emphasis on PFAS sampling procedures outlined in PFAS Field Sampling Guidance TGI (Arcadis 2020). Field personnel will have undergone in-field training in soil description methods, as described in Soil Description TGI (Arcadis 2018a).

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4 EQUIPMENT LIST

The following equipment and materials must be available for borehole advancement, single-interval groundwater sampling, and well construction activities:

- Site plan with proposed sampling locations;
- Relevant work plan (e.g., installation-specific Quality Assurance Project Plan [QAPP] Addendum);
- Site Safety and Health Plan (SSHP);
- Appropriate health and safety equipment, as specified in the SSHP;
- Drilling Equipment:
    - DPT, rotosonic, hollow stem auger, or air rotary drill rig, to be provided by drilling subcontractor. Type to be determined based on site-specific details.
    - Direct push groundwater samplers (e.g., Geoprobe® SP-22 or Geoprobe® SP-16) rotosonic sampling devices (e.g., Cascade Packer Isolation Groundwater Profiler or Geoprobe® SP-60 Sonic Groundwater Sampler), or hollow stem auger/air rotary sampling devices (e.g., pre-packed PVC well screens and PVC riser), to be provided by drilling subcontractor.
    - Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if not provided by the drillers.
    - Note: Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling equipment will be provided in quantities capable of achieving estimated target depths. Specifications of the sampling and well installation equipment are expected to vary by project, so communication with the driller is necessary to ensure that the materials provided will meet the project objectives. Equipment and materials typically provided by the driller could include:
        - Disposable acetate (or Lexan TM) liners (when drilling with direct-push equipment)
        - Appropriate length of drilling rods and tooling
        - Drilling and sampling equipment decontamination materials
        - Decontamination pad materials
        - Well construction materials
        - Drums for investigation derived waste
- Sampling:
    - Appropriate PFAS-free groundwater sampling equipment (e.g., disposable bailers for volumetric sampling, peristaltic pump for shallow groundwater sampling, submersible bladder pump for deeper sampling). Refer to the PFAS Field Sampling Guidance TGI (Arcadis 2020) and Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells TGI (Arcadis 2016) for necessary equipment.
    - Stainless-steel spatulas, spoons, and trowels.

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- Stainless-steel hand auger with at least 10-ft of extension rods.
- PVC piping of larger diameter than hand auger, if necessary, to keep hand auger borings open.
- Soil logging equipment as specified in the appropriate project documents.
- Dedicated low-density polyethylene (LDPE) plastic sheeting to prevent sample contact with the ground.
- Photoionization detector (PID) or flame ionization detector (FID) with calibration gas.
- 4-gas meter with calibration gas.
- Water level meter with fluorine-free materials (Geotech ET 3/8" with Delrin tip and Buna-N O-ring).
- YSI 6-Series multi-parameter water quality probe or equivalent (e.g., conductivity, temperature, dissolved oxygen, oxidation reduction potential) with flow-through cell.
- Turbidity meter.
- Laboratory provided PFAS-free water for field and equipment blank QC samples.
- Laboratory-provided HPDE PFAS shaker test vials.
- Appropriate sample containers and labels:
  - Laboratory-supplied HDPE sample bottles: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) for PFAS-specific considerations.
  - Polyethylene bags (Ziploc® brand only) to hold ice and samples.
  - Appropriate blanks (field reagent blanks supplied by the laboratory).
  - Packing and shipping materials.
  - Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a).
  - Appropriate transport containers (coolers) with ice and appropriate labeling; no blue ice.

- Decontamination/Waste Management:
  - PFAS-free decontamination fluids and equipment:
    - HDPE or PVC brushes and squirt bottles
    - Stainless steel bowl
    - HDPE buckets to hold decontamination fluids
    - Alconox or Liquinox (other detergents prohibited)
    - Distilled or laboratory-supplied deionized water
    - Laboratory provided PFAS-free water

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  - See the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) or the Groundwater and Soil Sampling Equipment Decontamination TGI (Arcadis 2017b) for additional guidance.
  - Portable field hand washing setup.
  - Non-hazardous drum labels as required for investigation-derived waste handling: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c).
- Field Notes:
  - Pens, pencils, and/or Sharpies® for writing
  - Appropriate field forms
  - Clipboards, field binders, field notebook, and field note pages that are not waterproof
  - Digital camera
- Other:
  - Field clothing made of cotton or other natural fibers that is well laundered (i.e., washed at least 6 times)
  - Well laundered cotton blankets for covering field vehicle seats
  - PFAS-free sunscreen and insect repellant
  - Garbage bags
  - Paper towels
- Locks and keys for securing the well after installation
- Engineer's tape/measuring wheel

5 CAUTIONS

5.1 Utility Clearance

The appropriate drilling authorities will be contacted and a site visit for public utility line clearance at the proposed boring locations will be conducted at least 72 hours prior to work commencing. As applicable, utility maps will be reviewed during field reconnaissance of the proposed inspection locations to determine if any are co-located with public utility lines. Arcadis will also contract an independent geophysical survey company to verify that proposed boring locations are not co-located with existing underground utility/substructure features, as necessary. Arcadis will clear locations with soft dig methods to assess the presence of underground utilities as necessary. See the Utility Location and Clearance Arcadis Health and Safety Standard (Arcadis 2017d) for reference.

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5.2 General Drilling and Well Construction Considerations

Prior to beginning field work, contact the project technical team to ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members.

Some regulatory agencies require a minimum annular space between the well or permanent casing and the borehole wall. When specified, the minimum clearance is typically 2 inches on all sides (e.g., a 2-inch diameter well requires a 6-inch diameter borehole). In addition, some regulatory agencies have specific requirements regarding grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the drilling and well installation plan.

If dense non-aqueous phase liquids (DNAPL) are known or expected to exist at the site, refer to the project specific documents for additional details regarding drilling and well installation to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquids (LNAPLs) are known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Consider the compatibility between the well materials and the surrounding environment. For example, PVC well materials are not preferred when DNAPL is present. In addition, some groundwater conditions leach metals from stainless steel or are corrosive to metal well materials. If questions arise, contact the CPM and/or project technical lead to discuss.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPLs are likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

As noted above, coated bentonite pellets will not be used in monitoring well construction, as the coating could impact the water quality in the completed well.

Heat of hydration during neat cement grout curing must be considered to avoid damage to PVC well materials. The annular space for a typical monitoring well is small enough that heat of hydration should not create excessive temperature increases which may damage PVC well material. However, washouts in the borehole can lead to thick accumulations of grout which can produce enough heat during curing to weaken and potentially damage PVC casing. If heat of hydration is a concern, contact the project technical lead to address the issue.

5.3 PFAS-Specific General Sampling Considerations

This section provides a summary of methods and procedures applicable to the collection of environmental samples for laboratory analysis during PFAS site characterization activities. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. For example, Teflon™ and other fluoropolymer containing materials are found in pumps, tubing, and sample storage containers and therefore should be

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avoided (Department of Environment Regulation [DER], Western Australia 2016; New Hampshire Department of Environmental Services [NHDES] 2016). Certain field documentation materials such as waterproof paper or field books, adhesive paper products, and some writing utensils (grouped as non-Sharpie® markers) are also prohibited items during PFAS sampling (DER 2016; NHDES 2016).

New nitrile gloves should be donned before any of the following activities:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or PFAS-free water bottles;
- Handling clean sample tubing/down-well equipment or connecting tubing;
- Handling QC samples including field blanks and equipment blanks.

Additionally, new nitrile gloves should also be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. **When in doubt change your gloves.**

Prior to initiating field activities, water sources to be used during drilling activities (e.g., rotosonic drilling, should be sampled to verify those sources are PFAS-free. While not part of the PQAPP, this is considered best practice and should be completed to the extent possible.

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and,
- Do not write on sampling bottles unless they are closed.

Tables 1 and **2** in **Attachment 1** provide recommendations for PFAS Site Inspection equipment. **Table 1** provides a summary of materials that have been approved for site inspection; this list is expected to grow longer as industry experience increases. **Table 2** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection. For materials that are suspected of containing PFASs and/or retaining PFASs, these recommendations are considered preliminary and subject to change.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are typically advised to err on the side of caution by strictly following field wear guidelines and decontamination procedures as specified in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020). **The most important consideration during PFAS related drilling and soil sampling is to prevent contact between sample media and suspect PFAS sources.**

5.4 PFAS-Specific Groundwater Sampling

The potential presence of PFASs in equipment that may come in contact with the target water sample must be evaluated as part of the sample planning process to maintain sample integrity. For example, low-flow sampling with a peristaltic pump should be conducted using silicone or HDPE tubing; Teflon™ tubing is prohibited (DER 2016). If a bladder pump is used to collect samples, the bladder and other internal

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parts (e.g., check balls, o-rings, compression fittings) should not be made of Teflon™ either, and bladder and o-rings should be changed between samples (DER 2016).

Note that if high concentrations of PFASs related to Class B firefighting foams are expected in a groundwater sample, it has been recommended to collect and shake a small portion of the sample at the time of sample collection (USACE 2016; Arcadis 2020). If foaming is noted within the sample, it indicates elevated concentrations of PFASs may be present and the sample should be proactively diluted at the laboratory prior to analysis. The foaming should be noted on the sample chain of custody form. It is recommended to collect sampling equipment blanks following foam observation to confirm the effectiveness of decontamination procedures.

5.5 PFAS-Specific Soil Sampling

Equipment that contacts soil cuttings during sampling activities should be carefully considered and selected. PFAS-containing materials are potentially present in some of the equipment typically used for soil sampling. This includes any lubricants, connections, fittings, etc. used on the cutting shoe on the head of a direct push drill string. Additionally, no materials that pose a cross-contamination risk should be introduced to the bucket of a hand auger. **To minimize the risk of cross-contamination, all hand augering activities (i.e. augering, sample collection, decontamination) should be performed by Arcadis personnel (as opposed to drilling subcontractor) when surface soil samples will be collected**. Each piece of reusable drilling/sampling equipment that comes into direct contact with soil cuttings or groundwater must be inspected before use to confirm that PFAS-containing materials are not present, which could be a source of cross-contamination and cause false positives, and that PFASs will not adhere to the material, which has the potential to cause low bias sample results. If equipment cannot be verified as being PFAS-free and there is a concern that it could potentially introduce contamination, a conservative number of equipment blanks should be collected to confirm that materials in the sample equipment do not cause false positives by introducing PFASs. Other quality assurance methods may be implemented to avoid materials that could result in potential losses associated with PFASs adhering to surfaces. For example, collecting soil samples for laboratory analysis from an “undisturbed” portion of a large diameter soil core is a good practice.

The following additional notes are provided regarding soil sampling materials:

- Where drilling or decontamination water is needed, a sample of the source water must be collected and analyzed for PFAS before drilling begins to ensure that background PFASs will not be introduced. Some water systems may be constructed with PFAS-containing thread and gasket sealants; therefore, an inspection of the source water distribution system may provide an additional level of assurance for identifying a source of PFAS-free water for site inspections.
- It is often standard practice to cover the ends of sample sleeves and protect the sample from potential cross-contamination from the plastic end caps with Teflon™ or other PTFE tape (Geotechnical Services, Inc. 2018); this practice is prohibited for PFAS sample collection (DER 2016).
- Lexan™ liner sleeves are made of polycarbonate and they are not expected to contain PFASs based on review of the Safety Data Sheet (Sabic 2016).

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- Acetate (i.e., cellulose acetate butyrate) liners are commonly used as sleeves and are not expected to contain PFASs.
- Studies evaluating the use of stainless steel indicate that PFASs do not strongly sorb to stainless-steel (Obal et al. 2012). Therefore, stainless-steel sleeves and equipment should be acceptable for collection of soil samples for PFAS analysis.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with drilling, soil sampling, and monitoring well installation will be performed in accordance with the SSHP, a copy of which will be present on site during such activities.

7 PROCEDURE

The procedures for drilling, soil sampling, and installing groundwater monitoring wells (if necessary), are presented below. All field sampling should be completed by a two-person team, with one collecting the samples, and the other handling documentation and providing support. This will help to limit the potential for accidental cross-contamination of the sample media.

7.1 Direct Push Technology (DPT) Method

Direct-push drilling may be used to complete soil borings and install monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system, GeoProbe®, or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells. The procedures for drilling, soil sampling, single-interval groundwater sampling, and installing monitoring wells in soil using the direct-push method are described below.

1. Place LDPE plastic sheeting over core/sampling processing area to create a clean working surface, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris prior to sampling.
3. Decontaminate all non-disposable sampling equipment and tooling that will or may to come into direct contact with soil prior to first use. Disposable sampling equipment must be kept in sealed PFAS-free packaging until it is used.
4. Use stainless-steel hand auger to collect samples from 0 - 5 ft bgs surface interval, if applicable. All hand auguring to collect soil samples will be completed by Arcadis personnel, not the drilling

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subcontractor. These samples can be collected either during other Utility Clearance activities (e.g., third party clearance) or immediately prior to drilling.

   a. The sample should be collected manually directly from the hand auger bucket (using stainless steel scoop, spatula, or trowel as necessary) and placed directly into the sample jar, following Steps 7 – 15 below. The sample should not contact the ground or LDPE sheeting.
   b. If collecting multiple samples from the same boring, after collecting sample from the surface or shallowest depth interval examine the stability of the soil in the boring sidewalls. If sidewalls appear to be at risk of collapsing into the borehole insert a length of PVC pipe into the boring to maintain the opening and prevent collapse prior to augering to the next deeper sampling interval.

5. Use dual tube rod system and collect soil cores in acetate or Lexan ™ liners. The cutting shoe and core extractor must be stainless steel with no PFAS-containing materials present (e.g., gaskets, coatings).
6. After each drilling run, drillers extract and cut open liners and provide to Arcadis personnel for characterization and sampling. Drillers must not touch soil inside of liners during this process. Arcadis personnel decontaminate cutter between uses (see below).
7. Don a new set of nitrile gloves prior to handling sample core, then characterize soils in accordance with P-04 TGI - Soil Description (Arcadis 2018a). Record descriptions in the field notes, boring logs, and/or tablet/cell phone via Arcadis Fulcrum application. It is also beneficial to photo document the samples. It should be noted that logs collected via tablet or cell phone must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data.
8. Don a new set of nitrile gloves prior collecting soil samples for analysis. Do not use gloved hands to handle items (e.g., papers, pens, clothes) before collecting samples. Do not touch outside of sample liner with gloved hands.
9. Collect field samples and any required QC samples from recovered soil cores using a clean stainless-steel trowel and place in clean, labeled bottles supplied by the laboratory for the required analyses. If collecting samples for multiple analyses, collect PFAS samples first. Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replacing on the bottle.
10. Once the sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
11. Place soil sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.
12. Record the label information and time of sampling in the field notes and sampling forms.
13. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
14. Decontaminate all reusable sampling equipment between sample intervals and borings as described in Section 10.
15. Repeat Steps 7 – 14 until all samples have been collected from the boring location.

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16. Abandon soil boring to grade in accordance with the site-specific work plan upon completion and before moving to the next boring location. **If single-interval groundwater sample is required, see Section 7.1.1 for procedure. If well is to be installed, see Section 7.1.2 for well construction procedure**.
17. Mark boring location with wooden stake that identifies boring ID for subsequent surveying, as necessary.
18. Manage investigation-derived-waste (IDW) as specified in Section 8 and in accordance with the site-specific work plan.
19. If samples are not shipped the same day as collected, add fresh ice to sample coolers at the end of the day to maintain the temperature between 0 and 6°C. Place ice in sealed Ziplock® bags. Do not use blue ice. Sample coolers must remain in the possession of the sampling team at all times or secured under lock and key until shipment to the laboratory.

7.1.1 DPT Single-Interval Groundwater Sampling

The steps below describe the procedure for collecting a single-interval groundwater sample at a desired sample interval, commonly from the first encountered shallow groundwater. It should be verified that samples are taken below the water table (i.e., not perched water in the vadose zone). Single-interval sampling should be performed with a Geoprobe® SP-22 sampling device or similar (e.g., HydroPunch ™). A primary difference with single-interval methods relative to multi-interval vertical aquifer profiling (VAP) sampling is that the sampling screen is driven to the appropriate depth by the drill rig instead of lowering the sampling screen through the drill tools after reaching the appropriate depth. If multi-interval VAP sampling is required, refer to Arcadis TGI for Vertical Aquifer Profiling for PFAS Analysis (Arcadis 2019).

If using a Geoprobe® SP-22 sampling device, the following steps will be followed:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log.
2. Advance Geoprobe® SP-22, equipped with stainless-steel screen, using standard Geoprobe® rods to the target depth interval in accordance with **Section 7.1**.
3. Retract the outer casing to expose the screen for the desired sample interval length, using extension rods to hold the screen in place. The Geoprobe® SP-22 sampling screen can be either 12” or 48”. Note: no soil cores will be retrieved using the Geoprobe® SP-22.
4. Go to Step 9.

If using a HydroPunch ™ sampling device, the following steps will be followed:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log.
2. The drilling subcontractor will advance the borehole to approximately 2 feet above the depth from which a discrete water sample is to be obtained.

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3. The drilling subcontractor will disassemble the HydroPunch™ sampling device according to the manufacturer's instructions to allow the sampler to be decontaminated. The sampler should be completely disassembled, including O-rings and/or check valves.
4. Decontaminate the sampler per instructions in Section 10 as appropriate for the range of groundwater analytes to be sampled for, by washing with laboratory-grade detergent and potable water wash, followed by solvent rinse (if sampling for organics) and final rinse with deionized or distilled water. Check the condition of the O-rings during each cleaning and replace if necessary.
5. The drilling subcontractor will reassemble the decontaminated HydroPunch™ sampling device according to the manufacturer's instructions and lower the device to the bottom of the borehole.
6. The drilling subcontractor will push or drive the HydroPunch™ 5 feet below the bottom of the casing or augers, then retract the sampler 3 feet upward. Subsurface friction will retain the drive point in place, exposing the screen and allowing groundwater to enter the sampling tool.
7. Allow sufficient time to allow the sampler to fill with water. Typically, 30 minutes is sufficient, except in low permeability materials. If sufficient water has not accumulated in approximately 30 minutes, leave the temporary well casing and screen in the borehole to allow for overnight recovery of groundwater for follow-up sampling the next day.
8. Go to Step 9.

Complete the following steps for sample collection:

9. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point.
10. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell, and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (small-diameter bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval.
    - Alternately, a Waterra-type inertial pump can be used to retrieve the water sample. If the formation has low-permeability and enough water is not anticipated in the tooling to allow purging of water, a stainless-steel bailer may be considered (after consulting with Arcadis RL).
11. Purge until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples.
    - Note: for low-permeability formations, collect a grab sample from the screen point sampling device and/or saturated soil sample from the soil core. Leave temporary well casing and screen in the borehole to allow for overnight recovery of groundwater for follow-up sampling the next day.
12. Don a new set of nitrile gloves prior to collecting groundwater sample and each QC sample. Do not use gloved hands to handle items (e.g., papers, pens, clothes, equipment) before collecting samples.

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13. Fill sample bottles using labeled HDPE bottles that are supplied by laboratory only. Ensure the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface; keep in hand opposite of sample collection and do not touch the inside of the cap.
14. If high concentrations of PFASs related to Class B firefighting foams are expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (approximately 10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The “shaker test” vial can then be disposed of as specified in Section 8.
15. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.
16. Place filled sample bottles in a sealed (Ziploc©) bag, record any label information that was not previously filled out (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples.
17. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
18. Pull the Geoprobe® SP-22, HydroPunch™, or other sampling device back up and decontaminate per instructions in Section 10.

7.1.2 DPT Monitoring Well Construction

1. Upon advancing the borehole to the desired depth, install the well through the inner drill casing. The well will consist of 2-inch ID PVC or stainless-steel slotted screen and blank riser. Screen length and construction will be specified in the Work Plan or discussed with the Arcadis PM.

2. When the monitoring well assembly has been set in place, place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie pipe. The filter pack is placed, and drilling equipment (i.e., rods) extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan. The well should be gently surged to prevent filter pack material bridging and to settle the filter pack prior to well seal installation.

    a. Alternately, a monitoring well assembly with a pre-packed screen can be installed. The monitoring well assembly (i.e., regular PVC or pre-packed) should be discussed and decided prior to beginning field work and specified in the QAPP addendum. Pre-packed filters should be verified as PFAS-free prior to use.

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3. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of bentonite—follow the specifications in the Work Plan). Use of a tremie pipe is not required for placement of the bentonite seal (though may be required if a well is very deep and borehole bridging is reasonably anticipated). However, bentonite should be poured into the annular space slowly enough to ensure borehole bridging does not occur. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. *No coated bentonite pellets will be used in monitoring well drilling or construction*. PFAS-free water (verified by laboratory analysis of source water) should be added to hydrate the bentonite if the seal is above the water table. Continuously monitor the placement of the sand pack and bentonite with a weighted tape measure.

4. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft bgs or as specified in the Work Plan. As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with PFAS-free water (verified by laboratory analysis of source water) following manufacturer's recommendations.

5. Install the monitoring well completion as specified in the Work Plan. Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing set within a neat cement pad at grade. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing set within a neat cement pad. In either case, the cement pad will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing and should slope gently away to promote drainage away from the well.

6. During well installation, record construction details and tabulate materials used in field notebook as well as appropriate field forms.

7. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

7.2 Rotosonic Drilling Methods

For sites with deep unconsolidated aquifers or challenging drilling conditions (e.g., presence of dense tills, caliche, cobbles), DPT drilling may not be feasible or cost effective due to limited production rates. In these cases, alternate drilling methods (e.g., rotosonic) are required. Rotosonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks.

1. Place LDPE plastic sheeting over core/sampling processing area to create a clean working surface, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.

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2. Clear the ground surface of brush, root mat, grass, leaves, or other debris prior to sampling.
3. Decontaminate all non-disposable sampling equipment/tooling that will or may to come into direct contact with soil prior to first use. Disposable sampling equipment must be kept in sealed PFAS-free packaging until it is used.
4. Use stainless-steel hand auger to collect samples from 0 - 5 ft bgs surface interval, if applicable. All hand augering to collect soil samples will be completed by Arcadis personnel, not the drilling subcontractor. These samples can be collected either during other Utility Clearance activities (e.g., third party clearance) or immediately prior to drilling.
    a. Hand auger soil sample should be collected manually from the hand auger bucket (using stainless steel scoop, spatula, or trowel as necessary) and placed directly into the sample jar. The sample should not contact the ground or LDPE sheeting.
    b. If sampling by hand auger, after collecting sample from the surface or shallowest depth interval examine the stability of the soil in the boring sidewalls. If sidewalls appear to be at risk of collapsing into the borehole insert a length of polyvinyl chloride (PVC) pipe into the boring to maintain the opening and prevent collapse prior to augering to the next deeper sampling interval.
5. During rotosonic drilling, drillers extract soil core bags after each drilling run, place the core bag onto LDPE sheeting, and cut open bags so Arcadis personnel can perform characterization and sampling. Arcadis personnel should confirm with drilling subcontractor that core bags are constructed of PFAS-free material. Drillers must not touch soil inside of bags during this process. Arcadis personnel decontaminate cutter between uses (see below).
6. Don a new set of nitrile gloves prior to collecting each sample. Do not use gloved hands to handle papers, pens, clothes, etc., before collecting samples. Do not touch outside of sample bag with gloved hands.
7. During sampling, characterize soils in accordance with P-04 TGI - Soil Description (Arcadis 2018a). Record descriptions in the field notes, boring logs, and/or personal digital assistant (PDA). It is also beneficial to photo document the samples. It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data.
8. Collect sample volumes from recovered soil cores using a clean stainless-steel trowel and place in clean, labeled bottles supplied by the laboratory for the required analyses (see sample container list in PQAPP Worksheets #19&30). Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replacing on the bottle.
9. Once the sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
10. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.
11. Place soil sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.
12. Record the label information and time of sampling in the field notes and sampling forms.

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13. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
14. Abandon all soil borings to grade as specified in the QAPP Addendum upon completion and before moving to the next boring location. **If single-interval groundwater sample is required, see Section 7.2.1 for procedure. If well is to be installed, see Section 7.2.2 for well construction procedure**.
15. Mark boring location with wooden stake that identifies boring ID for subsequent surveying, as necessary.
16. Manage investigation-derived-waste (IDW) as specified in site-specific work plan.
17. If samples are not shipped the same day as collected, add fresh ice to sample coolers at the end of the day to maintain the temperature between 0 and 6°C. Place ice in sealed polyethylene bags (Ziplock). Do not use blue ice. See QAPP worksheet #19 and 30 for sample containers, preservation and hold times. Sample coolers must remain in the possession of the sampling team at all times or secured under lock and key until shipment to the laboratory.

7.2.1 Rotosonic Single-Interval Groundwater Sampling

Groundwater profilers can be used to collect single-interval groundwater samples at a desired sample interval, commonly biased towards transport zones determined from soil lithological core, or from the first encountered groundwater. If multi-interval VAP sampling is required, refer to Arcadis TGI for Vertical Aquifer Profiling for PFAS Analysis (Arcadis 2019).

The configuration of individual samplers varies based on their manufacturer and drilling contractor (e.g., Cascade Packer Isolation Groundwater Profiler, Geoprobe® SP-60 Packer Sampler). The overall strategy of rotosonic drilling sampling is consistent with DPT sampling; however, drilling with sonic or some rotary methods requires the introduction of drilling water that can potentially affect the integrity of the groundwater sample. If drilling water is used, a source blank sample will be collected prior to the start of work. If state or local regulations allow, source water can be spiked with non-toxic fluorescent dyes per Arcadis SOP for use of visible tracer in drilling fluid to obtain representative groundwater samples during drilling (Arcadis 2010).

Rotosonic single-interval groundwater sampling will be performed using dual-tube casing. Packer Isolation Groundwater Profilers will be used to conduct groundwater sampling. The biggest advantage of this device is that the groundwater sampling depth interval can be determined based on lithological logs obtained from the same borehole since hydraulic profiling tool is not deployable via rotosonic drilling methods.

The following steps will be followed:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log.
2. Advance dual-tube sonic tooling casing to target depth interval in accordance with **Section 7.2**.
3. Retrieve the soil core and the inner sonic core barrel. Characterize soils in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018a).

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4. Insert the stainless-steel screen and packer assembly (e.g., Cascade Packer Isolation Groundwater Profiler, Geoprobe® SP60 Packer Sampler) to the base of the sonic casing.
5. Extract the outer sonic casing to expose the screen to the formation.
6. Inflate the packer to isolate the screened interval from any water that might be above the packer in the sonic casing.
7. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point.
8. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell, and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval.
9. Purge well until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples.
    - Note: for low-permeability formations, collect a grab sample from the screen point sampling device and/or saturated soil sample from the soil core. Leave temporary well casing and screen in the borehole to allow for overnight recovery of groundwater for follow-up sampling the next day.
10. Don a new set of nitrile gloves prior to collecting the groundwater sample and each QC sample. Do not use gloved hands to handle items (e.g., papers, pens, clothes, equipment) before collecting samples.
11. Fill sample bottles using labeled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface; keep in hand opposite of sample collection and do not touch the inside of the cap.
12. If high concentrations of PFASs related to Class B Firefighting foams are expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (approximately 10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The “shaker test” vial can then be disposed of as IDW as specified in Section 8.
13. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL;
14. Place filled sample bottles in a sealed (Ziploc©) bag, record any label information that was not pre-filled out (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples.
15. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
16. Deflate the packer.
17. Pull the Packer Isolation Groundwater Profiler back up and decontaminate per instructions in Section 10.

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7.2.2 Rotosonic Monitoring Well Construction

1. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction will be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. Grout should be mixed with PFAS-free water (verified by laboratory analysis of source water). The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

2. Before installing a screened well, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

   To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled using water (e.g., Rotosonic), monitor the water level in the borehole as it re-equilibrates to the static level. In low-permeability units like clay, fine-grained glacial tills, shale and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead or PM prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

3. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and solid PVC risers through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser

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casing. Smaller diameters may be used if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan (or equivalent) based on regulatory requirements and specific monitoring objectives. Monitoring well screens should be limited to 5 to 10 feet long. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

The slot size and filter pack gradation should be predetermined in the Work Plan (or equivalent) based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Typically, slot sizes for monitoring wells will range from 0.010 inches to 0.020 inches while the filter pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent filter pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent filter pack may be preferred. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.

Alternately, a monitoring well assembly with a pre-packed screen can be installed. The monitoring well assembly (i.e., regular PVC or pre-packed) should be discussed and decided prior to beginning field work and specified in the QAPP addendum. Pre-packed filters should be verified as PFAS-free prior to use.

A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centering the monitoring well in the borehole during construction.

4. When the monitoring well assembly has been set in place, place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie. The filter pack is placed, and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan (or equivalent). The well should be gently surged to prevent filter pack material bridging and to settle the filter pack prior to well seal installation.

5. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of bentonite—follow the specifications in the Work Plan). Use of a tremie pipe is not required for placement of the bentonite seal (though may be required if a well is very deep and borehole

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bridging is reasonably anticipated). However, bentonite should be poured into the annular space slowly enough to ensure borehole bridging does not occur. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. *No coated bentonite pellets will be used in monitoring well drilling or construction*. PFAS-free water (verified by laboratory analysis of source water) should be added to hydrate the bentonite if the seal is above the water table. Continuously monitor the placement of the sand pack and bentonite with a weighted tape measure.

6. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft bgs or as specified in the Work Plan (or equivalent). As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with PFAS-free water (verified by laboratory analysis of source water) following manufacturer's recommendations.

7. Install the monitoring well completion as specified Work Plan (or equivalent). Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing and should slope gently away to promote drainage away from the well.

8. Monitoring wells should be labeled using indelible ink or paint with the appropriate designation on both the inner and outer well casings or inside of the curb box lid. Use caution when labeling the well as paint or indelible ink could potentially contain PFAS materials.

9. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.

10. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook as well as appropriate field forms.

11. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

7.3 Hollow Stem Auger Drilling Methods

For some sites, direct push drilling may not be feasible and rotosonic drilling may not be cost effective. In these cases, hollow stem auger (HSA) drilling may be required. HSA drilling procedures are similar to

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rotosonic drilling, but HSA is not well suited to very coarse materials (e.g. cobbles and boulder) and it produces disturbed soil samples.

1. Place LDPE plastic sheeting over core/sampling processing area to create a clean working surface, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris prior to sampling.
3. Decontaminate all non-disposable sampling equipment/tooling that will or may to come into direct contact with soil prior to first use. Disposable sampling equipment must be kept in sealed PFAS-free packaging until it is used.
4. Use stainless-steel hand auger to collect samples from 0 - 5 ft bgs surface interval, if applicable. All hand augering to collect soil samples will be completed by Arcadis personnel, not the drilling subcontractor. These samples can be collected either during other Utility Clearance activities (e.g., third party clearance) or immediately prior to drilling.
    a. Hand auger soil sample should be collected manually from the hand auger bucket (using stainless steel scoop, spatula, or trowel as necessary) and placed directly into the sample jar. The sample should not contact the ground or LDPE sheeting.
    b. If sampling by hand auger, after collecting sample from the surface or shallowest depth interval examine the stability of the soil in the boring sidewalls. If sidewalls appear to be at risk of collapsing into the borehole insert a length of polyvinyl chloride (PVC) pipe into the boring to maintain the opening and prevent collapse prior to augering to the next deeper sampling interval.
5. During HSA drilling, soil cuttings will accumulate around the outside of the borehole. Periodically the drillers will shovel cuttings into containers for disposal. Arcadis personnel can also perform characterization and sampling directly from these cuttings.
6. Drillers must not touch soil that will be collected for sampling. Arcadis personnel will use a stainless-steel spatula, spoon, or trowel to collect soil direct from the cuttings pile at the desired sample depth. Arcadis personnel decontaminate spatula, spoon, or trowel between uses in accordance with Section 10.
7. Don a new set of nitrile gloves prior to collecting each sample. Do not use gloved hands to handle papers, pens, clothes, etc., before collecting samples. Do not touch outside of sample bag with gloved hands.
8. During sampling, characterize soils in accordance with P-04 TGI - Soil Description (Arcadis 2018a). Record descriptions in the field notes, boring logs, and/or personal digital assistant (PDA). It is also beneficial to photo document the samples. It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data.
9. Collect sample volumes from cuttings pile using a clean stainless-steel trowel and place in clean, labeled bottles supplied by the laboratory for the required analyses (see sample container list in PQAPP Worksheets #19&30). Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replacing on the bottle.
10. Once the sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).

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11. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.
12. Place soil sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.
13. Record the label information and time of sampling in the field notes and sampling forms.
14. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
15. Abandon all soil borings to grade as specified in the QAPP Addendum upon completion and before moving to the next boring location. **If single-interval groundwater sample is required, see Section 7.3.1 for procedure. If well is to be installed, see Section 7.3.2 for well construction procedure**.
16. Mark boring location with wooden stake that identifies boring ID for subsequent surveying, as necessary.
17. Manage investigation-derived-waste (IDW) as specified in site-specific work plan.
18. If samples are not shipped the same day as collected, add fresh ice to sample coolers at the end of the day to maintain the temperature between 0 and 6°C. Place ice in sealed polyethylene bags (Ziplock). Do not use blue ice. See QAPP worksheet #19 and 30 for sample containers, preservation and hold times. Sample coolers must remain in the possession of the sampling team at all times or secured under lock and key until shipment to the laboratory.

7.3.1 Hollow Stem Auger Single-Interval Groundwater Sampling

Unlike direct push and rotosonic methods, there are limited single-interval groundwater sampling devices for HSA drilling. Commonly, groundwater samples will be collected with pre-packed PFAS-free temporary PVC well screen and PVC riser. This method is most appropriate for sampling the first encountered groundwater. Because soil samples are disturbed, it is often not possible to target specific intervals based on transport properties.

The following steps will be followed to collect the groundwater sample:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log.
2. Advance augers until groundwater is encountered.
3. Arcadis will continuously characterize soil and/or rock cuttings.
4. When groundwater is encountered, the water level in the borehole will be allowed to reach static condition. If a grab groundwater sample is required, a pre-packed PFAS-free temporary PVC well screen will be lowered to the desired sample depth. Then, the augers will be raised to above the temporary well screen to expose the screen.
5. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point.

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6. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (small-diameter bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval.
    a. Alternately, a Waterra-type inertial pump can be used to retrieve the water sample. If the formation has low-permeability and enough water is not anticipated in the tooling to allow purging of water, a stainless-steel bailer may be considered (after consulting with Arcadis RL).
7. Purge until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples.
    a. Note: for low-permeability formations, collect a grab sample from the screen point sampling device and/or saturated soil sample from the soil core. Leave temporary well casing and screen in the borehole to allow for overnight recovery of groundwater for follow-up sampling the next day.
8. Don a new set of nitrile gloves prior to collecting the groundwater sample and each QC sample. Do not use gloved hands to handle items (e.g., papers, pens, clothes, equipment) before collecting samples.
9. Fill sample bottles using labelled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface; keep in hand opposite of sample collection and do not touch the inside of the cap.
10. If high concentrations of PFASs related to Class B Firefighting foams are expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (approximately 10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The “shaker test’ vial can then be disposed of as IDW as specified in Section 8.
11. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.
12. Place filled sample bottles in a sealed (Ziploc©) bag, record any label information that was not pre-filled out (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples.
13. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
14. Retrieve the temporary well screen dispose of as specified in Section 8.

7.3.2 Hollow Stem Auger Monitoring Well Construction

HAS well construction methods are the same as when using rotosonic drilling methods and are outlined below.

1. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the

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zone above the confining layer, then a telescopic well construction will be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. Grout should be mixed with PFAS-free water (verified by laboratory analysis of source water). The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

2. Before installing a screened well, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

   To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled using water (e.g., Rotosonic), monitor the water level in the borehole as it re-equilibrates to the static level. In low-permeability units like clay, fine-grained glacial tills, shale and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead or PM prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

3. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and solid PVC risers through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser casing. Smaller diameters may be used if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan (or equivalent) based on regulatory requirements and specific monitoring objectives. Monitoring well screens should be limited to 5 to

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10 feet long. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

The slot size and filter pack gradation should be predetermined in the Work Plan (or equivalent) based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Typically, slot sizes for monitoring wells will range from 0.010 inches to 0.020 inches while the filter pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent filter pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent filter pack may be preferred. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.

Alternately, a monitoring well assembly with a pre-packed screen can be installed. The monitoring well assembly (i.e., regular PVC or pre-packed) should be discussed and decided prior to beginning field work and specified in the QAPP addendum. Pre-packed filters should be verified as PFAS-free prior to use.

A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centering the monitoring well in the borehole during construction.

4. When the monitoring well assembly has been set in place, place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie. The filter pack is placed, and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan (or equivalent). The well should be gently surged to prevent filter pack material bridging and to settle the filter pack prior to well seal installation.

5. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of bentonite—follow the specifications in the Work Plan). Use of a tremie pipe is not required for placement of the bentonite seal (though may be required if a well is very deep and borehole bridging is reasonably anticipated). However, bentonite should be poured into the annular space slowly enough to ensure borehole bridging does not occur. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding.

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No coated bentonite pellets will be used in monitoring well drilling or construction. PFAS-free water (verified by laboratory analysis of source water) should be added to hydrate the bentonite if the seal is above the water table. Continuously monitor the placement of the sand pack and bentonite with a weighted tape measure.

6. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft bgs or as specified in the Work Plan (or equivalent). As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with PFAS-free water (verified by laboratory analysis of source water) following manufacturer's recommendations.

7. Install the monitoring well completion as specified Work Plan (or equivalent). Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing and should slope gently away to promote drainage away from the well.

8. Monitoring wells should be labeled using indelible ink or paint with the appropriate designation on both the inner and outer well casings or inside of the curb box lid. Use caution when labeling the well as paint or indelible ink could potentially contain PFAS materials.

9. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.

10. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook as well as appropriate field forms.

11. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

7.4 Air Rotary Drilling Methods

For sites that require bedrock investigations but no collection of undisturbed rock cores, air rotary drilling may be required. Air rotary drilling procedures are similar to HSA. It produces disturbed soil and rock samples that are lifted to the surface by blowing compressed air into the borehole. Air rotary drilling is not well suited for situations that require high-resolution bedrock logging, but can be an effective way to generally characterize bedrock lithology and sample bedrock groundwater.

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1. Place LDPE plastic sheeting over sampling processing area to create a clean working surface, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity.
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris prior to sampling.
3. Decontaminate all non-disposable sampling equipment/tooling that will or may to come into direct contact with soil prior to first use. Disposable sampling equipment must be kept in sealed PFAS-free packaging until it is used.
4. Use stainless-steel hand auger to collect samples from 0 - 5 ft bgs surface interval, if applicable. All hand augering to collect soil samples will be completed by Arcadis personnel, not the drilling subcontractor. These samples can be collected either during other Utility Clearance activities (e.g., third party clearance) or immediately prior to drilling.
    a. Hand auger soil sample should be collected manually from the hand auger bucket (using stainless steel scoop, spatula, or trowel as necessary) and placed directly into the sample jar. The sample should not contact the ground or LDPE sheeting.
    b. If sampling by hand auger, after collecting sample from the surface or shallowest depth interval examine the stability of the soil in the boring sidewalls. If sidewalls appear to be at risk of collapsing into the borehole insert a length of polyvinyl chloride (PVC) pipe into the boring to maintain the opening and prevent collapse prior to augering to the next deeper sampling interval.
5. During air rotary drilling, soil and rock cuttings will accumulate around the outside of the borehole. Periodically the drillers will shovel cuttings into containers for disposal. Arcadis personnel can also perform characterization and sampling directly from these cuttings.
6. Drillers must not touch soil that will be collected for sampling. Arcadis personnel will use a stainless-steel spatula, spoon, or trowel to collect soil direct from the cuttings pile at the desired sample depth. Arcadis personnel decontaminate spatula, spoon, or trowel between uses in accordance with Section 10.
7. Don a new set of nitrile gloves prior to collecting each sample. Do not use gloved hands to handle papers, pens, clothes, etc., before collecting samples. Do not touch outside of sample bag with gloved hands.
8. During sampling, characterize soils in accordance with P-04 TGI - Soil Description (Arcadis 2018a). Record descriptions in the field notes, boring logs, and/or personal digital assistant (PDA). It is also beneficial to photo document the samples. It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data.
9. Collect sample volumes from cuttings pile using a clean stainless-steel trowel and place in clean, labeled bottles supplied by the laboratory for the required analyses (see sample container list in PQAPP Worksheets #19&30). Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replacing on the bottle.
10. Once the sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
11. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.

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12. Place soil sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.
13. Record the label information and time of sampling in the field notes and sampling forms.
14. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
15. Abandon all soil borings to grade as specified in the QAPP Addendum upon completion and before moving to the next boring location. **If single-interval groundwater sample is required, see Section 7.4.1 for procedure. If well is to be installed, see Section 7.4.2 for well construction procedure**.
16. Mark boring location with wooden stake that identifies boring ID for subsequent surveying, as necessary.
17. Manage investigation-derived-waste (IDW) as specified in site-specific work plan.
18. If samples are not shipped the same day as collected, add fresh ice to sample coolers at the end of the day to maintain the temperature between 0 and 6°C. Place ice in sealed polyethylene bags (Ziplock). Do not use blue ice. See QAPP worksheet #19 and 30 for sample containers, preservation and hold times. Sample coolers must remain in the possession of the sampling team at all times or secured under lock and key until shipment to the laboratory.

7.4.1 Air Rotary Single-Interval Groundwater Sampling

Similar to HSA drilling methods, there are limited single-interval groundwater sampling devices for air rotary drilling. Commonly, groundwater samples will be collected with pre-packed PFAS-free temporary PVC well screen and PVC riser. This method is most appropriate for sampling the first encountered groundwater when it is expected to occur in bedrock. Because soil and rock samples are disturbed, it is often not possible to target specific intervals based on transport properties. Unlike single-interval groundwater sampling with DPT, rotosonic, and HSA boreholes, the central opening of the air rotary drill bit is too narrow to accommodate a pre-packed PFAS-free temporary PVC well screen. Therefore, complete removal of air rotary drill tooling is required to collect single-interval groundwater samples. After removal of drill tooling, groundwater samples will be collected by inserting the pre-packed PFAS-free temporary PVC well screen through the open borehole to the desired sample depth.. In some air rotary drilling scenarios, air rotary drill tooling is advanced through a temporary casing (e.g. larger-diameter augers) in order to prevent borehole collapse, typically in the overburden above bedrock. It is not necessary to remove the temporary casing to collect groundwater samples in those scenarios.

The following steps will be followed to collect the groundwater sample:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log.
2. Advance rotary bit until groundwater is encountered.
3. Arcadis will continuously characterize soil and/or rock cuttings.
4. When groundwater is encountered, the water level in the borehole will be allowed to reach static condition. If a grab groundwater sample is required, remove all air rotary tooling from the

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borehole and insert a pre-packed PFAS-free temporary PVC well screen to the desired sample depth.

5. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point.
6. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (small-diameter bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval.
    a. Alternately, a Waterra-type inertial pump can be used to retrieve the water sample. If the formation has low-permeability and enough water is not anticipated in the tooling to allow purging of water, a stainless-steel bailer may be considered (after consulting with Arcadis RL).
7. Purge until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples.
    a. Note: for low-permeability formations, collect a grab sample from the screen point sampling device and/or saturated soil sample from the soil core. Leave temporary well casing and screen in the borehole to allow for overnight recovery of groundwater for follow-up sampling the next day.
8. Don a new set of nitrile gloves prior to collecting the groundwater sample and each QC sample. Do not use gloved hands to handle items (e.g., papers, pens, clothes, equipment) before collecting samples.
9. Fill sample bottles using labelled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface; keep in hand opposite of sample collection and do not touch the inside of the cap.
10. If high concentrations of PFASs related to Class B Firefighting foams are expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (approximately 10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The “shaker test’ vial can then be disposed of as IDW as specified in Section 8.
11. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL.
12. Place filled sample bottles in a sealed (Ziploc©) bag, record any label information that was not pre-filled out (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples.
13. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
14. Retrieve the temporary well screen dispose of as specified in Section 8.

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7.4.2 Air Rotary Monitoring Well Construction

Air rotary well construction methods are the same as when using HSA drilling methods and are outlined below.

1. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction will be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. Grout should be mixed with PFAS-free water (verified by laboratory analysis of source water). The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

2. Before installing a screened well, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

   To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled using water (e.g., Rotosonic), monitor the water level in the borehole as it re-equilibrates to the static level. In low-permeability units like clay, fine-grained glacial tills, shale and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead or PM prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

3. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and solid PVC risers through the augers or

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casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser casing. Smaller diameters may be used if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan (or equivalent) based on regulatory requirements and specific monitoring objectives. Monitoring well screens should be limited to 5 to 10 feet long. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

The slot size and filter pack gradation should be predetermined in the Work Plan (or equivalent) based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Typically, slot sizes for monitoring wells will range from 0.010 inches to 0.020 inches while the filter pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent filter pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent filter pack may be preferred. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.

Alternately, a monitoring well assembly with a pre-packed screen can be installed. The monitoring well assembly (i.e., regular PVC or pre-packed) should be discussed and decided prior to beginning field work and specified in the QAPP addendum. Pre-packed filters should be verified as PFAS-free prior to use.

A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centering the monitoring well in the borehole during construction.

4. When the monitoring well assembly has been set in place, place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie. The filter pack is placed, and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan (or equivalent). The well should be gently surged to prevent filter pack material bridging and to settle the filter pack prior to well seal installation.

5. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of

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bentonite—follow the specifications in the Work Plan). Use of a tremie pipe is not required for placement of the bentonite seal (though may be required if a well is very deep and borehole bridging is reasonably anticipated). However, bentonite should be poured into the annular space slowly enough to ensure borehole bridging does not occur. If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. *No coated bentonite pellets will be used in monitoring well drilling or construction*. PFAS-free water (verified by laboratory analysis of source water) should be added to hydrate the bentonite if the seal is above the water table. Continuously monitor the placement of the sand pack and bentonite with a weighted tape measure.

6. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft bgs or as specified in the Work Plan (or equivalent). As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with PFAS-free water (verified by laboratory analysis of source water) following manufacturer's recommendations.

7. Install the monitoring well completion as specified Work Plan (or equivalent). Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing and should slope gently away to promote drainage away from the well.

8. Monitoring wells should be labeled using indelible ink or paint with the appropriate designation on both the inner and outer well casings or inside of the curb box lid. Use caution when labeling the well as paint or indelible ink could potentially contain PFAS materials.

9. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.

10. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook as well as appropriate field forms.

11. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

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8 WASTE MANAGEMENT

Investigation-derived waste (IDW) including soil cuttings, purge water, and decontamination water generated during cleaning procedures will be collected and placed in Department of Transportation approved containers, segregated by waste streams: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c). All containers will be labeled as non-hazardous unless otherwise instructed by the project manager. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific Work Plan (QAPP addendum) and will be consistent with applicable AFCEC policies and AFCEC Base requirements. Personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) resulting from personnel cleaning procedures and soil sampling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

9 DATA RECORDING AND MANAGEMENT

The supervising field lead will be responsible for documenting drilling events to record all relevant information in a clear and concise format. The record of drilling events should include:

- Start and finish drilling dates;
- Project name and location;
- Project number, client, and site location;
- Boring number and depths;
- Soil descriptions;
- Depth to water;
- Well construction specifications, if applicable (screen and riser material and diameter, sump length, screen length and slot size, riser length, sand pack type);
- Quantities of materials used (e.g., bentonite, grout);
- Type of drilling tools used (e.g., rig type);
- Core barrel size;
- Names of contractor's drillers, inspectors, or other people onsite; and,
- Weather conditions.

Field staff should ensure COC Forms are properly completed, and verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the modified method 537 target analyte list) are required for analysis and note on the COC.

All documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. In addition, the locations of newly-installed wells will be documented

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photographically or in a site sketch. If appropriate, a measuring wheel or engineer's tape will be used to determine approximate distances between important site features.

The well location, ground surface elevation, and inner and outer casing elevations will be surveyed using the method specified in the site Work Plan. Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum of 1929 or 1988 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the National Geodetic Vertical Datum of 1929. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

10 DECONTAMINATION

To avoid cross-contamination during drilling and sampling, all reusable groundwater sampling equipment that has or is suspected to have come into contact with groundwater or soil will be decontaminated between each sample using the following steps. If Class B firefighting foam is a suspected PFAS source at any sampling location, then these steps should be performed twice.

- Don new pair of Nitrile gloves prior to decontamination
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;
- Double-rinse in potable deionized or distilled water;
- Rinse once with methanol or isopropyl alcohol;
- Rinse once with laboratory-certified PFAS-free water;
- Collect all rinsate in a sealed pail for disposal
- Allow time for equipment to air dry prior to re-use.

While strongly recommended, the use of solvents may be excluded for project-specific H&S concerns. If solvents are prohibited after DQO development, then additional procedures should be evaluated by the project team. Contingencies could include the use of dedicated sampling equipment at each sampling location or amending laboratory procedures to mitigate the increased risk of cross-contamination.

Additionally, the following decontamination procedure could be utilized when organic solvent use is not possible.

- Don new pair of Nitrile gloves prior to decontamination
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;
- Single-rinse in potable deionized or distilled water;
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;

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- Rinse twice with deionized water and once with PFAS-free water;
- Collect all rinsate in a sealed pail for disposal
- Allow time for equipment to air dry prior to re-use.

Drive casings and other drilling tooling will be steam cleaned or replaced with new equipment between boreholes. Steam cleaning will be performed by the drillers within a temporary decontamination or other containment area designated by the supervising engineer or geologist that is located outside of the work zone. All decontamination water will be collected and containerized for disposal.

See additional specifics in P-04, TGI - Groundwater and Soil Sampling Equipment Decontamination in PQAPP Appendix A.

11QUALITY ASSURANCE

In general, the following quality assurance and quality control (QA/QC) samples should be collected:

- Equipment blanks
- Field (i.e., reagent) blanks
- Field duplicates
- Matrix spike/matrix spike duplicate

Details on QC sampling requirements (e.g., frequency of collection, types of QA/QC samples) are provided in the PQAPP and will be outlined in various Site-specific sampling scopes of work in the QAPP Addendum. Additionally, detailed procedures related to equipment and field (i.e., reagent) blank sample collection are outlined in the Equipment and Reagent Blank Sample Collection TGI (Arcadis 2018b). In general, equipment blanks should be collected from every piece of downhole equipment that could come in contact with soil or groundwater during sample collection. This includes all downhole tooling (e.g., drill bits, drill rods).

Prior to initiating field activities, water sources to be used during drilling and well construction activities should be sampled to verify those sources are PFAS-free. While not part of the PQAPP, this is considered best practice and should be completed to the extent possible.

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and,
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

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12 REFERENCES

American Society for Testing Materials (ASTM), Designation D5092-04. *Standard Practice for Design and Installation of Ground Water Monitoring Wells*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

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ATTACHMENT 1

Table 1 and Table 2: PFAS Inspection Material Recommendations

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Table 1: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Inspections

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to inspections	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Sharpie®	--	NHDES 2016; USACE 2016; MassDEP 2017
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to inspections	DER 2016
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

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Table 2: Summary of Equipment and Materials Not Recommended for PFAS Site Inspections

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
Some detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

N**ote**: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

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TECHNICAL GUIDANCE INSTRUCTION - EQUIPMENT AND REAGENT BLANK SAMPLE COLLECTION FOR PFAS ANALYSIS

Rev: 0

Rev Date: October 2, 2018



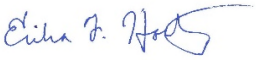
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VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 2, 2018	All	TGI – Equipment and Reagent Blank Sample Collection for PFAS Analysis	Erika Houtz

SOP # P-13

APPROVAL SIGNATURES

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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

Equipment and reagent blanks will be collected in the field during sampling activities and submitted for laboratory analysis. These samples are primarily intended to verify that sampling and decontamination practices are effectively preventing cross-contamination caused by reusable sample equipment or other per- and polyfluoroalkyl substances (PFAS)-containing materials.

The intent of this Technical Guidance Instruction (TGI) is to provide instructions for collection of equipment and reagent blanks. More detailed instructions related to general PFAS sampling considerations is provided in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020).

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3 PERSONNEL QUALIFICATIONS

Equipment and reagent samples will be collected by persons who have been trained in proper sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Blank sampling should be completed with a two-person sampling team.

4 EQUIPMENT LIST

The following equipment and materials must be available for equipment and reagent blank sampling:

- Site plan which specifies frequency/quantity of blank sampling;
- Relevant work plan (e.g., PQAPP);
- Site Safety and Health Plan (SSHP);
- Appropriate health and safety equipment, as specified in the SSHP;
- Laboratory-provided “PFAS-free” water;
- Nitrile gloves;
- Dedicated plastic sheeting (preferably low-density polyethylene) or other clean surface to prevent sample contact with the ground;
- Pail or bucket with closable lid for excess rinse water;
- Garbage bags;
- Appropriate sample containers and labels;
    - Labeled high density polypropylene (HDPE) sample bottles: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) for PFAS-specific considerations;
    - Ziploc®-style bags to hold ice and samples;
    - Packing and shipping materials;
    - Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a);
    - Appropriate transport containers (coolers) with ice and appropriate labeling; no blue ice is to be used.
- Decontamination:
    - Equipment cleaning materials: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) or the Groundwater and Soil Sampling Equipment Decontamination TGI (Arcadis 2017b) as applicable;
    - An organic solvent such as isopropanol, methanol, or acetone should be used to decontaminate reusable equipment if it can be brought to the site safely. While strongly recommended, the use

of solvents may be excluded for project-specific health and safety concerns. Refer to Section 7.1.1 for more details.

- Drum labels as required for investigation-derived waste handling: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c);

- Field Notes:
  - Pens and/or pencils (Sharpies® are not permitted), for writing;
  - Appropriate field forms;
  - Clipboards, field binders, field notebook, and field note pages that are not waterproof.

5 CAUTIONS

In general, sampling techniques used for PFAS sample collection are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. The most important consideration during PFAS-related sampling is to prevent contact between sample media and suspect PFAS sources. During collection of equipment and reagent blanks, the sampled media (i.e., PFAS-free water) should not contact anything but the sample container. New nitrile gloves should be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. **When in doubt change your gloves.** More detailed instructions related to general PFAS sampling considerations is provided in the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020).

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with equipment and reagent blank sampling will be performed in accordance with the SSHP, a copy of which will be present on site during such activities.

7 PROCEDURE

The specific procedure for equipment and reagent blank sampling was developed after careful review and consideration of project data quality objectives. Procedures for equipment blank sampling and reagent blank sampling are further described in this section. **Note: the laboratory has to analyze the entire sample bottle for aqueous solutions of PFASs. When collecting each blank, fill two sample bottles and instruct the lab to hold one of them in reserve. If an unacceptable detection occurs in a blank, the second bottle of sample may be analyzed.**

7.1 Equipment Blank Sampling

7.1.1 Decontamination

Prior to collecting blank samples, the applicable piece of equipment should be properly decontaminated following these steps:

- Hand Tools and Sampling Devices (including hand augers and bladder pumps)
    1. Don new pair of nitrile gloves prior to decontamination
    2. Remove o-rings and bladder (applies only to bladder pump)
    3. Scrub using a plastic brush and a non-phosphate soap free of volatile organic compounds (VOCs) (e.g., Liquinox, Alconox);
    4. Double-rinse in deionized or distilled water;
    5. Rinse once with the site-approved organic rinsing solvent (e.g., isopropanol, methanol, acetone);
    6. Rinse once with PFAS-free water;
    7. Collect all rinsate in a sealed pail for disposal;
    8. Allowed time to air dry prior to re-use.
    9. Insert new o-rings and bladder (applies only to bladder pump)

See additional specifics in P-04, TGI - Groundwater and Soil Sampling Equipment Decontamination in the PQAPP Appendix A.

While strongly recommended, the use of solvents may be excluded for project-specific health and safety concerns. If solvents are prohibited, then additional procedures should be evaluated by the project team. Contingencies could include the use of dedicated sampling equipment at each sampling location or amending laboratory procedures to mitigate the increased risk of cross-contamination.

The following decontamination procedure could be utilized when organic solvent use is not possible:

1. Don new pair of nitrile gloves prior to decontamination
2. Remove o-rings and bladder (applies only to bladder pump)
3. Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox);
4. Single-rinse in deionized or distilled water;
5. Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox);
6. Rinse twice with deionized water and once with PFAS-free water;
7. Collect all rinsate in a sealed pail for disposal;
8. Allowed time to air dry prior to re-use.
9. Insert new o-rings and bladder (applies only to bladder pump)

- Drilling Rods
    - Drive casings and other drilling equipment will be steam cleaned or replaced with new equipment between boreholes.
    - The drilling equipment will be cleaned in an area designated by the supervising engineer or geologist that is located outside of the work zone.

After verifying the piece of equipment is properly decontaminated, and after determining an equipment blank is warranted per the sampling quality assurance / quality control (QA/QC) plan, follow the specific procedures for the relevant type of equipment found in the following sections.

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7.1.2 Drilling Equipment (Hand Auger or Cutting Shoe/Drill Rod)

- Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.
- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place the sealable bucket or pail on top of plastic sheeting.
4. Don a new pair of nitrile gloves prior to blank collection (Field Personnel #1 and #2). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open the sample container and position the piece of clean, decontaminated sample equipment (i.e., hand auger or drilling rod/cutting shoe) above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
    - The bucket of the hand auger can be removed from the rods/handle and held manually.
    - The drillers should assist the field staff with removing the cutting shoe from the drill string and positioning it for sampling.
6. Slowly pour laboratory-provided "PFAS-free" water over any surface of the decontaminated sampling device that previously contacted sampled material (Field Personnel #2).
    - Pour water through the inside of the hand auger bucket while manually rotating the bucket so that "PFAS-free" water contacts all sides of the sampling device. Collect runoff in the sample container (Field Personnel #1), making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
    - Pour water through the inside of cutting shoe while drilling contractor holds and manually rotates the shoe so that "PFAS-free" water contacts all sides of the shoe (Field Personnel #2). Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

7.1.3 Reusable Sediment Sampling Equipment (Stainless-Steel Hand Tools, Petite Ponar Grab Sampler)

- Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.
- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open sample container and position the clean, decontaminated piece of sample equipment (i.e., hand tool, grab sampler) above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Slowly pour the laboratory-provided "PFAS-free" water over any surface of the sampling device that contacted sampled material (Field Personnel #2).
    - Pour water over front and back of all decontaminated hand tools such as spoons, spatulas, and trowels so that "PFAS-free" water touches all sides of the sampling device. Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail (Field Personnel #1).
    - Pour water through inside of the decontaminated Petite Ponar Grab Sampler while rotating the sampler (or the "PFAS-free" water container) so that "PFAS-free" water contacts all interior sides of the sampler (Field Personnel #2). Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add the sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

7.1.4 Disposable Sediment Sampling Equipment (Lexan ™ Liner Sleeve)

- Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.

- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open sample container and position a clean, new, and unused section of Lexan™ liner above the container (Field Personnel #1). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Slowly pour laboratory-provided "PFAS-free" water over any surface of the sampling device that contacted sampled material (Field Personnel #2).
    - Pour water through inside of Lexan ™ liner while rotating the liner so that "PFAS-free" water contacts all interior sides of the liner. Collect runoff in the sample container, making sure that any excess "PFAS-free" water is contained in the sealable bucket or pail.
7. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
8. Collect the second bottle with the same procedure (Steps 5 to 7), if collecting a backup.
9. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
10. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
11. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
12. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

7.1.5 Reusable Water Sampling Equipment (Peristaltic Pump, Bladder Pump, Stainless-Steel Bailer)

7.1.5.1 Peristaltic Pump

- Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should set up the pump and pour/ transfer the blank water.
- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting other clean surface to prevent sample contact with the ground.

3. Don new pair of nitrile gloved prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
4. Pour laboratory-supplied “PFAS-free” water into a clean HDPE sample bottle (Field Personnel #2).
5. Insert new HDPE tubing into the HDPE bottle containing “PFAS-free” water and connect tubing to peristaltic pump (with new silicone tubing) (Field Personnel #2).
6. Open sample container, keeping the sample cap in the hand of the sampler until it is replaced on the bottle (Field Personnel #1).
7. Turn the peristaltic pump on and slowly pump the “PFAS-free” water into the labeled sample container (Field Personnel #2).
8. After collecting the necessary sample volume, place cap back on the sample bottle (Field Personnel #1). The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
9. Collect the second bottle with the same procedure (Steps 6 to 8), if collecting a backup.
10. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
11. Add the sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
12. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
13. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

7.1.5.2 Bladder Pump

- Two field personnel should participate in the collection of the equipment blank. One person (“Field Personnel #1”) should hold the sampling bottle and collect the sample, and the second person (“Field Personnel #2”) should set up the pump and pour/ transfer the blank water.
- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Don new pair of nitrile gloved prior to blank collection (both field personnel). Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples.
4. Pour laboratory-supplied “PFAS-free” water into an approved container (to avoid PFAS cross-contamination) large enough to submerge the bladder pump.
5. After properly decontaminating the bladder pump and replacing the bladder, attach a new section of HDPE tubing to the bladder pump, long enough to hold and direct flow into the labeled sample container. Submerge the bladder pump into the approved container of “PFAS-free” water (Field Personnel #2).
6. Open sample container, keeping the sample cap in the hand of the sampler until it is replaced on the bottle (Field Personnel #1).
7. Turn the bladder pump on and slowly pump the “PFAS-free” water into the labeled sample container (Field Personnel #2).

8. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
9. Collect the second bottle with the same procedure (Steps 6 to 8), if collecting a backup.
10. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
11. Add sample to laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
12. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
13. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

7.1.5.3 Stainless-Steel Bailer

- Two field personnel should participate in the collection of the equipment blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the rinse water.
- The best timing to collect equipment blanks is immediately after the collection of a sample likely to contain high concentrations of PFASs, after the sampling equipment has been appropriately decontaminated.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep bottle lid on until immediately prior to sample collection.
2. Lay down dedicated plastic sheeting or other clean surface to prevent sample contact with the ground.
3. Place sealable bucket or pail on top of plastic sheeting.
4. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
5. Open sample container (Field Personnel #1) and position the bailer above the container (Field Personnel #2). Keep the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle.
6. Fill the stainless-steel bailer with enough laboratory-provided "PFAS-free" water to collect the necessary sample volume (Field Personnel #2).
7. Slowly pour laboratory-provided "PFAS-free" water from the stainless-steel bailer into the sample container (Field Personnel #2).
8. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
9. Collect the second bottle with the same procedure (Steps 5 to 8), if collecting a backup.
10. Place filled sample bottles in sealed Ziploc® bags, record any label information that was not pre-filled out, if necessary (e.g., sample time). Record the label information and time of sampling in the field notes and sampling forms.
11. Fill out the laboratory COC and check against the labels on the Equipment Blank sample bottle(s) progressively after each Equipment Blank is collected. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
12. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in a separate cooler from any other types of samples**.
13. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

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7.2 Field Reagent Blank Sampling

- Two field personnel should participate in the collection of the reagent blank. One person ("Field Personnel #1") should hold the sampling bottle and collect the sample, and the second person ("Field Personnel #2") should pour the blank water.
- This sample should be collected after field staff return from an offsite break (e.g., lunch) to capture any potential cross-contamination from field personnel.

1. Label the laboratory-provided HDPE bottles with applicable information (e.g., sample ID, date, time, analysis required). Keep the bottle lid on until immediately prior to sample collection.
2. Don new pair of nitrile gloves prior to blank collection (both field personnel). Do not use gloved hands to handle other objects (e.g., papers, pens, clothes, equipment) before collecting samples.
3. Open sample container, keeping the sample cap in the hand of the sampler (Field Personnel #1) until it is replaced on the bottle (Field Personnel #1).
4. Slowly pour laboratory-provided "PFAS-free" water from the laboratory-provided container into the sample container ("Field Personnel #2").
5. After collecting the necessary sample volume, place cap back on the sample bottle. The bottle should be filled approximately full, but some headspace in the bottle is acceptable.
6. Collect the second bottle with the same procedure (Steps 3 to 5) if collecting a backup.
7. Record any label information that was not pre-filled out, if necessary (e.g., sample time), and place filled sample bottles in sealed Ziploc® bags. Record the label information and time of sampling in the field notes.
8. Add sample to the laboratory COC. Double check that the sample labels and COC agree. Note on the COC that one bottle should be held in reserve, if a backup bottle is collected.
9. Place sealed Ziploc® bag into the sample cooler. **Store PFAS samples in separate cooler from any other types of samples**.
10. Place dedicated plastic sheeting and nitrile gloves in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

8 WASTE MANAGEMENT

Excess water generated during equipment and reagent blank collection procedures will be collected and contained on site in appropriate containers, (see the Investigation-Derived Waste Handling and Storage TGI for details [Arcadis 2017c]). All investigation-derived waste (IDW) generated will be placed in Department of Transportation approved containers, sealed, and labeled. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific Work Plan (QAPP addendum) and will be consistent with applicable policies and requirements. Disposable personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) will be placed in plastic bags. These bags will be transferred into appropriately labeled containers for appropriate disposal.

9 DATA RECORDING AND MANAGEMENT

The supervising field lead will be responsible for documenting equipment and reagent blank collection to record all relevant information in a clear and concise format. The record should include:

- Project name and location;
- Project number, client, and site location;
- Date and time of sample collection;
- Weather conditions.

Field staff should ensure COC Forms are properly completed, and verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list) are required for analysis and note on the COC. Any samples collected as backup and not intended to be immediately analyzed should be clearly documented.

9.1 Field Notes

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and,
- Do not write on sampling bottles unless they are closed.

10 QUALITY ASSURANCE

Refer to quality control requirements for the project to ensure that appropriate QA/QC samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically:

- **Duplicate samples of each equipment blank and reagent blank should be collected and submitted to the laboratory with instructions to hold for analysis. The purpose of this sample is to provide analytical back-up in case there are any issues with the original blank sample.**
- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and,
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

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11 REFERENCES

Arcadis. 2020. TGI – Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance. Rev. 5. October 15.

Arcadis. 2017a. SOP – Sample Chain of Custody, Rev. #1. May 23.

Arcadis. 2017b. TGI – Groundwater and Soil Sampling Equipment Decontamination, Rev. #0. February 23.

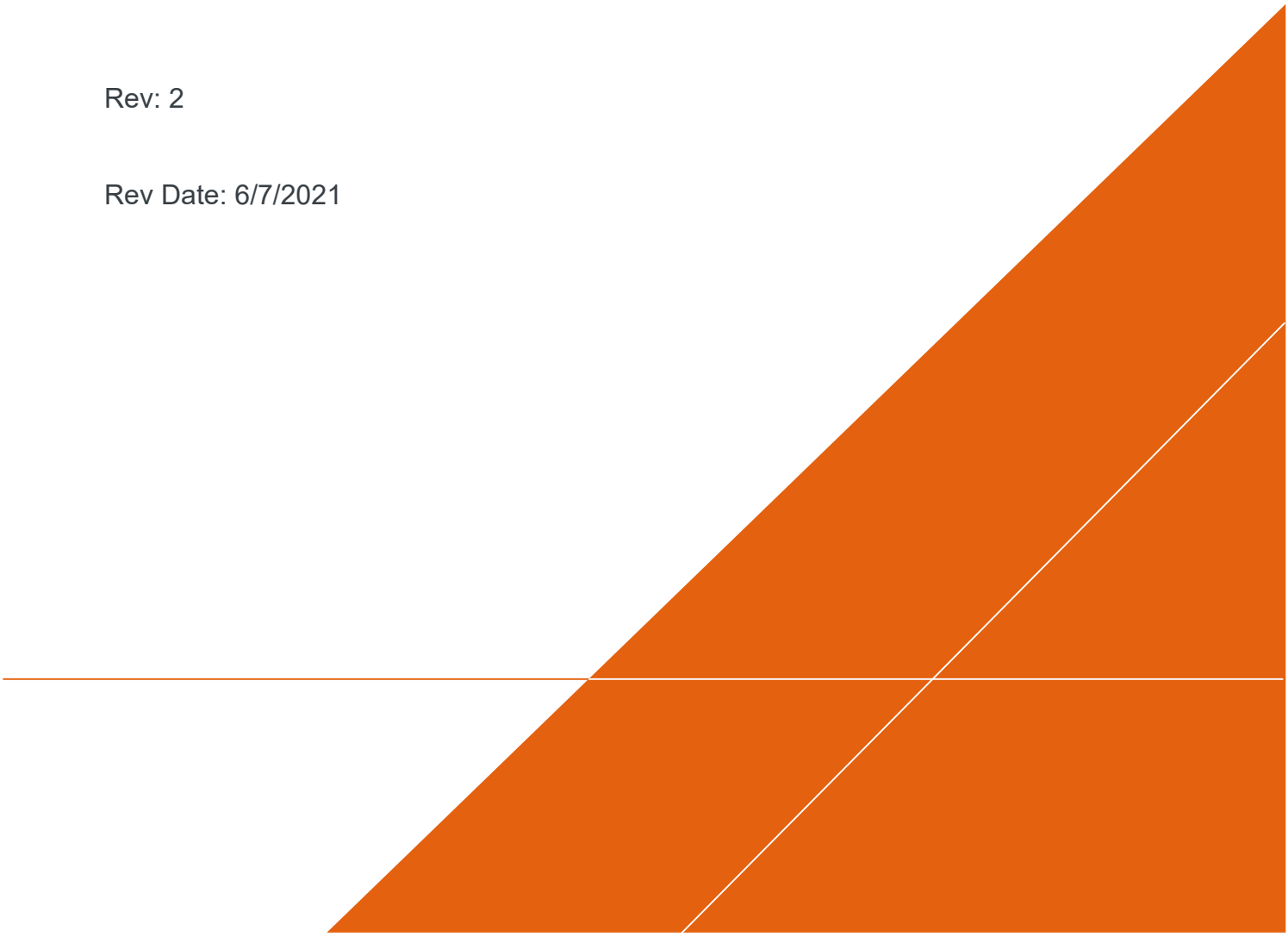
Arcadis. 2017c. TGI – Investigation-Derived Waste Handling and Storage, Rev. #0. February 23.

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TECHNICAL GUIDANCE INSTRUCTIONS - VERTICAL AQUIFER PROFILING FOR PFAS ANALYSIS

Rev: 2

Rev Date: 6/7/2021



SOP P-14

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Created by combining aspects of the generic VAP TGI (Rev 0, June 22, 2018) and Ft. Leavenworth VAP TGI (Rev 1, July 19, 2018). PFAS-specific guidance.	Ankit Gupta
1	3/26/2019	Attachments	Added a restriction against all fluoropolymer materials in Table 2 for sampling; Removed Citranox as an appropriate decon solution in Table 1. Made a correction that Liquinox contains trace levels of 1,4 Dioxane, not Alconox.	Erika Houtz
2	June 7, 2021	All	Updated the TGI to include the use of the Geoprobe® GWS	Thomas Darby

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APPROVAL SIGNATURES

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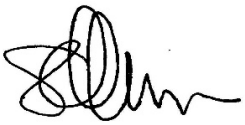
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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The intent of this Technical Guidance Instruction (TGI) is to provide instructions for groundwater VAP sampling during per- and polyfluoroalkyl substances (PFASs) investigations. It also covers specific considerations for PFASs due to their unique chemical and physical properties, low detection limits, and low regulatory standards.

Soil borings will be advanced via direct push technology (DPT) or rotosonic drilling techniques to enable vertical aquifer profile (VAP) groundwater sampling to collect single or multiple depth-discrete groundwater samples using low-flow or grab sampling methodologies. Both methods will enable retrieval of continuous soil cores and lithologic logging, as well as collection of multiple depth-discrete dry and saturated soil samples. VAP groundwater sampling intervals should be co-located with or biased towards potential discrete transport zones (and target slow advection zones when feasible) as indicated by soil logging observations, permeability measurements (e.g., point slug tests, Geoprobe® hydraulic profiling tool [HPT] [preferred], Waterloo APS™ [alternate]), and/or interpreted hydrostratigraphy.

Multiple-depth discrete groundwater samples can be collected via drilling rod tooling They can be analyzed quickly by expedited, off-site, fixed lab or on-site mobile lab analysis to provide adaptive high-resolution quantitative groundwater concentration data. The vertical frequency of groundwater sampling within a formation should be determined relative to the scale of variability demonstrated in site hydrostratigraphy. Thin aquifers with transport zones only tens of feet thick can be sampled at intervals as close as 3 to 5 feet. In aquifers with transport zones of substantial thickness (e.g., more than 50 feet), sample spacing of 5 to 20 feet is usually adequate. It is important to note that field data should be evaluated to verify that sampling intervals provide sufficient resolution to meet data quality objectives (DQOs) (See **Section 7**).

3 PERSONNEL QUALIFICATIONS

VAP activities will be performed by persons who have been trained in proper drilling and sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Drilling subcontractors will need current applicable drilling licenses. Arcadis and subcontractor personnel must also have completed any site/project/client-specific training requirements.

4 EQUIPMENT LIST

The following equipment and materials must be available for borehole advancement and VAP groundwater sampling:

- Site plan with proposed sampling locations;
- Relevant work plan (e.g., installation-specific Quality Assurance Project Plan [QAPP] Addendum);
- Site Safety and Health Plan (SSHP);
- Appropriate health and safety equipment, as specified in the SSHP;
- Drilling Equipment:
    - DPT and/or rotosonic drill rig (to be provided by drilling subcontractor). Type to be determined based on site-specific details;
    - Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if not provided by the drillers;
    - Note: Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling equipment will be provided in quantities capable of achieving estimated target depths. Typical equipment/materials provided by the driller could include:
        - Acetate or other PFAS-free plastic liners;
        - Appropriate length of drilling rods and tooling;
        - Drilling and sampling equipment decontamination materials; and,
        - Decontamination pad materials, if required. See **Section 5.3** below for more information;

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- Sampling:
    - Appropriate PFAS-free groundwater sampling equipment (e.g., disposable bailers for volumetric sampling, peristaltic pump for shallow groundwater sampling, submersible bladder pump for deeper sampling). Refer to the PFAS Field Sampling Guidance TGI (Arcadis 2020) and Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells TGI (Arcadis 2016) for necessary equipment;
    - Direct push groundwater samplers (e.g., Geoprobe® SP-22, Geoprobe® SP-16, Geprobe® Groundwater Profiler (GWS)) or rotosonic sampling devices (e.g., Cascade Packer Isolation Groundwater Profiler or Geoprobe® SP-60 Sonic Groundwater Sampler) to be provided by drilling subcontractor;
    - Appropriate soil sampling equipment if included in scope. Refer to the PFAS-Specific Drilling and Monitoring Well Installation TGI (Arcadis 2018a) for necessary equipment;
    - Dedicated low-density polyethylene (LDPE) plastic sheeting to prevent sample contact with the ground;
    - YSI 6-Series multi-parameter water quality probe (e.g., conductivity, temperature, dissolved oxygen, oxidation reduction potential) with flow-through cell;
    - Turbidity meter;
    - Water level meter with fluorine-free materials (Geotech ET 3/8" with Delrin tip and Buna-N O-ring);
    - Laboratory provided PFAS-free water for field and equipment blank QC samples.
    - Laboratory-provided HPDE PFAS shaker test vials
    - Appropriate sample containers and labels;
        - Laboratory-supplied HDPE sample bottles: see the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) for PFAS-specific considerations;
        - Polyethylene bags (Ziploc® brand only) to hold ice and samples;
        - Appropriate blanks (field reagent blanks supplied by the laboratory);
        - Packing and shipping materials;
        - Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a);
        - Appropriate transport containers (coolers) with ice and appropriate labeling, no blue ice;
- Decontamination/Waste Management:
    - PFAS-free decontamination fluids and equipment
        - HDPE or PVC brushes and squirt bottles, stainless steel bowl
        - HDPE buckets to hold decontamination fluids

  - Alconox or Liquinox (other detergents prohibited)
  - Distilled or laboratory-supplied deionized water
  - Laboratory provided PFAS-free water
- See the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020) or the Groundwater and Soil Sampling Equipment Decontamination TGI (Arcadis 2017b) for additional guidance;
- Portable field hand washing setup
- Non-hazardous drum labels as required for investigation-derived waste handling: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c);

- Field Notes:
  - Pens, pencils, and/or Sharpies® for writing;
  - Appropriate field forms;
  - Clipboards, field binders, field notebook, and field note pages that are not waterproof.
- Other
  - Field clothing made of cotton or other natural fibers that is well laundered (i.e., washed at least 6 times)
  - Well laundered cotton blankets for covering field vehicle seats
  - PFAS-free sunscreen and insect repellant

5 CAUTIONS

5.1 Utility Clearance

The appropriate drilling authorities will be contacted and a site visit for public utility line clearance at the proposed boring locations will be conducted at least 72 hours prior to work commencing. As applicable, utility maps will be reviewed during field reconnaissance of the proposed inspection locations to determine if any are co-located with public utility lines. Arcadis will also contract an independent geophysical survey company to verify that proposed boring locations are not co-located with existing underground utility/substructure features, as necessary. Arcadis will clear locations with soft dig methods to assess the presence of underground utilities, as necessary. See the Utility Location and Clearance Arcadis Health and Safety Standard (Arcadis 2017d) for reference.

5.2 PFAS-Specific General Sampling Considerations

This section provides a summary of methods and procedures applicable to the collection of environmental samples for field screening or laboratory analysis during PFAS site characterization activities. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-

containing materials and cross-contamination potential. For example, Teflon™ and other fluoropolymer containing materials are found in pumps, tubing, and sample storage containers and therefore should be avoided (Department of Environment Regulation [DER], Western Australia 2016; New Hampshire Department of Environmental Services [NHDES] 2016). Certain field documentation materials such as waterproof paper or field books, adhesive paper products, and some writing utensils (grouped as non-Sharpie® markers) are also prohibited items during PFAS sampling (DER 2016; NHDES 2016).

New nitrile gloves should be donned before any of the following activities:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or PFAS-free water bottles;
- Handling clean sample tubing/down-well equipment or connecting tubing;
- Handling QC samples including field blanks and equipment blanks.

Additionally, new nitrile gloves should also be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. **When in doubt change your gloves.**

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and,
- Do not write on sampling bottles unless they are closed.

Tables 1 and **2** in **Attachment 1** provides recommendations for PFAS Site Inspection equipment. **Table 1** provides a summary of materials that have been approved for site inspection; this list is expected to grow longer as industry experience increases. **Table 2** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection. For materials that are suspected of containing PFASs and/or retaining PFASs, these recommendations are considered preliminary and subject to change.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are typically advised to err on the side of caution by strictly following field wear guidelines and decontamination procedures as specified in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2020). **The most important consideration during PFAS related VAP sampling is to prevent contact between sample media and suspect PFAS sources.**

5.3 PFAS-Specific Groundwater Sampling

The potential presence of PFASs in equipment that may come in contact with the target water sample must be evaluated as part of the sample planning process to maintain sample integrity. For example, low-flow sampling with a peristaltic pump should be conducted using silicone or HDPE tubing; Teflon™ tubing is prohibited (DER 2016). If a bladder pump is used to collect samples, the bladder and other internal

parts (e.g., check balls, o-rings, compression fittings) should not be made of Teflon™ either, and bladder and o-rings should be changed between samples (DER 2016).

Note that if high concentrations of PFASs related to Class B firefighting foams are expected in a groundwater sample, it has been recommended to collect and shake a small portion of the sample at the time of sample collection (USACE 2016; Arcadis 2020). If foaming is noted within the sample, it indicates elevated concentrations of PFASs may be present and the sample should be proactively diluted at the laboratory prior to analysis. The foaming should be noted on the sample chain of custody form. It is recommended to collect sampling equipment blanks following foam observation to confirm the effectiveness of decontamination procedures.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with borehole advancement and VAP groundwater sampling will be performed in accordance with the SSHP, a copy of which will be present on site during such activities.

7 PROCEDURE

The following sub-sections provide different approaches that can be utilized at different sites depending on the nature of the site to perform VAP sampling. The specific procedure for advancing borings for VAP groundwater sampling should be developed after careful review and consideration of project DQOs.

7.1 Direct Push Technology Vertical Aquifer Profile Sampling

Direct push tooling (DPT) is ideal for shallow unconsolidated aquifers (i.e. less than 100 feet bgs) and requires minimal water for drilling, thus reducing the potential for sample dilution. Typically, DPT VAP borings are conducted in boreholes adjacent to prior HPT borings to develop stratigraphic flux profiles. The primary advantage of completing permeability profiles via HPT in advance of sampling is to gain understanding of hydrofacies to ensure that the most appropriate intervals and sampling methods are used. Sampling depth intervals are determined based on the HPT profiles to target transport zones. Waterloo APS™ can be utilized as an alternative to HPT to provide permeability profiles, but it is more time intensive than HPT; therefore, it is not considered the preferred tool for permeability profiling. In the absence of HPT data from a co-located adjacent borehole, sampling depth intervals can be determined based upon lithologic logging of soil cores, either from a separate co-located adjacent borehole or from the same borehole. Soil lithologic logging should be performed in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).

The VAP groundwater samples are typically collected every 5 to 20 feet with a bias to the more permeable transport zones. Samples are collected by driving a screen point sampling device such as Geoprobe® SP-22 or Geoprobe® SP-16 to the target interval and the screen opened to collect a groundwater sample. In poorly sorted aquifers with appreciable amounts of silt, VAP sampling from an adjacent borehole after completing initial permeability profiling (e.g., Geoprobe® HPT or point slug tests) is typically more efficient and cost effective.

DPT VAP sampling will be completed using a top-down sampling approach, which requires pulling the tooling out after each sample depth interval, decontaminating the tooling, resetting the groundwater

sampler, and advancing the tooling to the next planned interval. This requires more time per borehole than some other sampling methods (e.g. bottom-up); however, it minimizes any potential for cross-contamination, and is therefore the preferred approach for PFAS projects due to the low detection limits and regulatory levels associated with PFASs. Furthermore, the top-down approach allows for grouting of the borehole from its bottom to the surface as tooling is retracted during borehole abandonment.

Single-Interval VAP Sampling

In some cases, it may be preferred to perform single-interval VAP sampling from the first encountered shallow groundwater. It should be verified that samples are taken below the water table (i.e., not perched water in the vadose zone). Single-interval VAP sampling should be performed with a Geoprobe® SP-16 sampling device or similar (e.g., HydroPunch ™). A primary difference with single-interval methods relative to multi-interval VAP sampling is that the sampling screen is driven to the appropriate depth by the drill rig (as opposed to lowering the sampling screen through the drill tools after reaching the appropriate depth).

If using a Geoprobe® SP-16 sampling device, the following steps should be followed:

1. Ensure PID, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log;
2. Advance Geoprobe® SP-16, equipped with stainless-steel screen, using standard Geoprobe® rods to the target depth interval in accordance with Arcadis TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2018a);
3. Retract the tool string and screen sheath to expose the screen for the desired sample interval length, using extension rods to hold the screen in place. The Geoprobe® SP-16 sampling screen can range from 0” to approximately 44”. Note: no soil cores will be retrieved using the Geoprobe® SP-16;
4. Go to Step 13.

If using a HydroPunch ™ sampling device, the following steps should be followed:

5. Ensure PID, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log;
6. The drilling subcontractor will advance the borehole to approximately 2 feet above the depth from which a discrete water sample is to be obtained;
7. The drilling subcontractor will disassemble the HydroPunch™ sampling device according to the manufacturer’s instructions to allow the sampler to be decontaminated. The sampler should be completely disassembled, including O-rings and/or check valves;
8. Decontaminate the sampler per instructions in Section 10 as appropriate for the range of groundwater analytes to be sampled for, by washing with laboratory-grade detergent and potable water wash, followed by solvent rinse (if sampling for organics) and final rinse with deionized or distilled water. Check the condition of the O-rings during each cleaning and replace if necessary;
9. The drilling subcontractor will reassemble the decontaminated HydroPunch™ sampling device according to the manufacturer’s instructions and lower the device to the bottom of the borehole;

10. The drilling subcontractor will push or drive the HydroPunch™ 5 feet below the bottom of the casing or augers, then retract the sampler 3 feet upward. Subsurface friction will retain the drive point in place, exposing the screen and allowing groundwater to enter the sampling tool;
11. Allow sufficient time to allow the sampler to fill with water. Typically, 30 minutes is sufficient, except in low permeability materials;
12. Go to Step 13.

Complete the following steps for sample collection:

13. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point;
14. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (small-diameter bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval
    - Alternately, a Waterra-type inertial pump can be used to retrieve the water sample. If the formation has low-permeability and enough water is not anticipated in the tooling to allow purging of water, a stainless-steel bailer may be considered (after consulting with Arcadis RL);
15. Purge until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples;
    - Note: for low-permeability formations, collected a grab sample from the screen point sampling device and/or saturated soil sample from the soil core retrieved earlier, and then allow for overnight recovery of groundwater leaving temporary well casing and screen in the borehole for follow-up sampling the next day.
16. Don a new set of nitrile gloves prior to collecting groundwater sample and each QC sample. Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples;
17. Fill sample bottles using labeled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, keep in hand opposite of sample collection, do not touch the inside of the cap;
18. If high concentration of PFAS related to class B Firefighting foams is expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (~10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The 'shaker test' vial can then be disposed;
19. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL;
20. Place filled sample bottles in a sealed (Ziploc) bag, record any label information that was not pre-filled out (i.e. sample time). Record the label information and time of sampling in the field notes

and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples;

21. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected;
22. Geoprobe® SP-16 sampling device is pulled back up and decontaminated (see Section 10);
23. Abandon the borehole as detailed in Section 7.3.

Multi-Interval VAP Sampling

In most cases, it is preferred to perform VAP sampling at multiple depth intervals in the same borehole. Multi-interval VAP sampling should be performed with a Geoprobe® SP-22 sampling device (or similar), or a Geoprobe® GWP. A primary difference with multiple-interval methods relative to single-interval VAP sampling is that the sampling screen is placed at the bottom of the borehole for sampling through the drill rods after retrieval of soil cores, rather than driven to the sampling depth by the drill rig.

If using a Geoprobe® SP-22 screen point sampling device, the following steps should be followed:

1. Ensure PID, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log;
2. Advance dual-tube direct push casing with a plastic liner for soil core retrieval to target depth interval in accordance with Arcadis TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2018a);
3. Retrieve the soil core and characterize soils in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b);
4. Lower the stainless-steel screen point sampling screen (Geoprobe® SP-22) to target depth and pull up the outer casing to expose the screen;
5. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point;
6. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval;
7. Purge well until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples;
    - Note: for low-permeability formations, collected a grab sample from the screen point sampling device and/or saturated soil sample from the soil core retrieved earlier, and then allow for overnight recovery of groundwater leaving temporary well casing and screen in the borehole for follow-up sampling the next day.
8. Don a new set of nitrile gloves prior to collecting groundwater sample and each QC sample. Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples;

9. Fill sample bottles using labeled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, keep in hand opposite of sample collection, do not touch the inside of the cap;
10. If high concentration of PFAS related to class B Firefighting foams is expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (~10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The 'shaker test' vial can then be disposed;
11. Collect QC samples at frequency specified in QAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL;
12. Place filled sample bottles in a sealed (Ziploc) bag, record any label information that was not pre-filled out (i.e. sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples;
13. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected;
14. Screen point sampling screen is pulled back up and decontaminated (see Section 10);
15. A new plastic liner is lowered back in and the entire assembly is then advanced to the next depth interval;
16. Repeat these steps until all samples have been collected from all target intervals;
17. Abandon the borehole as detailed in Section 7.3.

If using a Geoprobe® GWP, the following steps should be followed:

1. Ensure PID, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log;
2. Prior to drilling, ensure an appropriate volume of PFAS free water is available for injection during probe advancement. Contact the project team to verify source blanks of the water have been collected and the water is PFAS free.
3. Advance the GWS to the pre-determined sample interval, as determined by HPT profiling or visual observation of a soil core. Advancement of the GWS should be completed in accordance with Geoprobe's® recommendations (i.e. probe advancement of 2 cm/sec with water injection at 400 ml/min).
4. Once the target depth is reached, the probe advancement will be stopped along with the flow of water.
5. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point;
6. Don a new set of nitrile gloves, connect tubing the flow-through cell to the end of the discharge tubing,
7. The driller will use the controls to start the pump using the Geoprobe controller and purging will start.

8. Purge well until water is visually clear of sediment and field parameters are stable, or for a maximum of 30 minutes before collecting GW samples.
9. Don a new set of nitrile gloves prior to collecting groundwater sample and each QC sample. Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples;
10. Fill sample bottles using HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, keep in hand opposite of sample collection, do not touch the inside of the cap;
11. If high concentration of PFAS related to class B Firefighting foams is expected in a groundwater sample (as specified in the QAPP), collect and shake a small portion of the sample (~10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the CoC to notify laboratory personnel. The 'shaker test' vial can then be disposed;
12. Collect QC samples at frequency specified in QAPP Worksheet #20. QC sample locations to be selected based on consultation with the project team;
13. Place filled sample bottles in a sealed (Ziploc) bag, record any label information that was not pre-filled out (i.e. sample time). Record the label information and time of sampling in the field notes and sampling forms or via Fulcrum. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples;
14. Once purging and sampling are completed for a given interval, the discharge tubing will be flushed with PFAS free water. This flushing will be completed by starting the flow of water from the discharge tank to the sampling port while leaving the sampling valve open at the surface. Field parameters should be collected throughout the purging to ensure formation water has been removed from the discharge line.
    - Flushing will be completed for a minimum of 5 minutes and should be extended if parameters from the discharge do not return to baseline levels consistent with the PFAS free water source.
    - If parameters do not achieve baseline levels after 10 minutes of flushing, contact the technical leads to discuss potential options for evaluation.
15. Repeat steps 3 through 14 until all samples have been collected from all target intervals;
16. Abandon the borehole as detailed in Section 7.3.

7.2 Sonic Drilling Vertical Aquifer Profile Sampling

For sites with deep unconsolidated aquifers or challenging drilling conditions (e.g., presence of dense tills, caliche, cobbles), direct push drilling may not be feasible or cost effective due to limited production rates. In these cases, alternate drilling methods (e.g., rotosonic) are required. Like direct push, groundwater profilers can be used to collect multiple depth-discrete groundwater samples biased towards transport zones based on soil lithological cores. The configuration of individual samplers varies based on their manufacturer and drilling contractor (e.g., Cascade Packer Isolation Groundwater Profiler or Geoprobe® SP-60 Packer Sampler). The overall strategy of sonic drilling VAP sampling is consistent with direct push VAP sampling; however, drilling with sonic or some rotary methods requires the introduction of drilling water that can potentially affect the integrity of the groundwater sample. If drilling water is used, a source blank sample will be collected prior to the start of work. Additionally, source water should be spiked with

non-toxic fluorescence dyes per Arcadis SOP for use of visible tracer in drilling fluid to obtain representative groundwater samples during drilling (Arcadis 2010).

Sonic VAP sampling will be performed in a top-down manner using dual-tube casing. Packer Isolation Groundwater Profilers will be used to conduct VAP sampling. Thus, sampling will require pulling the tooling after each sample interval, decontaminating the tooling (if necessary), resetting the groundwater sampler, and advancing the tooling to the next planned interval. The biggest advantage of this device is that groundwater sampling depth intervals can be determined based on lithological logs obtained from the same borehole (since HPT is not deployable via rotosonic drilling methods), and the potential for cross-contamination between adjacent sampling intervals is limited.

The following steps should be followed:

1. Ensure 4-gas meter, YSI 6-Series multi-parameter water quality probe, and turbidity meter are calibrated each morning (see QAPP worksheet #22 and P-09 Calibration and Control of Measuring and Test Equipment in PQAPP Appendix A). Document calibration results on equipment calibration log;
2. Advance dual-tube sonic tooling casing to target depth interval in accordance with Arcadis TGI for PFAS-Specific Drilling and Monitoring Well Installation (Arcadis 2018a);
3. Retrieve the soil core and the inner sonic core barrel. Characterize soils in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b);
4. Insert the stainless-steel screen and packer assembly (e.g., Cascade Packer Isolation Groundwater Profiler or Geoprobe® SP60 Packer Sampler) to the base of the sonic casing;
5. Extract the outer sonic casing to expose the screen to the formation;
6. Inflate the packer to isolate the screened interval from any water that might be above the packer in the sonic casing;
7. Place LDPE plastic sheeting adjacent to the sample port for use as a clean work area, if conditions allow. Otherwise, prevent sampling equipment from contacting the ground or other surface that could compromise sample integrity. Do not allow vehicle exhaust to point towards the sample point;
8. Don a new set of nitrile gloves, connect tubing to sampling pump and flow-through cell and slowly lower tubing and/or pump into well. If possible, use two field personnel to insert tubing/pump into well to avoid contact with surrounding ground surface or other materials that could cause cross-contamination. Insert tubing (peristaltic pump, if depth to water <25 ft bgs), or pump intake (bladder pump, if depth to water >25 ft bgs) at the approximate mid-depth of the sampler screen interval;
9. Purge well until water is visually clear of sediment, or for a maximum of 20 minutes before collecting GW samples;
    - Note: for low-permeability formations, collected a grab sample from the screen and/or saturated soil sample from the soil core retrieved earlier, and then allow for overnight recovery of groundwater leaving temporary well casing and screen in the borehole for follow-up sampling the next day.
10. Don a new set of nitrile gloves prior to collecting groundwater sample and each QC sample. Do not use gloved hands to handle papers, pens, clothes, equipment, etc., before collecting samples;
11. Fill sample bottles using labeled HDPE bottles that are supplied by laboratory only. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed

back on the bottle immediately after sample collection. Do not place the cap on any surface, keep in hand opposite of sample collection, do not touch the inside of the cap;

12. If high concentration of PFAS related to class B Firefighting foams is expected in a groundwater sample (as specified in the QAPP Addendum), collect and shake a small portion of the sample (~10-25 mL) on site. If foaming is observed, document the foaming on the sample log and on the COC to notify laboratory personnel. The 'shaker test' vial can then be disposed;
13. Collect QC samples at frequency specified in PQAPP Worksheet #20. QC sample locations to be selected based on consultation with Arcadis RL;
14. Place filled sample bottles in a sealed (Ziploc) bag, record any label information that was not pre-filled out (i.e. sample time). Record the label information and time of sampling in the field notes and sampling forms. Place samples into sample coolers. Store PFAS samples in separate cooler from any other types of samples;
15. Fill out laboratory COC and check against the labels on the sample bottles progressively after each sample is collected;
16. Deflate the packer;
17. Packer Isolation Groundwater Profiler is pulled back up and decontaminated (see Section 10);
18. The dual-tube sonic tooling casing is then advanced to the next depth interval;
19. Repeat these steps until all samples have been collected from all target intervals;
20. Abandon the borehole as detailed in Section 7.3.

7.3 Borehole Abandonment

Borehole abandonment will be completed in accordance with the requirements set forth by applicable State agencies. Upon completion, each borehole is backfilled with bentonite grout from the terminal end (i.e. bottom) of the boring upward. A tremie grout pipe will be used to assist backfilling of deeper VAP boreholes. The top portion of each boring is sealed with asphalt or concrete to match the existing grade.

8 WASTE MANAGEMENT

Investigation-derived waste (IDW) soil cuttings, purge water, and decontamination water generated during cleaning procedures will be collected and contained on site in appropriate containers: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c). All IDW generated during field activities will be placed in Department of Transportation approved containers, sealed, and labeled. Containerized IDW will be stored on site until waste characterization samples are analyzed and waste profile generated and are subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific Work Plan (QAPP addendum) and will be consistent with applicable policies and requirements. Personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) resulting from personnel cleaning procedures and soil sampling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

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9 DATA RECORDING AND MANAGEMENT

The supervising field lead will be responsible for documenting drilling events to record all relevant information in a clear and concise format. The record of drilling events should include:

- Start and finish drilling dates;
- Project name and location;
- Project number, client, and site location;
- VAP boring number and depths;
- Soil descriptions;
- Depth to water;
- Type of VAP-special tools;
- Core barrel size;
- Names of contractor's drillers, inspectors, or other people onsite; and,
- Weather conditions.

Field staff should ensure COC Forms are properly completed, and verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the modified method 537 target analyte list) are required for analysis and note on the COC. All documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access.

10 DECONTAMINATION

To avoid cross-contamination during drilling and sampling, all reusable groundwater sampling equipment that has or is suspected to have come into contact with groundwater or soil will be decontaminated between each sample using the following steps. If Class B firefighting foam is a suspected PFAS source at any sampling location, then these steps should be performed twice.

- Don new pair of Nitrile gloves prior to decontamination
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;
- Double-rinse in potable deionized or distilled water;
- Rinse once with methanol or isopropyl alcohol;
- Rinse once with laboratory-certified PFAS-free water;
- Collect all rinsate in a sealed pail for disposal
- Allow time for equipment to air dry prior to re-use.

While strongly recommended, the use of solvents may be excluded for project-specific H&S concerns. If solvents are prohibited after DQO development, then additional procedures should be evaluated by the

project team. Contingencies could include the use of dedicated sampling equipment at each sampling location or amending laboratory procedures to mitigate the increased risk of cross-contamination. Additionally, the following decontamination procedure could be utilized when organic solvent use is not possible.

- Don new pair of Nitrile gloves prior to decontamination
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;
- Single-rinse in potable deionized or distilled water;
- Scrub using a plastic brush and a non-phosphate soap free of VOCs (e.g., Liquinox, Alconox) and plastic brush;
- Rinse twice with deionized water and once with PFAS-free water;
- Collect all rinsate in a sealed pail for disposal
- Allow time for equipment to air dry prior to re-use.

Drive casings and other drilling tooling (including Geoprobe® SP sampling tools, Packer Isolation Groundwater Profiler) will be steam cleaned between boreholes. Steam cleaning will be performed by the drillers within a temporary decontamination or other containment area designated by the supervising engineer or geologist that is located outside of the work zone. All decontamination water will be collected and containerized for disposal.

See additional specifics in P-04, TGI - Groundwater and Soil Sampling Equipment Decontamination in PQAPP Appendix A.

11 QUALITY ASSURANCE

In general, the following quality assurance and quality control (QA/QC) samples should be collected:

- Equipment blanks
- Field (i.e., reagent) blanks
- Field duplicates
- Matrix spike/matrix spike duplicate

Details on QC sampling requirements (e.g., frequency of collection, types of QA/QC samples) are provided in the PQAPP and will be outlined in various Site-specific sampling scopes of work in the QAPP Addendum. Additionally, detailed procedures related to equipment and field (i.e., reagent) blank sample collection are outlined in the Equipment and Reagent Blank Sample Collection TGI (Arcadis 2018c). In general, equipment blanks should be collected from every piece of downhole equipment that could come in contact with soil or groundwater during sample collection. This includes the profiling tools (e.g., Geoprobe® SP-16, Geoprobe® SP-22, Geoprobe® SP-60, Cascade Packer Isolation Groundwater Profiler).

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Prior to initiating field activities, water sources to be used during drilling activities should be sampled to verify those sources are PFAS-free. While not part of the PQAPP, this is considered best practice and should be completed to the extent possible.

Refer to quality control requirements for the project to ensure that appropriate quality assurance and quality control (QA/QC) samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles;
- Bottle caps must remain in the hand of the sampler until replaced on the bottle;
- Labels must be completed after the caps have been placed back on each bottle; and,
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

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12 REFERENCES

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ATTACHMENT 1

Table 1 and Table 2: PFAS Inspection Material Recommendations

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Table 1: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Inspections

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to inspections	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Sharpie®	--	NHDES 2016; USACE 2016; MassDEP 2017
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to inspections	DER 2016
Alconox® or Liquinox® followed by deionized water or PFAS-free water rinse	Liquinox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

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Table 2: Summary of Equipment and Materials Not Recommended for PFAS Site Inspections

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon®, PTFE-containing or other fluoropolymer coated or containing field equipment (e.g., tubing, bailers, liners, tape, plumbing paste, pump parts)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
Some detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

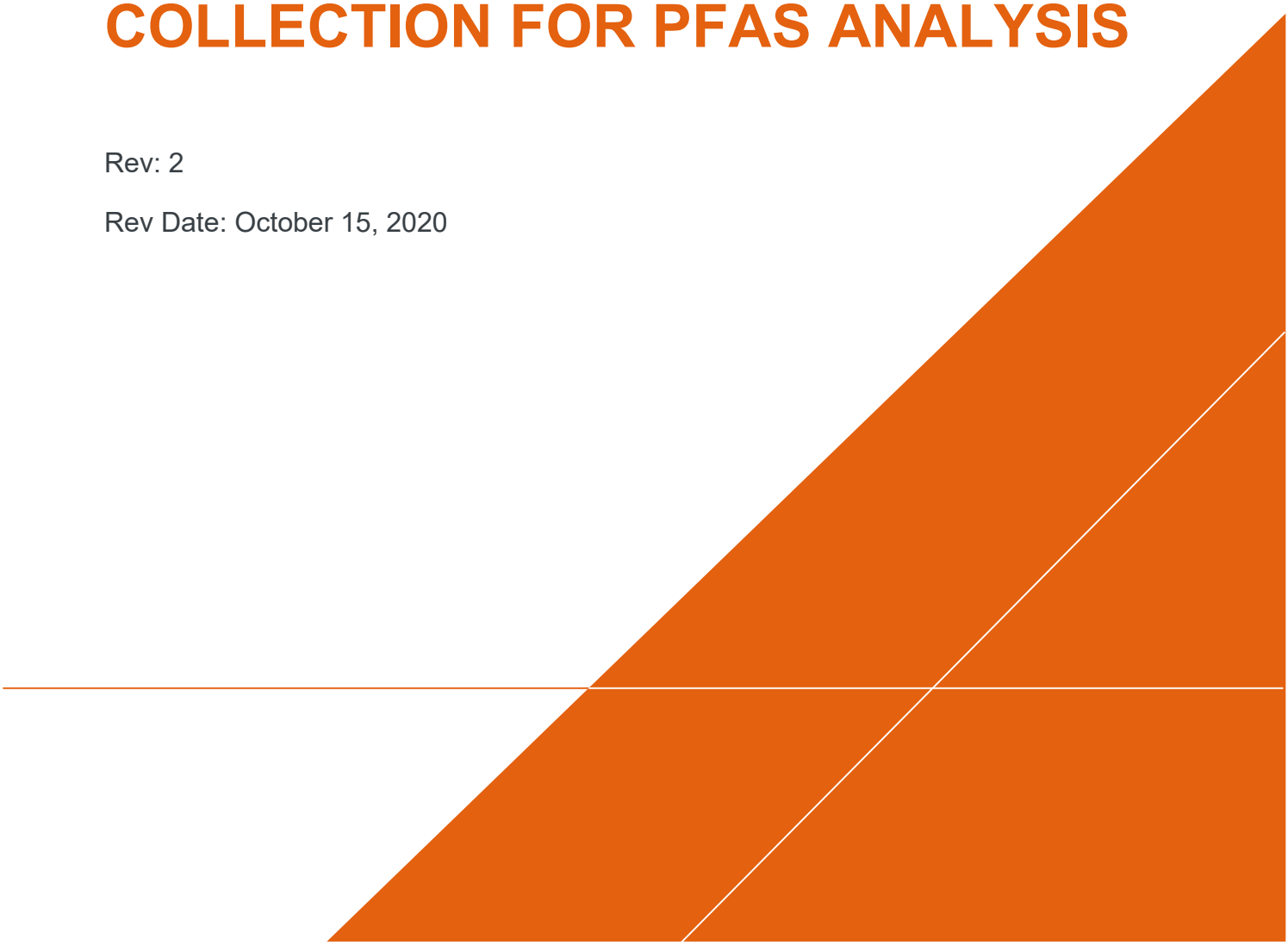
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SOP # P-15

TGI – SEDIMENT, SURFACE WATER, AND STORMWATER SAMPLE COLLECTION FOR PFAS ANALYSIS

Rev: 2

Rev Date: October 15, 2020



SOP # P-15

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 5, 2018	All	Combined aspects of generic Sediment Sample Collection TGI (Rev 0, June 18, 2018) and Stormwater Sampling TGI (Rev 0, August 29, 2018). Added surface water collection guidance and made this TGI PFAS-specific. Added stormwater and surface water sections; made PFAS-specific	Shannon Dunn
1	March 27, 2020	15, 16	Revised the depth criteria to 0.5 to 1 feet for shallow surface water and >1 for deeper surface water	Shannon Dunn
2	October 15, 2020	15, 16	Added Air Force preference to sample surface water at surface for Air Force investigations.	Erika Houtz

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SOP # P-15

APPROVAL SIGNATURES

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10/5/2018

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10/19/2020

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SOP # P-15

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes the collection of sediment, surface water, and stormwater samples, including logging of sediment samples. Sediment samples will be collected using a hand-held dredge, push cores, and/or stainless-steel scoop or trowel (the proper technique will be selected in the field depending on site conditions) for the laboratory analysis of sediment chemistry samples. Surface water and stormwater samples will be collected using direct-fill methods or peristaltic pumps. The general procedures to be utilized in obtaining sediment, surface water, and stormwater samples are outlined below. The intent of this TGI is to provide instructions for sampling during United States Army Environmental Command (USAEC) per- and polyfluoroalkyl substances (PFASs) Preliminary Assessment and Site Inspection (PA/SI) at various installations. It also covers specific considerations for PFASs due to their unique chemical and physical properties, low detection limits, and regulatory standards.

This TGI may change depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this TGI will be approved in advance by the Project Manager.

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3 PERSONNEL QUALIFICATIONS

All field personnel must have the appropriate training required by Arcadis as described in the project Site Safety and Health Plan (SSHP). Arcadis field sampling personnel will be trained in proper sampling procedures under the guidance of an experienced field geologist, engineer, or technician. Arcadis field sampling personnel will also be versed in the relevant TGIs and standard operating procedures (SOPs) necessary to successfully complete the desired field work.

4 EQUIPMENT LIST

The following materials will be available, as required, during sampling. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

Site plan with proposed sampling locations;

Relevant work plan (e.g., Programmatic Quality Assurance Project Plan [PQAPP]);

SSHP;

Health and Safety equipment, as required by the site SSHP and task-specific Job Safety Analysis;

Sediment Sampling Equipment:

- Boat with outboard motor and associated equipment (as necessary);
- Global Positioning System (GPS) unit;
- Navigation chart(s) for on-water activities (if available and as applicable);
- Stainless-steel hand-held dredge (6-inch x 6-inch Ekman or Petite Ponar);
- Lexan™ tubes (4-inch) and PFAS-free plastic caps;
- Stainless-steel bowl;
- Stainless-steel spatula, scoop, bent spoon, or trowel;
- Steel core driver (i.e., slide hammer);
- YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, oxidation reduction potential (ORP), and dissolved oxygen (DO);
- Supplemental turbidity meter;
- Stainless-steel probe rod – for evaluating bottom softness when wading to sampling locations
- Polypropylene twine/rope
- Hacksaw with stainless steel blade;
- Tape measure;
- Stainless steel, polyvinyl chloride (PVC) or high-density polyethylene (HDPE) yard stick for measuring water depth.
- Stainless-steel extension rod (if necessary to extend reach of scoop or trowel);

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- Rubber boots or rubber waders (only non-coated rubber, other more high-tech waterproof material is not permitted);
- Life jacket or other personal flotation device (PFD) as necessary based on water depth (note, these will likely have PFAS-containing materials so need to be careful to avoid cross-contamination when using).

Surface Water Sampling Equipment:

- If not using direct-fill method:
  - ISCO Model 150 peristaltic pump;
  - Rechargeable marine or car battery (for peristaltic pump);
  - Dedicated HDPE and silicon tubing (Teflon® or polytetrafluoroethylene [PTFE] tubing is prohibited);
  - Stainless steel rod (1/4-inch diameter x 4-feet long or similar) to support HDPE sampling tubing;
  - HDPE zip ties (nylon zip ties are not allowed) to attach tubing to rod;
  - YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO;
  - Supplemental turbidity meter;
  - Pail or bucket with closable lid for pump discharge;
- Rubber boots or rubber waders (only non-coated rubber, other more high-tech waterproof material is not permitted);
- Life jacket or other PFD as necessary based on water depth (note, these will likely have PFAS-containing materials so need to be careful to avoid cross-contamination when using).

Stormwater Sampling Equipment:

- Wrench, socket, manhole cover hook or magnetic manhole cover remover for access;
- Approximately 1-inch outer diameter Lexan™ pipe long enough to extend from bottom of storm drain to at least 2 feet above the manhole;
- HDPE zip ties (nylon zip ties are not allowed) to attach tubing to the Lexan™ pipe;
- Tape measure;
- ISCO Model 150 peristaltic pump;
- Rechargeable marine or car battery (for peristaltic pump);
- Dedicated HDPE and silicon tubing (Teflon® or PTFE tubing is prohibited);
- YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO;
- Supplemental turbidity meter;

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- Pail or bucket with closable lid for pump discharge.

Appropriate sample containers and labels:

- Labeled sample bottles: see the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a) for PFAS-specific considerations;
- 1-quart and 1-gallon polyethylene bags (Ziploc® brand only) to hold ice and samples;
- Appropriate blanks (field reagent blanks supplied by the laboratory);
- Packing and shipping materials;
- Chain-of-Custody (COC) Forms; see the Sample Chain of Custody Standard Operating Procedure (SOP) for reference (Arcadis 2017a);
- Appropriate transport containers (coolers) with ice and appropriate labeling, no blue ice;

Decontamination/Water Management:

- PFAS-free decontamination fluids and equipment
  - HDPE or PVC brushes and squirt bottles
  - Stainless steel bowl
  - HPDE buckets to hold decontamination fluids
  - Alconox® or Liquinox® (other detergents are prohibited)
  - Methanol or isopropyl alcohol (for sediment sampling equipment decontamination only)
  - Distilled or laboratory-supplied deionized water
  - Laboratory-provided PFAS-free water
- See the TGI - Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a) or the TGI - Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2017b) for additional guidance;
- Portable field hand washing setup;
- Non-hazardous drum labels as required for investigation-derived waste handling: see the TGI - Investigation-Derived Waste Handling and Storage for details (Arcadis 2017c);

Field Notes:

- Pens, pencils, and/or Sharpies® for writing;
- Appropriate field forms;
- Clipboards, field binders, field notebook, and field note pages that are not waterproof;
- Digital camera.

Other

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- Garbage bags;
- Paper towels;
- Duct and packing tape;
- Dedicated low-density polyethylene (LDPE) plastic sheeting to prevent sample contact with the ground;
- Field clothing made of cotton or other natural fibers that is well laundered (i.e., washed at least 5 times);
- PFAS-free sunscreen and insect repellant.

5 CAUTIONS

5.1 Utility Clearance

Sediment sampling requires a minimum of three reliable lines of evidence for utility clearance to demonstrate that sample locations are clear of subsurface utilities. A site visit for public utility line clearance at the proposed boring locations will be conducted at least 72 hours prior to work commencing. As applicable, utility maps will be reviewed during field reconnaissance of the proposed inspection locations to determine if any are co-located with public utility lines. Arcadis will also contract an independent geophysical survey company to verify, if possible, that proposed boring locations are not co-located with existing underground utility/substructure features. See the Utility Location and Clearance Arcadis Health and Safety Standard (Arcadis 2017d), including Supplement 6 Utility Location Procedures for Aquatic Work Activities, for reference.

5.2 PFAS-Specific General Sampling Considerations

This section provides a summary of methods and procedures applicable to the collection of environmental samples for field screening or laboratory analysis during PFAS site characterization activities. In general, sampling techniques used for PFAS site characterization are consistent with conventional sampling techniques used in the environmental industry, but special consideration is made regarding PFAS-containing materials and cross-contamination potential. For example, Teflon™ and other fluoropolymer containing materials are found in pumps, tubing, and sample storage containers and therefore should be avoided if possible (Department of Environment Regulation [DER], Western Australia 2016; New Hampshire Department of Environmental Services [NHDES] 2016). Certain field documentation materials such as waterproof paper or field books, adhesive paper products, and some writing utensils (grouped as non-Sharpie® markers) are also prohibited items during PFAS sampling (DER 2016; NHDES 2016).

New nitrile gloves should be donned before any of the following activities:

- Decontamination of re-usable sampling equipment;
- Contact with sample bottles or PFAS-free water bottles;
- Handling clean sample tubing or connecting tubing;
- Handling QC samples including field blanks and equipment blanks.

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Additionally, new nitrile gloves should also be donned after handling of any non-dedicated sampling equipment; contact with contaminated surfaces; and whenever judged necessary by field personnel. **When in doubt change your gloves.**

Waterproof field books must not be used for field notes. Instead, field notes should be on loose paper on Masonite, plastic, or aluminum clip boards. Other requirements for field notes include:

- Keep field notes, writing implements, and electronic data collection tablets away from samples and sampling materials; and
- Do not write on sampling bottles unless they are closed.

Tables 1 and **2** in **Attachment 1** provides recommendations for PFAS Site Inspection equipment. **Table 1** provides a summary of materials that have been approved for site inspection; this list is expected to grow longer as industry experience increases. **Table 2** provides a summary of field equipment and materials that have available testing information and/or industry knowledge regarding PFAS cross-contamination potential and it is recommended that these materials be prohibited for sample collection. For materials that are suspected of containing PFASs and/or retaining PFASs, these recommendations are considered preliminary and subject to change.

Given the extremely low detection limits associated with PFAS analysis and the many potential sources of trace levels of PFASs, field personnel are typically advised to err on the side of caution by strictly following field wear guidelines and decontamination procedures as specified in the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).**The most important consideration during PFAS-related sampling is to prevent contact between sample media and suspect PFAS sources.**

5.3 PFAS-Specific Sediment Sampling

Because of the potential presence of PFASs in equipment typically used to collect samples, consideration for other sampling materials that contact sediment through the sampling process is necessary. Each piece of equipment that comes into direct contact with the sediment needs to be evaluated to determine if there are either PFAS-containing materials present, which could be a source of cross-contamination and cause false positives, or if PFASs adhere to the material, which has the potential to cause low bias sample results. For each additional piece of equipment that may introduce contamination, an equipment blank should be collected to confirm that materials in the sample equipment do not cause false positives by introducing PFASs. Equipment blanks are particularly important for any device/component where PFASs may be present or cannot be verified as being a non-PFAS containing material. Other quality assurance methods may be implemented to avoid materials that could result in potential losses associated with PFASs adhering to surfaces.

The following additional notes are provided regarding sediment sampling materials:

- Lexan™ liner sleeves are made of polycarbonate and they are not expected to contain PFASs based on review of the Safety Data Sheet (Sabic 2016).
- Studies evaluating the use of stainless steel indicate that PFASs do not strongly sorb to stainless-steel (Obal et al. 2012). Therefore, stainless-steel sleeves and equipment should be acceptable for collection of sediment samples for PFAS analysis.

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5.4 PFAS-Specific Surface Water and Stormwater Sampling

As described for sediment sampling, the potential presence of PFASs in equipment that may come in contact with the target water sample must be evaluated as part of the sample planning process to maintain sample integrity.

Note that if high concentrations of PFASs related to Class B firefighting foams are expected in a surface water sample, it has been recommended to collect and shake a small portion of the sample at the time of sample collection (USACE 2016; Arcadis 2018a). If foaming is noted within the sample, it indicates elevated concentrations of PFASs may be present and the sample should be proactively diluted at the laboratory prior to analysis. The foaming should be noted on the sample COC form. It is recommended to collect sampling equipment blanks following foam observation to confirm the effectiveness of decontamination procedures.

While permissible during fog or intermittent showers, surface water samples should not be collected during steady, prolonged rainfall. Avoid entraining sediment in surface water samples. If accessing the sample location from water, approach slowly from downstream to avoid disturbing the bottom.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with sediment, surface water, and stormwater sampling and description will be performed in accordance with a site-specific SSHP, a copy of which will be present on site during such activities. Additional health and safety discussions are specifically discussed below.

6.1 Sediment Sampling

- Walk established paths whenever possible to avoid slip/trip hazards. Take your time and watch your footing.
- A PFD may be required to complete sediment sampling. Review the Arcadis Water Operations Health and Safety Standard and the SSHP to determine if a PFD is required.
- To the extent possible, maintain three points of physical contact (i.e., two feet and one hand, or one foot and two hands) when entering and exiting a stream channel.
- Ensure the state One Call has been completed and the Arcadis Utilities and Structures Checklist is completed before sampling.
- Take breaks as needed to avoid repetitive use injury or muscle strain and take turns with co-workers as needed.
- Do not touch sediments with bare hands or detect odors by placing sediments close to your nose.
- STOP WORK when conditions change or become unsafe and discuss if/how to proceed safely before resuming work.
- If boats are required for sampling, the following considerations should be made:
    - Good housekeeping and three-points of physical contact should be maintained when entering/exiting the boat to prevent falls or trips
    - Boat operator will be properly trained
    - To avoid impact with other water traffic, ensure navigational lighting is functional (if applicable). Be vigilant and maintain situational awareness of other water traffic.

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6.2 Surface Water Sampling

- A PFD may be required to complete surface water sampling. Review the Arcadis Water Operations Health and Safety Standard and the SSHP to determine if a PFD is required.
- Always have three points of contact when entering and exiting a stream channel, if necessary.
- If boats are required for sampling, the following considerations should be made:
    - Good housekeeping and three-points of physical contact should be maintained when entering/exiting the boat to prevent falls or trips
    - Boat operator will be properly trained
    - To avoid impact with other water traffic, ensure navigational lighting is functional (if applicable). Be vigilant and maintain situational awareness of other water traffic.

6.3 Stormwater Sampling

- The ability to safely access the stormwater sampling vaults or manholes should be verified prior to sampling. Confined space entry is not allowed.

7 PROCEDURE

7.1 Sediment Sampling

Sediment samples will be collected by one of the following methods considered most appropriate for the site conditions.

- Hand-held scoop or trowel – for shallow water depths (e.g., < 2 feet) that are nearshore and that sediment conditions preclude sampling by push core or grab sampler
- Push core – for sampling in deeper water (e.g., > 2 feet) or offshore
- Petite Ponar Grab Sampler – for sampling in deeper water offshore with coarse sediment or hard bottom.

Sampling Mobilization/Prep

- Don personal protective equipment (PPE) as discussed in Section 5.2 and the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).
- Mobilize to sampling location.
    - If accessing by wading, approach slowly from a downstream direction to limit disturbance of the bottom and resulting suspension of sediment into the surface water at sampling location.
    - If accessing by boat, maneuver to the target sample location using GPS and secure the vessel in place.
- Identify the proposed sample location in the field notebook along with other appropriate information (e.g., location, date, time, personnel, weather).

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- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Measure and record water depth at the sampling location.

Sample Collection by Stainless Steel Scoop or Trowel

- Attach stainless steel scoop, bent spoon, or trowel to a stainless-steel extension rod (if needed) and lower vertically downward through the water column until it reaches the bottom. Collect sediment from the top 2 inches (5 centimeters [cm]) of the bottom surface.
- Retrieve the scoop, bent spoon, or trowel. Slowly decant overlying water and take care to prevent fine sediment from being poured out with the water. Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles. If the sample contains too much vegetation to be removed effectively, collect another sediment sample from the bottom.
- Place the sediment in a decontaminated stainless-steel bowl.
- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab sample ID, date, and time, written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.
- Describe lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- Collect sediment samples. If additional sediment is needed to fill the bottles, collect additional sample volume approximately 1-2 feet upstream from the first to minimize disturbance.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use the supplemental turbidity meter to measure turbidity.

Sample Collection by Push Core

- Lower section of clean Lexan™ tube (at least as long as the target sediment penetration depth plus the water depth) until it contacts the top of the sediment.
- Push Lexan™ tube with a straight vertical entry into the sediment to a depth of approximately 4 inches (10 cm) below the sediment surface. If necessary, drive the tube a few more inches down into the sediment either by hand or using a steel core driver to obtain a plug at the bottom of the core

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that will prevent the sediment from falling out during core retrieval. Note that only the top 2 inches (5 cm) of soil will be used for laboratory sampling.

- Place a cap made of PFAS-free materials (e.g., HDPE, silicon) on the top of the sediment tube and slowly pull the tube from the sediment, twisting it slightly as it is removed (if necessary)
- Before the tube is fully removed from the water, place a PFAS-free cap on the bottom end of the tube while it is still submerged. Ensure that the bottom end cap fits tightly and will not inadvertently slip off. Remove the tube from the water.
- Keeping the tube upright, wipe the bottom end dry and double check that the bottom cap is tight. If necessary (e.g., walking away from the sampling area to a more secure area to fill sample jars), keep one hand beneath the bottom cap to prevent the cap from falling off. Measure the length of sediment recovered and evaluate the integrity of the core.
- While keeping the core upright, use a hacksaw to make a horizontal cut in the tube approximately 2 - 3 inches above the sediment and carefully drain water from the core to prepare it for inspection and sampling.
    - Note: If possible, use a section of Lexan ™ tubing short enough to allow for sampling without cutting the core. This is only possible in shallow water conditions, as the Lexan ™ tubing should be at least long enough to keep the top of the tube above water.
- Slowly decant overlying water and take care to prevent fine sediment from being poured out with the water. Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles. If the sample contains too much vegetation to be removed effectively, collect another sediment sample from the bottom.
- Using a stainless-steel bent spoon, scoop, or trowel, place the top 2 inches (5 cm) of sediment in a decontaminated stainless-steel bowl.
- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab sample ID, date, and time written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.
- Describe the lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- Collect sediment samples. If additional sediment is needed to fill the bottles, collect additional sample volume approximately 1-2 feet upstream from the first to minimize disturbance
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.

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- Use supplemental turbidity meter to measure turbidity.

Sample Collection by Petite Ponar Grab Sampler

- Use polypropylene twine/rope with the dredge or similar PFAS-free approved material.
- Set the stainless-steel Petite Ponar grab sampler dredge and slowly lower the open dredge from the side of the boat until it is just above the top of the sediment surface. Then drop the open dredge into the sediment.
- Once the dredge has been allowed to settle into the bottom sediment, pull hard on the rope, or send the messenger to trigger the dredge and close the sediment inside.
- Retrieve the dredge onto the boat.
- Inspect the sample for acceptability in accordance with the following criteria:
    - Sampler is not overfilled with sample such that the sediment surface presses against the top of the sampler or is extruding through the top of the sampler.
    - Overlying water is present above the sediment (indicates minimal leakage)
    - At least 4 inches (10 cm) of sediment penetration depth has been achieved.
- Tilt the dredge over slightly to drain the overlying water to prepare the sediment for inspection and sampling, being careful not to disturb the recovered sediment. Also take care to prevent fine sediment from being poured out with the water.
- Inspect recovered sediment to confirm it does not contain vegetation (e.g., grass, leaves, sticks or similar undecomposed organic material). Use the stainless-steel trowel to remove any vegetation prior to filling sample bottles if possible to do so with minimum disturbance of the recovered sediment. If the sample contains too much vegetation to be removed effectively without disturbing sediment, collect another sediment sample from the bottom.
- Using a stainless-steel bent spoon, scoop, or trowel, place the top 2 inches (5 cm) of sediment in a decontaminated stainless-steel bowl.
- Photograph the grab sample to provide reference for post-processing questions regarding descriptions of color/staining, general texture, recovery, and other characteristics. Photos of the sample will include the grab sample ID, date, and time written on loose paper with a Sharpie® marker. The photo will also include a view of a tape measure for scale.
- Describe the lithology of recovered sediment in accordance with Arcadis TGI for Soil Descriptions (Arcadis 2018b).
- Homogenize the sediment with a stainless-steel mixing spoon until the sediment is of uniform color.
- If additional sediment volume is needed to fill sample bottles, redeploy the dredge 1 – 2 feet upstream from the previous sampling location.

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- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Collection/Management, Post-Sampling

- Fill the sample bottle for PFAS analysis first, then fill bottles for any remaining analyses.
- Don clean nitrile gloves and use a stainless-steel trowel to fill clean labeled bottles supplied by the laboratory for the required analyses with sediment. Collect lab samples from the top 5 cm of the recovered 10 cm interval only. Do not overfill bottles.
- Make sure caps remain on PFAS sample bottles until immediately prior to filling. Caps must remain in the hand of the sampler until replaced on the bottle.
- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in Quality Assurance Project Plan (QAPP) Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis Regional Lead (RL). **Note, if using waders to access sampling locations, collect equipment blank off of the waders.**
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place the sample bottles in a sealed Ziploc© bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

7.2 Surface Water Sampling

Sampling Mobilization/Prep

- Don PPE as discussed in Section 5.2 and the Poly- and Perfluorinated Alkyl Substances (PFAS) Field Sampling Guidance (Arcadis 2018a).
- Mobilize to sampling location.
    - If accessing by wading, approach slowly from downstream direction to limit disturbance of bottom and resulting suspension of sediment into the surface water at the sampling location.

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- If accessing by boat, maneuver to the target sample location using GPS and secure the vessel in place.

- Identify the proposed sample location in the field notebook along with other appropriate information (e.g., location, date, time, personnel, weather).
- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Measure and record water depth at the sampling location.
- Do not sample surface water when it is raining. Fog or intermittent showers are okay, but not steady rainfall. Avoid entraining sediment in surface water samples.

Shallow Surface Water (0.5 – 1 feet)

- Cut a length of new HDPE tubing to the appropriate size for desired sampling depth and pump location and attach to stainless steel rod using HDPE zip ties. Insert a new length of silicon tubing into the peristaltic pump and connect HDPE tubing on intake side and a shorter length of new HDPE tubing on discharge side.
- Direct pump discharge into pail/bucket during sampling.
- For general PFAS investigation, lower the HPDE tubing on intake side of pump to the desired depth in the water column. For water depths < 1 ft, place tubing intake at approximately mid-depth of the water column.
- For Air Force investigations, place the HDPE tubing on intake at the surface. Collect samples from the water surface.
- Do not disturb sediment at bottom of water body with sampling equipment, as this could cause suspension of sediment into the surface water that could introduce cross contamination into the sample.
- Verify pump flow direction and turn on pump.
- Once water fills the tubing and begins flowing out of the discharge end turn off pump and prepare to sample.
- Don fresh set of nitrile gloves. Disconnect HDPE tubing from silicon tubing on discharge end. Keep silicon tubing in clean gloved hand and do not allow it to contact any surfaces or equipment. Turn on pump and fill sample bottle to the neck directly from silicon tubing, headspace is acceptable. Do not rinse PFAS sample bottles during sampling.
- Only use labelled HDPE bottles that are supplied by the laboratory. Make sure the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on the sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

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Deeper Surface Water (>1 feet)

- Don fresh set of nitrile gloves immediately prior to collecting samples. Use nitrile glove with long cuff that covers the forearm, as this will help avoid submerging clothing or skin during sampling.
- Only use labelled HDPE bottles that are supplied by the laboratory. Do not rinse PFAS sample bottles prior to collecting sample. Do not remove cap prior to or after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Facing the upstream direction (if the surface water body is flowing), place sample container in freshly gloved hand and gently submerge the sample container beneath the water surface with the cap on. For Air Force investigations, the bottle should be submerged at the water surface.
- Tilt the container so the mouth is angled slightly upward, then with the other gloved hand gently unscrew the cap, open it a crack and allow water to flow slowly down the inner wall of the container filling it. For Air Force investigations, the mouth should be at the surface.
- Do not submerge hands below top of gloves during sampling such that clothing or bare skin of sampling personnel comes into contact with the surface water.
- When the sample container is full, replace and tighten the cap while the container is still submerged, then remove it from the water.
- Measure surface water pH, conductivity, temperature, and turbidity at sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.
    - Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Management, Post-Sampling

- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in the QAPP Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis RL. **Note, if using waders to access sampling locations, collect equipment blank off of the waders.**
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place sample bottles in a sealed Ziploc® bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

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7.3 Stormwater Sampling

The following general guidelines apply when sampling stormwater.

- Sampling should be started from the manhole farthest downstream and work upstream. This mitigates the impact of subsequent samples if anything on the bottom is disturbed and migrates downstream.
- Care should be taken not to disturb the bottom sediments in catch basin sumps or other storm water sampling locations.
- Stormwater samples should only be collected from active flow. Stormwater will not be collected from pools or standing water.

Use the following procedure to collect grab stormwater samples.

- Verify all dedicated sample gear has been properly decontaminated as discussed in Section 10.
- Mobilize to stormwater sampling location.
- Confirm that active flow is entering the sampling space.
- Measure the depths from the top of the manhole to the top of the stormwater surface and to the bottom of the stormwater system with a tape measure (do this downstream from the spot where the sample will be collected).
- Subtract the depth of the water surface from the depth of the stormwater system. This is the thickness of the stormwater column. Divide the thickness by two. Add the result to the depth of the stormwater surface. This is the sampling depth.
- Strap the HDPE sampling tubing to the Lexan ™ pipe using the HDPE zip ties.
- Place a HDPE zip tie on the Lexan ™ pipe that marks the sampling depth, as measured above. This HDPE zip tie will be used as a marker to guide how far to insert the pipe and tubing into the manhole. The HDPE zip tie marker will prevent over inserting the Lexan ™ pipe and tubing and thus prevent disturbing the deposited sediment in the stormwater system.
- Attach the other end of the tubing (the end that will not be placed into the stormwater for sampling) to the peristaltic pump.
- Collect active flow sample.
    - Slowly lower the Lexan ™ pipe and tubing into the stormwater system to the sample collection depth, using the marker HDPE zip tie as a guide.
- Verify pump flow direction and turn on pump.
- Once water fills the tubing and begins flowing out of the discharge end turn off pump and prepare to sample.
- Don fresh set of nitrile gloves. Disconnect HDPE tubing from silicon tubing on discharge end. Keep silicon tubing in clean gloved hand and do not allow it to contact any surfaces or equipment. Turn on pump and fill sample bottle to the neck directly from silicon tubing, headspace is acceptable. Do not rinse PFAS sample bottles during sampling.

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- Only use labelled HDPE bottles that are supplied by laboratory. Make sure that the cap remains on the bottle until immediately prior to sample collection and gets placed back on the bottle immediately after sample collection. Do not place the cap on any surface, and keep cap in gloved hand opposite of sample collection, do not touch the inside of the cap.
- Measure surface water pH, conductivity, temperature, and turbidity at the sampling location and record on sampling forms.
    - Use YSI 6-Series Multi-Parameter Instrument water quality meter with flow-through cell for monitoring temperature, conductivity, ORP, and DO.

Use supplemental turbidity meter to measure turbidity.

Laboratory Sample Management, Post-Sampling

- Once the PFAS sample has been placed in the bottle, and the bottle cap has been completely tightened, label the sample with sample identification number, date, and time of collection. Labels must be completed only after the caps have been placed back on each bottle. (See P-01 QP#3.06 Field Activities documentation for sample label information).
- Collect QC samples at the frequency specified in the QAPP Addendum Worksheet #20. QC sample locations are to be selected based on consultation with the Arcadis RL. **Note, if using waders to access sampling locations, collect equipment blank off of the waders.**
- Record the label information and time of sampling in the field notes and sampling forms.
- Fill out the laboratory COC and check against the labels on the sample bottles progressively after each sample is collected.
- Place sample bottles in a sealed Ziploc® bag, and then into sample coolers. Store PFAS samples in separate cooler from other samples.

8 WASTE MANAGEMENT

Investigation-derived waste (IDW) including excess sediment, surface water, stormwater and decontamination fluids will be collected and placed in Department of Transportation approved containers, segregated by waste streams: see the Investigation-Derived Waste Handling and Storage TGI for details (Arcadis 2017c). All containers will be labeled as non-hazardous unless otherwise instructed by the Project Manager. Containerized IDW will be stored on site until it is profiled and subsequently transported to an approved facility for disposal or recycling. Waste manifests for all IDW suspected to have come into contact with PFAS should clearly note the presence of PFAS. Additional IDW sampling and management details will be provided in the site-specific QAPP Addendum and will be consistent with applicable Army policies and Army post requirements. Personal protective equipment (e.g., gloves, disposable clothing, disposable equipment) resulting from personnel cleaning procedures and soil sampling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled waste containers for appropriate disposal.

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9 DATA RECORDING AND MANAGEMENT

The supervising field lead will be responsible for documenting sampling events to record all relevant information in a clear and concise format. The record of sampling events should include:

- Sample dates
- Project name and location
- Project number, client, and site location
- Sampling details (e.g., field measured water quality parameters, standing water column depth)
- Sediment core log
- Type of tools used
- Weather conditions

Field staff should ensure COC Forms are properly completed, and verify which PFAS analytes (e.g., just PFOS and PFOA, some or all of the 537 list) are required for analysis and note on the COC.

10 DECONTAMINATION

To avoid cross-contamination during sampling, all reusable sampling equipment will be cleaned between sampling locations as follows. Repeat these steps twice at all locations suspected of containing a Class B firefighting foam source.

Sediment Sampling

With Organic Solvent Rinse (Preferred Method)

- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only)
- Double-rinse in deionized or distilled water
- Rinse once with methanol or isopropyl alcohol
- Rinse once with PFAS-free water
- Collect all rinsate in a sealed pail for disposal
- Allow time to air dry prior to re-use

Without Organic Solvent Rinse (Contingency Method)

- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Single-rinse in deionized or distilled water;
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Double-rinse in deionized or distilled water and single-rinse with PFAS-free water;
- Collect all rinsate in a sealed pail for disposal;
- Allow time to air dry prior to re-use.

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- Don new pair of nitrile gloves prior to decontamination
- Scrub using a plastic brush and non-phosphate soap (Liquinox® or Alconox® only);
- Double-rinse in deionized or distilled water;
- Collect all rinsate in a sealed pail for disposal;
- Allow time to air dry prior to re-use.

See additional specifics in P-04, TGI - Groundwater and Soil Sampling Equipment Decontamination in PQAPP Appendix A.

11 QUALITY ASSURANCE

In general, the following quality assurance and quality control (QA/QC) samples should be collected:

- Equipment blanks
- Field (i.e., reagent) blanks
- Field duplicates
- Matrix spike/matrix spike duplicate

Details on QC sampling requirements (e.g., frequency of collection, types of QA/QC samples) are provided in the PQAPP and will be outlined in various Site-specific sampling scopes of work in the QAPP Addendum. Additionally, detailed procedures related to equipment and field (i.e., reagent) blank sample collection are outlined in the Equipment and Reagent Blank Sample Collection TGI (Arcadis 2018c).

Refer to QC requirements for the project to ensure that appropriate QA/QC samples are collected. When collecting QA/QC samples, the same guidelines apply as when collecting regular samples – specifically that:

- Samples should be collected in laboratory-supplied HDPE bottles
- Bottle caps must remain in the hand of the sampler until replaced on the bottle
- Labels must be completed after the caps have been placed back on each bottle
- Samples must be stored in appropriate transport containers (coolers) with ice (Ziploc®-type bags for use as ice containers) with appropriate labeling. **Do not use blue ice. Store PFAS samples in a separate cooler from other types of samples.**

12 REFERENCES

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Arcadis. 2018b. TGI – Soil Description. Rev. #2. February 16.

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SOP # P-15

ATTACHMENT 1

Table 1 and Table 2: PFAS Inspection Material Recommendations

Internal Working Document - Internal Use Only

SOP # P-15

Table 1: Summary of Acceptable Sampling Equipment and Materials for PFAS Site Inspections

Sampling Materials	Additional Considerations	References
Water Sampling Materials		
High density polyethylene (HDPE) or silicone tubing materials	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
HDPE HydraSleeves™	Low density polyethylene (LDPE) HydraSleeves™ are not recommended	USACE 2016; MassDEP 2017
Drilling and Soil Sampling Materials		
PFAS-free drilling fluids	--	DER 2016
PFAS-free makeup water	Confirm PFAS-free water source via laboratory analysis prior to inspections	--
Acetate liners	For use in soil sampling	USACE 2016
Sample Containers and Storage		
HDPE sample containers with HDPE lined lids for soil and water samples	Laboratory should provide; whole bottle analysis of aqueous samples combined with a solvent rinse of bottle is recommended	DER 2016, MassDEP 2017
Ice contained in plastic (polyethylene) bags (double bagged)	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation		
Sharpie®	--	NHDES 2016; USACE 2016; MassDEP 2017
Ball point pens	--	MassDEP 2017
Standard paper and paper labels	--	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Decontamination		
Water-only decontamination	Confirm PFAS-free water source via laboratory analysis prior to inspections	DER 2016
Alconox®, Liquinox® or Citranox® followed by deionized water or PFAS-free water rinse	Alconox® known to contain trace levels of 1,4-dioxane	NHDES 2016; USACE 2016; MassDEP 2017
Methanol, isopropanol, or acetone	Special health and safety precautions are necessary	UNEP 2015; USACE 2016

Note: This list is considered preliminary and additional materials may be added as additional information becomes available. Project teams are expected to follow a methodical evaluation process of materials to be used and confirm acceptance prior to implementation of field activities.

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Table 2: Summary of Equipment and Materials Not Recommended for PFAS Site Inspections

Sampling Materials	Known PFAS-Containing Materials	Suspected PFAS-Containing Materials	Materials with Potential to Retain PFASs	References
Water Sampling Materials				
Teflon® or polytetrafluoroethylene (PTFE)-containing or coated field equipment (e.g., tubing, bailers, tape, plumbing paste)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Passive diffusion bags			x	MassDEP 2017
LDPE HydraSleeves ™			x	USACE 2016; MassDEP 2017
Water particle filters			x	MassDEP 2017
Drilling and Soil Sampling Materials				
Aluminum foil			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Drilling fluid containing PFASs	x	x		DER 2016
Sample Containers and Storage				
Glass sample containers with lined lids			x	DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
LDPE containers and lined lids			x	USACE 2016
Teflon® or PTFE- lined lids on containers (e.g., sample containers, rinsate water storage containers)	x			DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Reusable chemical or gel ice packs (e.g., BlueIce®)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Field Documentation				
Self-sticking notes and similar office products (e.g., 3M Post-it®-notes)		x		DER 2016; USACE 2016; NHDES 2016; MassDEP 2017
Waterproof paper, notebooks, and labels	x			DER 2016, MassDEP 2017
Non-Sharpie® markers		x		NHDES 2016
Decontamination				
Some detergents and decontamination solutions (e.g., Decon 90® Decontamination Solution)	x	x		DER 2016; NHDES 2016; MassDEP 2017

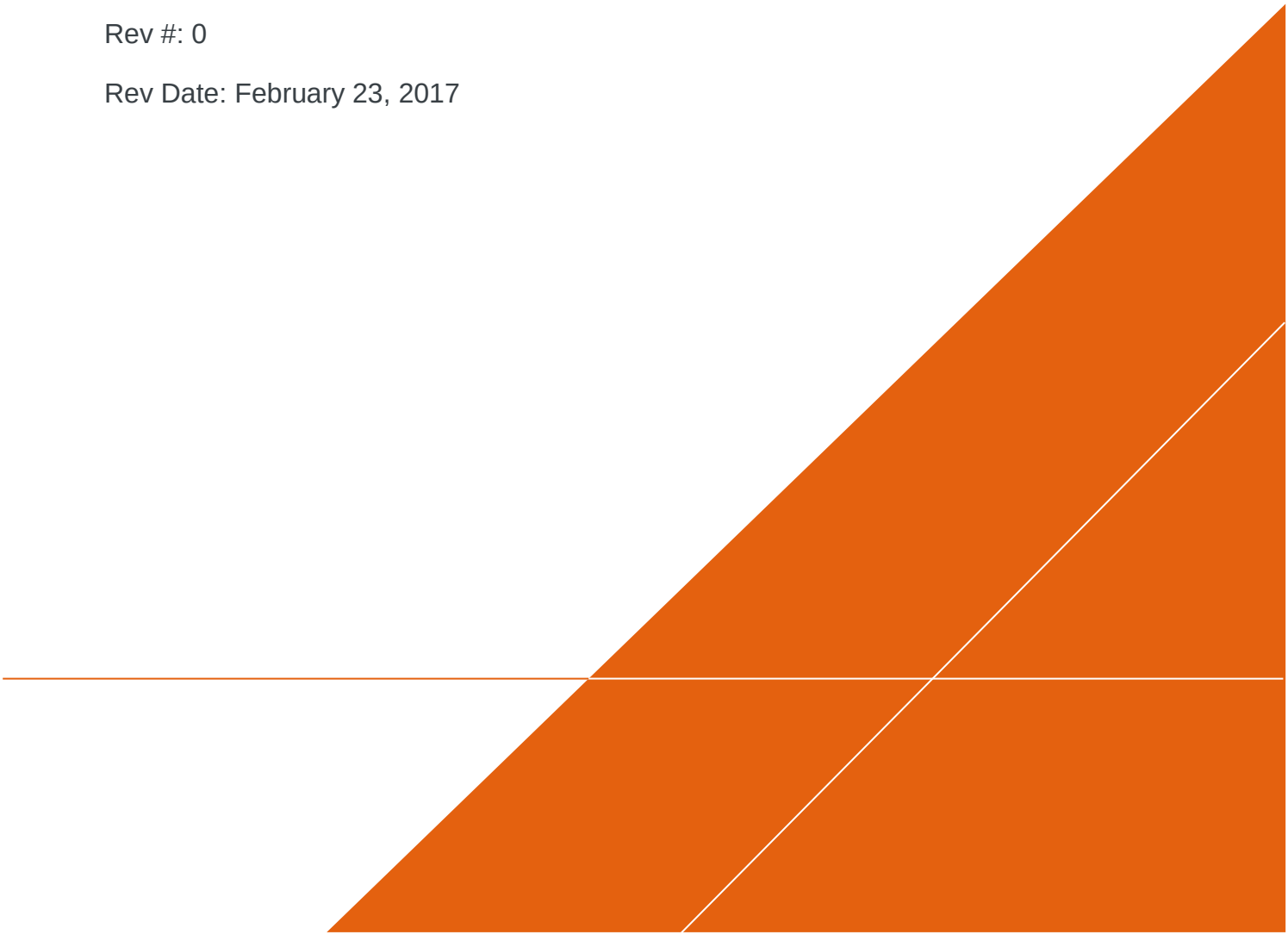
Note: For materials that are suspected of containing PFASs, or have the potential to retain PFASs, project specific considerations may provide adequate justification for use during the field event. For example, further evaluation may be conducted in the form of pre-field equipment blank sample analysis.

SOP # P-16

TGI - INVESTIGATION-DERIVED WASTE HANDLING AND STORAGE

Rev #: 0

Rev Date: February 23, 2017



SOP # P-16

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Ryan Mattson / Peter Frederick

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SOP # P-16

APPROVAL SIGNATURES

Prepared by:		02/23/2017
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Technical Expert Reviewed by:		02/23/2017
	Ryan Mattson (Technical Expert)	Date:

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SOP # P-16

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The objective of this Technical Guidance Instruction (TGI) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and nonhazardous, generated during site activities, which may include, but are not limited to: drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. For the purposes of this TGI, IDW is considered to be discarded materials which are defined as solid waste by United States Environmental Protection Agency (EPA) standard 40 CFR § 261.2 (which may include liquids, solids, or sludges). IDW may include soil, groundwater, drilling fluids, decontamination liquids, as well as contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Hazardous or uncharacterized IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary onsite storage area (discussed in further detail under Drum Storage) pending characterization and disposal. IDW materials will be characterized using process knowledge and appropriate laboratory analyses to determine the waste classification and evaluate proper safe handling and disposal methods.

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This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly transported from the project site and disposed. The procedures included in this TGI for handling and temporary storage of IDW are based on the EPA's guidance document *Guide to Management of Investigation Derived Wastes* (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). Although not comprehensive, the following laws and regulations on Hazardous Waste Management should be considered as potential ARAR. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987.
- Federal Hazardous Waste Regulations 40 CFR § 260-265

Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Regional, County, Municipal, and Local Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Initial Storage

Pending characterization, IDW will be temporarily stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Uncharacterized wastes are considered potentially hazardous wastes and must be stored in DOT approved packaging. Liquid wastes must be stored in DOT approved closed head drums or other approved containers (e.g., portable tank containers) that are compatible with the type of material stored therein. Solid materials must be stored in DOT approved open head drums where practicable. Larger quantities of solid IDW can be containerized in bulk containers (such as in a roll-off box). Soil from large excavation projects may be managed in stockpiles with within the AOC and does not need to be containerized until exiting the AOC.

Characterization

Waste characterization can either be based on generator knowledge, such as using historical process knowledge and safety data sheets (SDS), or can be based upon characterization sampling analytical results. IDW typically is not characterized using SDS as it is a mixture of aged chemicals and environmental media. Historical process knowledge should be used to determine if the IDW is a listed hazardous waste (40 CFR § 261.31-33). If the IDW is not a listed hazardous waste, waste

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characterization can be completed by laboratory analysis of representative samples of the IDW. The laboratory used for waste characterization analysis must have the appropriate state and federal accreditations and may be required to be pre-approved by the Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization determination.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Waste material classified as RCRA nonhazardous may be handled and disposed of as nonhazardous waste in accordance with applicable federal, state, and local regulations.

Storage Time Limitations

Containerized hazardous wastes can be temporarily stored for a maximum of 90 calendar days from the accumulation start date for a large quantity generator or a maximum of 180 calendar days from the accumulation start date for a small quantity generator. Wastes classified as nonhazardous may be handled and disposed of as nonhazardous waste and are not subject to storage time limitations.

This is TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling and packaging hazardous waste and performing hazardous waste characterizations must have RCRA hazardous waste management training per 40 CFR § 264.16.

Although not common practice, in certain situations Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator. Arcadis personnel who sign waste profiles and/or waste manifests will have both current RCRA hazardous waste management training per 40 CFR § 264.16 and current DOT hazardous materials transportation training per 49 CFR § 172.704. Arcadis field personnel will also comply with client-specific training. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

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4 EQUIPMENT LIST

The Following Materials, as required, will be available for IDW handling and Storage:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan (HASP)
- DOT approved containers
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Portable tank container
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook

5 CAUTIONS

Filled drums can be very heavy, become unbalanced, or spill its contents. Therefore, use appropriate moving techniques and equipment for safe handling. Similar media (e.g. soils with other soils; or liquids with other liquids) will be stored in the same drums to aid in sample analysis and disposal. Drum lids must be secured to prevent rainwater from entering the drums and leakage during movement. Drums containing solid material may not contain any free liquids. Waste containers stored for extended periods of time may be subject to deterioration. Drum Over Packs may be used as secondary containment. All drums must be visually inspected for condition to ensure that they are in good condition without visible evidence of rusting, holes, breakage, etc., to prevent potential leakage and facilitate subsequent disposal. All drum lids must be verified as having a properly functioning secured lid prior to use.

6 HEALTH AND SAFETY CONSIDERATIONS

Click here and enter text] As determined by the site's known and suspected hazards, appropriate PPE must be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as required in the Site Health and Safety Plan. If soil excavation in areas with potentially hazardous contaminants is possible, contingency plans will be developed to address the potential for encountering gross contamination or non-aqueous phase liquids. All excavation

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activities shall be in compliance with OSHA standard 29 CFR 1926.651 Excavations, and any other applicable regulations.

Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

7 PROCEDURE

Specific waste temporary storage and handling procedures to be used are dependent upon the type of generated waste, including type of media (e.g. soils or free liquids) and constituents of concern. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, where solids can be stockpiled onsite (if nonhazardous) and purge water may be stored in portable tank containers. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the project team during all phases of the project. Site managers may want to consider techniques such as replacing solvent based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be properly decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that minimize the generation of waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring.

Drum Storage

Drums containing hazardous waste will be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized onsite location that is readily accessible for vehicular pick-up. Drums confirmed as, or assumed to contain hazardous waste will be stored over an impervious surface provided with secondary spill containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific or local-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate

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greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Conditionally exempt small quantity generators (CESQG) are generators who generate less than 100 kilograms of hazardous waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator's state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 calendar days or less without a permit and without having interim status, provided that such accumulation is in compliance with requirements in 40 CFR § 262.34. A SQG may accumulate hazardous waste on site for 180 calendar days or less without a permit or without having interim status, subject to the requirements of 40 CFR § 262.34(d). CESQG requirements are found in 40 CFR § 261.5. NOTE: The CESQG and SQG provisions of 40 CFR § 261.5, 262.20(e), 262.42(b) and 262.44 may not be recognized by some states (e.g., California and Rhode Island). State-specific and local-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste Satellite accumulation (SAA) will mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.34(a) and without any storage time limit, provided that the generator complies with 40 CFR § 262.34(c)(1)(i).

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable Hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste must be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste) per 40 CFR § 265.176.
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (e.g., polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or "Testing in Progress" label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Pending Analysis, Hazardous, or Nonhazardous)
- Waste generator's name (e.g., client name)
- Project Name
- Name and telephone number of Arcadis project manager

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- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date
- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a “Waste Container” or “Pending Analysis” label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied.

- Containers with waste determined to be non-hazardous will be labeled with a green and white "Nonhazardous Waste" label over the "Waste Container" label.
- Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label.

The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition, a DOT proper shipping name will be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g., Boring-1, Test Pit 3, etc.) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health outside of the site or when Client or ARCADIS has knowledge of a spill that has reached surface water, Client or ARCADIS must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.34. Other notifications to state and/or other local regulatory agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may

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be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

Excavated Solids

Excavated solids may include, but are not limited to: soil, fill, and construction and demolition debris. Prior to permitted treatment or offsite disposal, potentially hazardous excavated solids may be temporarily stockpiled onsite as long as the stockpile remains in the same AOC from where it was excavated. Potentially hazardous excavated solids removed from the AOC must be immediately containerized in labeled drums or closable top roll-offs lined with 9-mil polyvinyl chloride (PVC) sheeting and are subject to LQG storage time limits. Nonhazardous excavated solids can be stockpiled either inside or outside of the AOC, do not have to be containerized and are not subject to hazardous waste regulations. Potentially hazardous excavated solids must not be mixed with nonhazardous excavated solids. All classes of excavated solid stockpiles should be maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (USEPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner or sprayed dust control product. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in closed head drums compatible with the decontamination solution. Decontamination procedures, including personnel and field sampling equipment, must comply with applicable Arcadis procedural documents.

Disposable Equipment

Disposable equipment includes personal protective equipment (e.g., tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, contaminated disposable equipment will also be disposed of as a hazardous waste. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If these materials are not compatible (i.e., the IDW is a liquid and the disposal equipment is a solid), the disposable equipment will be stored onsite in separate labeled 55-gallon drums. Uncontaminated or decontaminated disposable equipment can be considered nonhazardous waste.

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Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert plastic materials. The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are described in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any visible sediment and water before returning, a professional cleaning service may be required. Each specific vendor should be consulted concerning specific requirements for returning tanks.
- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

8 WASTE MANAGEMENT

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and local/state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific applicable regulatory agency thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered “listed” hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 10 cubic yard basis for stockpiled soil or one per 55-gallon drum for containerized. A four-point composite sample will be collected per 10 cubic yards of stockpiled material and for each drum. Sample and composite frequencies may be adjusted in accordance with the waste handling facility’s requirements. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls (PCBs), as well as reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional

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sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches.

Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and local/state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility. Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- and/or local-specific regulations may require different or additional sampling approaches.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with current Arcadis sample chain of custody, handling, packing, and shipping procedures and guidance instructions.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

Preparing Waste Shipment Documentation (Hazardous and Nonhazardous)

Waste profiles will be prepared by the Arcadis CPM and forwarded, along with laboratory analytical data to the Client for approval/signature. The Client will then return the profile to Arcadis who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by Arcadis prior to forwarding to the Client for approval. Upon approval of the manifest, the Client will return the original signed manifest directly to the waste contractor or to the Arcadis CPM for forwarding to the waste contractor. Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator.

Final drum labeling and pickup will be supervised by an Arcadis representative who is trained and experienced with applicable waste labeling procedures. The Arcadis representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums. A copy of the Arcadis drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

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9 DATA RECORDING AND MANAGEMENT

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan or Sampling and Analysis Plan. Copies of the chain-of-custody forms will be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

10 QUALITY ASSURANCE

The CPM or APM will review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to: the proposal/scope of work, QAPP, SAP, HASP, etc. Deficiencies will be noted, tracked, and resolved. Upon correction, they will be noted for project documentation.

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.

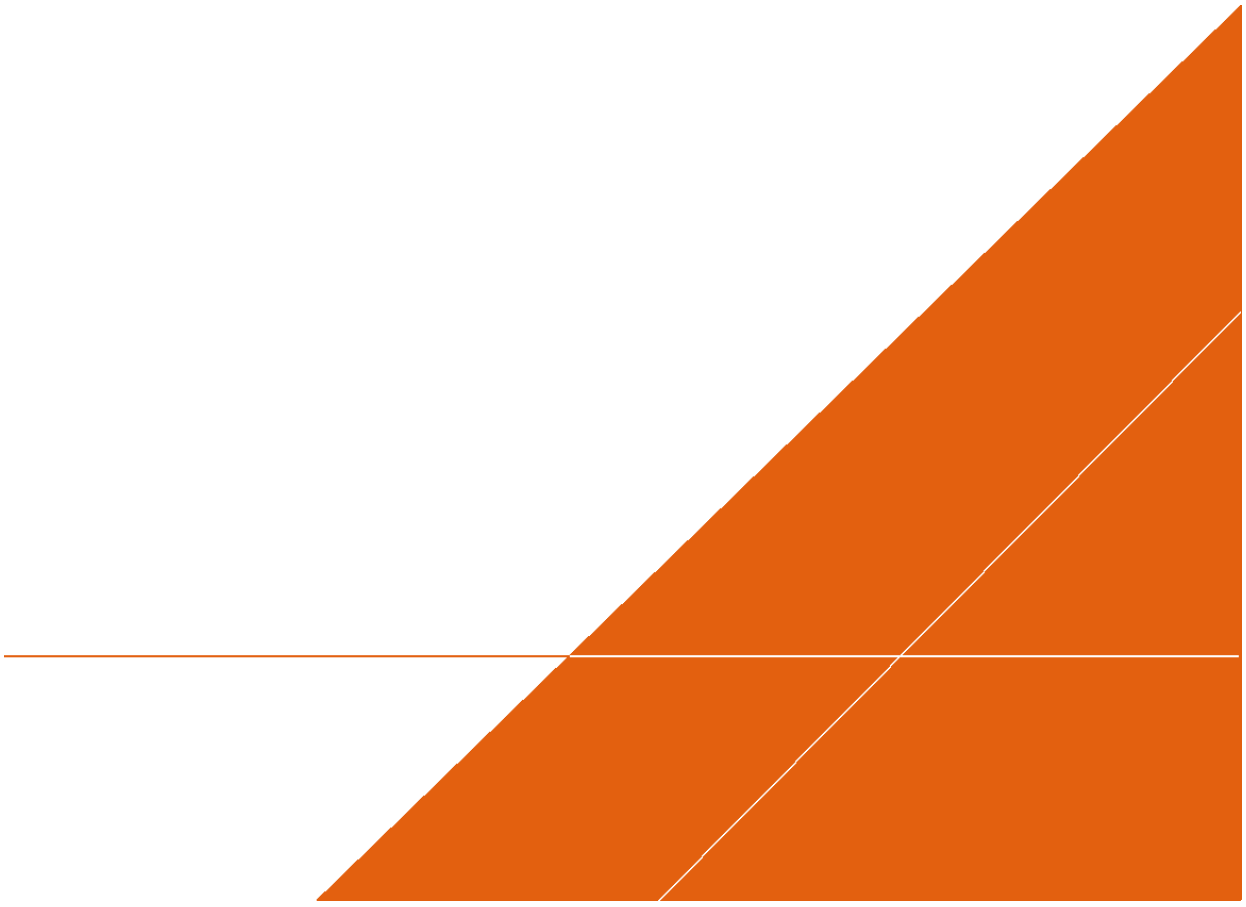
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SOP – FISH SAMPLING PROCEDURE

Rev: 1

Rev Date: June 2, 2021



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VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 8, 2021			David Rigg
1	June 2, 2021	5, 10	Text revisions	David Rigg

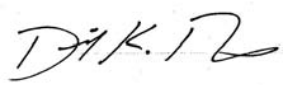
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APPROVAL SIGNATURES

Prepared by:  06/02/2021

Nick Firman, Environmental Scientist

Technical Expert Reviewed by:  06/02/2021

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1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

The following procedures describe the general methodologies that will be used in the field to collect fish for tissue analysis.

3 PRE-COLLECTION

Staff assigned the responsibility of collecting fish will be provided with the following information:

- Work documents (field sampling plan, health and safety plan, etc.);
- Water body name and site maps;
- Number and size of each species to be collected;
- Collection and sample processing procedures;
- Special instructions (if any);

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- Appropriate fisheries office contact; and
- Sampling permits and licenses.

4 EQUIPMENT

The following collection equipment and materials will be available, as required, during fish sampling:

- Personal protective equipment (as required by the health and safety plan);
- Boat equipment;
- Electrofishing equipment;
- Dip nets with non-conductive handles;
- Non-conductive gloves and boots;
- Chest or hip waders;
- Polarized sunglasses;
- Fish nets or traps;
- Angling tackle and bait;
- Chest or hip waders;
- Live well, cooler, or 5-gallon bucket;
- Measuring board or ruler;
- Top-loading electronic and suspended-weight spring balances;
- Insulated coolers with ice;
- Aluminum foil;
- Plastic sealable bags and indelible ink markers;
- Camera;
- Chain-of-custody (COC) forms and/or field tablet;
- Global positioning system (GPS); and
- Field notebook.

5 FIELD NOTES

Field notes will be recorded during sampling activities, and at a minimum, will include the following:

- Names of field crew and oversight personnel;
- General weather conditions;
- Date, time, and capture location/area (GPS if specified);
- Capture technique;
- Sample duration;

General observations of fish habitat, abundance, and diversity; and

- Sample reach approximate length and/or area;
- Site photographs

6 COLLECTION PROCEDURES

Fish will be collected using trained personnel and approved sampling techniques. State personnel (conservation officers) will be notified of the sampling activities prior to going into the field per the permit requirements. Only those target species identified in the work plan and scientific collectors permit will be retained. Collection of other species may occur when target species are absent, and as approved. Non-target species will be released back to the system. Fish sampling will begin at the central portion of the proposed sampling location, and will be conducted outward until the target number of fish have been collected, and the approximate length/area of the sampling reach will be recorded in the field notes.

The following procedures will be used, as necessary, to collect fish:

6.1 Electrofishing

This section describes the procedures associated with the use of boat-mounted, barge-mounted, and backpack electrofishing units. Electrofishing activities will be temporarily halted when any unauthorized persons, pets, or livestock are observed in the water or on the shore in close proximity to the electrofishing unit.

6.1.1 Boat-Mounted Electrofishing

The following procedures describe the use of an electrofishing boat to collect fish:

1. The field crew will don personal protective equipment (life jackets, non-conductive shoes and gloves, etc.), set up the electrofishing equipment, and test it upon arrival at the site.
2. The boat operator will be responsible for control of the boat, and operation of the control equipment and generator. The remaining field crew will operate from the front of the boat and will be responsible for control of the on-off floorboard switch, and capturing the fish.
3. Electricity will be applied to the water by actively maintaining the on-off switch in the closed position while the generator and control equipment are operative.
4. The electrical current will be set to stun the fish, but should not cause mortality.
5. Target species of appropriate size will be collected using non-conductive dip-nets and will be placed in a live-well with fresh water until they can be transferred to a cooler with ice.

6.1.2 Barge-Mounted Electrofishing

The following procedures describe the use of a barge-mounted electrofishing unit to collect fish:

1. The field crew will don personal protective equipment (life jackets, non-conductive waders and gloves, etc.), set up the electrofishing equipment, and test it upon arrival at the site.

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2. The barge operator will be responsible for pushing the barge (six-foot in length), and operation of the control equipment and generator. The remaining field crew will walk in front of the barge with anodes and will be responsible for control of the on-off switch on the anode handles, and capturing the fish.
3. Electricity will be applied to the water by actively maintaining the on-off switch in the closed position while the generator and control equipment are operative.
4. The electrical current will be set to stun the fish, but should not cause mortality.
5. Target species of appropriate size will be collected using non-conductive dip-nets and will be placed in a cooler with fresh water until they can be transferred to a cooler with ice.

6.1.3 Backpack Electrofishing

The following procedures describe the use of a backpack electrofishing unit to collect fish:

1. The field crew will don personal protective equipment (non-conductive waders and gloves, etc.), set up the electrofishing equipment, and test it upon arrival at the site.
2. The backpack operator will be responsible for control of the on-off switch on the **anode** handle, operation of the control equipment, and for capturing fish. The remaining field crew will work alongside the backpack operator and will capture fish.
3. Electricity will be applied to the water by actively maintaining the on-off switch in the closed position while the control equipment is operative.
4. The electrical current will be set to stun the fish, but should not cause mortality.
5. Target species of appropriate size will be collected using non-conductive dip-nets and will be placed in a 5-gallon bucket with fresh-water until they can be transferred to a cooler with ice.
6. Backpack electrofishing batteries will be recharged as needed.

6.2 Fish Nets and Traps

This section describes the procedures for using fish nets (gill nets and seines) and traps (trap nets, minnow traps, and eel pots) to collect fish.

6.2.1 Gill Nets

The following procedures describe the use of gill nets to collect fish:

1. The field crew will ready the appropriate sized gill nets (length, depth, and mesh size) for site conditions prior to field sampling.
2. In large water bodies, the boat operator will be responsible for selecting the locations to place the gill nets, and for control of the boat. The remaining crew will be responsible for setting the buoys, and anchoring, playing out, and retrieving the gill nets.
3. In small water bodies, where boat use is impractical, one crew member will be responsible for tossing a lead line that is attached to the gill net across the water body. Another crew member will retrieve the lead line and pull the gill net into position.

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4. Gill nets will be placed within or adjacent to aquatic habitats that contain the target fish species desired for collection, and will be set to intercept moving fish.
5. Gill nets will be checked a minimum of once per 24-hour period.
6. Target species of appropriate size will be removed from the gill nets and will be placed into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

6.2.2 Seines

The following procedures describe the use of seines to collect fish:

1. The field crew will ready the appropriate sized seines (length, depth, and mesh size) for site conditions prior to field sampling.
2. In large water bodies, one crew member will hold the end of a large seine secure at the shoreline. The other crew member will pull the seine away from shore in a semi-circle pattern, reconnecting with the shoreline a distance away. Both crew members will haul the net in, keeping the bottom of the seine in contact with the substrate and the top of the seine above the water, to collect fish.
3. In small water bodies, two crew members will use a small seine to guide fish to the shoreline or to scoop them up. When moving through the water, the bottom of the seine should remain in contact with the substrate.
4. Target species of appropriate size will be removed from the seines and will be placed into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

6.2.3 Trap Nets

The following procedures describe the use of trap nets to collect fish:

1. The field crew will ready the appropriate sized trap nets (hoop diameter and mesh size) for site conditions prior to field sampling. An assortment of lead-net and wing-net panels will be available to meet site-specific demands.
2. In large water bodies, the boat operator will be responsible for selecting the locations to place the trap nets, and for control of the boat. The remaining crew will be responsible for setting the buoys, and anchoring, playing out, and retrieving the trap nets.
3. In small water bodies, where boat use is impractical, one crew member will be responsible for tossing a lead line that is attached to the trap net across the water body. Another crew member will retrieve the lead line and pull the trap net into position.
4. Trap nets will be placed within or adjacent to aquatic habitats that contain the target fish species desired for collection, and will be set to intercept moving fish.
5. Trap nets will be checked a minimum of once per 24-hour period.
6. Target species of appropriate size will be removed from the trap nets and will be placed into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

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6.2.4 Minnow Traps

The following procedures describe the use of minnow traps to collect small fish:

1. The field crew will ready the minnow traps prior to field sampling.
2. In large water bodies, the boat operator will be responsible for selecting the locations to place the minnow traps, and for control of the boat. The remaining crew will be responsible for setting the buoys, and baiting, anchoring, and retrieving the minnow traps.
3. Without a boat, minnow traps will be baited, tethered, and set just off the shoreline.
4. Minnow traps will be placed within or adjacent to aquatic habitats that contain the target fish species desired for collection.
5. Minnow traps will be checked a minimum of once per 24-hour period.
6. Target species of appropriate size will be removed from the minnow traps and will be placed into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

6.3 Angling Techniques

This section describes the procedures used to collect fish by angling (rod-and-reel) and trotline techniques (multiple hooks on an anchored line).

6.3.1 Rod-and-Reel

The following procedures describe the use of rods-and-reels to collect fish:

1. The field crew will ready the rods-and-reels and tackle (hooks, line, bait, and artificial lures) prior to field sampling.
2. Baited hooks or artificial lures will be cast into aquatic habitats that contain the target fish species desired for collection
3. Target species of appropriate size will be retained and will be placed on a stringer, in a live-well, or into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

6.4 Trotlines

The following procedures describe the use of trotlines to collect fish:

1. The field crew will ready the trotlines and clip-on hooks prior to field sampling.
2. In large water bodies, the boat operator will be responsible for selecting the locations to place the trotlines, and for control of the boat. The remaining crew will be responsible for setting the buoys, and anchoring, baiting, playing out, and retrieving the trotlines.

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3. In small water bodies, where boat use is impractical, one crew member will be responsible for tossing a lead line that is attached to the trotline across the water body. Another crew member will retrieve the lead line and pull the trotline into position.
4. Trotlines will be placed within or adjacent to aquatic habitats that contain the target fish species desired for collection, and will be set to intercept moving fish.
5. Trotlines will be checked a minimum of once per 24-hour period.
6. Target species of appropriate size will be removed from the trotlines and will be placed into sealable plastic bags, and then into a cooler with ice. Non-target species will be counted and noted in the field notebook.

7 SAMPLE HANDLING

The following identifies the temporary storage procedures that will be used to preserve fish in the field prior to sample processing, handling, and shipment to the laboratory:

1. Measure or weigh each fish after collection, as necessary, to ensure that appropriate sized fish are taken and that minimum sample mass requirements are satisfied.
2. Count the number of fish to ensure that the correct amount is taken.
3. Transfer fish to aluminum foil to be wrapped and then placed in a sealable plastic bags (if not done previously) and label with sampling date and capture location, and place in coolers with ice until field processing can occur. Large fish that do not fit into plastic bags may be placed on ice in clean coolers that are clearly labeled.
4. Initiate COC procedures.

8 SPECIAL CONSIDERATIONS FOR PFAS SAMPLING

The detection of PFAS compounds at very low concentrations can be influenced by common PFAS-containing materials that may be present during sampling. Therefore, sampling protocols are to be strictly followed by the sampling personnel. To minimize the potential for cross-contamination, attention will be given to sampling materials, decontamination procedures, as well as clothing and personal care products used by sampling personnel. Some examples of products to avoid and that are acceptable are provided below.

Products to Avoid

- Materials containing polytetrafluorethylene (PTFE or Teflon), polyvinylidene fluoride (PVDF), polyvinyl fluoride (PVF), fluorinated ethylene propylene (FEP) and perfluoropolyether (PFPE)
- Clothing or boots containing Gore-Tex
- Clothing washed with fabric softener containing PFAS
- PFAS chemically treated clothing or insect/stain resistance and ultraviolet (UV) protection
- Personal care products (cosmetics, shampoo, sunscreens, dental floss, etc.) containing PFAS
- PFAS treated paper towel
- Plastic clipboards or notebooks made with PFAS treated paper

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- Pre-wrapped food or snacks, carry-out food, fast food

Note: When staff requires a break to eat, they should remove their gloves and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves before returning to the sampling area.

Materials That are Acceptable

- Life jackets made of polyethylene foam and nylon shell fabric
- Natural rubber (electrofishing lineman's gloves)
- PFAS free dip-nets and seines, gill nets, trap nets and/or trotlines
- High density polyethylene (HDPE) or polypropylene (PP) coolers and buckets
- Waders made of polyvinyl chloride (PVC) or neoprene
- Synthetic and natural fibers (preferably cotton)
- Any boots made of polyurethane and PVC
- Well-laundered clothes without fabric softener from time of purchase
- Powderless nitrile gloves
- Untreated wooden measuring board or stainless-steel meter stick
- Stainless steel processing table, tray, electronic balance boat, and/or fillet knife
- Alconox, Liquinox, or Citranox
- Polypropylene scrub brush
- PFAS-free DI water
- Low-density polyethylene (LDPE) plastic freezer bags (Ziploc) and aluminum foil
- Ballpoint pen, pencil or fine-point Sharpie marker
- Rite in the Rain notebooks
- Aluminum or Masonite clipboard with loose paper (non-waterproof, non-recycled)
- Bottled water and hydration drinks (Gatorade)
- Sunscreen (Banana Boat, Coppertone, Neutrogena), OFF Deep Woods, Sawyer

Permethrin Items That May Need Screening

- Municipal potable water (if used to rinse fish or cleaning)
- Aluminum foil
- Any special gloves required by a HASP (electrofishing lineman's gloves)

Powderless nitrile gloves should frequently be changed any time there is an opportunity for cross-contamination of the sampling including, but not limited to, the following activities:

- Each time sampling equipment is handled.
- Prior to sample collection.

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- After handling any sample, including QA/QC samples such as field reagent blanks or equipment rinse blanks.
- After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.
- During and after decontamination of non-dedicated sampling equipment.

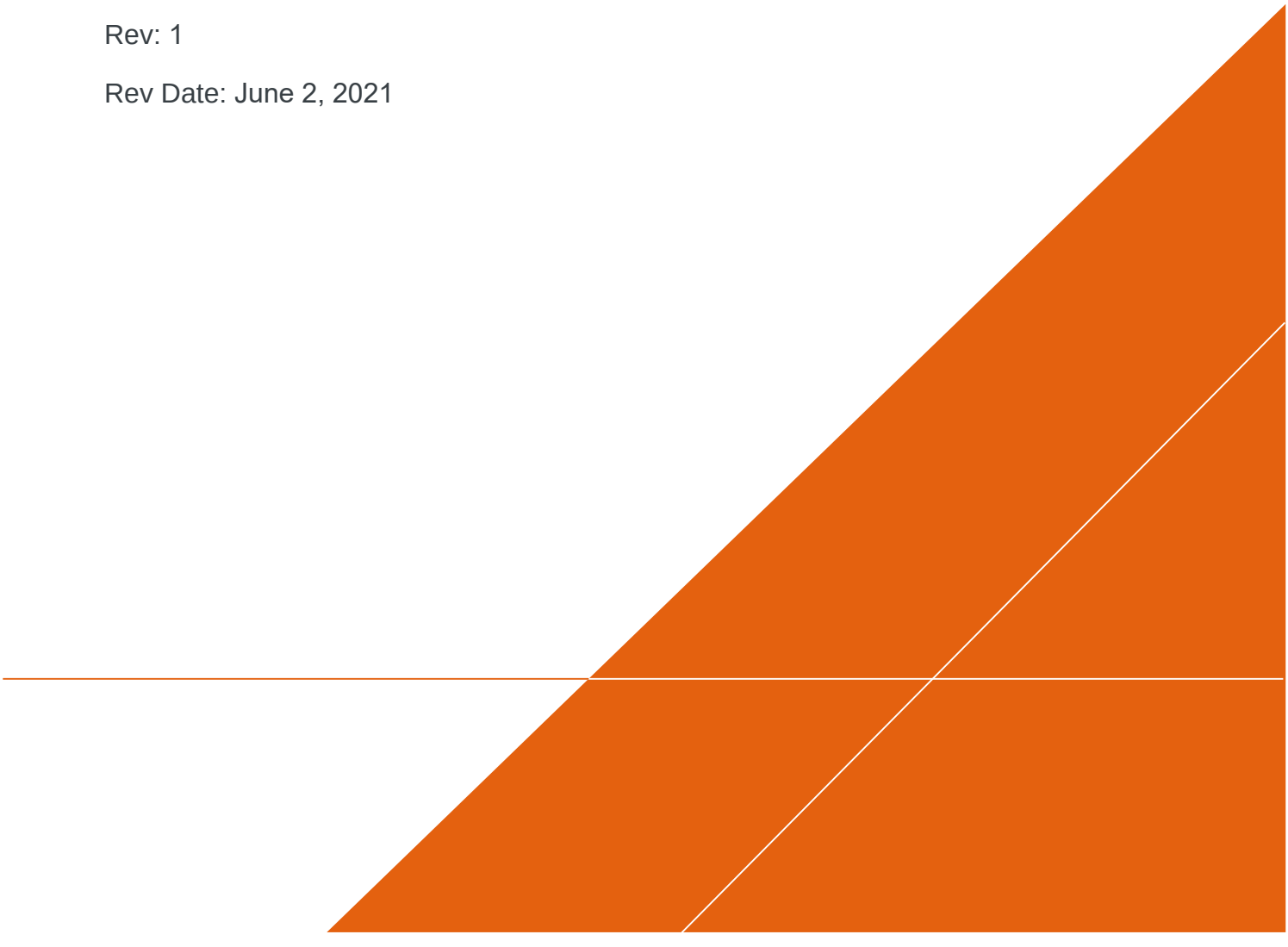
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SOP # P-18

TGI – FIELD PROCESSING FOR FISH SAMPLES PROCEDURES

Rev: 1

Rev Date: June 2, 2021



VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
1	June 2, 2021	4	Text Revision	David Rigg

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SOP P-18

APPROVAL SIGNATURES

Prepared by:

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Date:

Technical Expert Reviewed by:

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Date:

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SOP P-18

1 INTRODUCTION

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2 SCOPE AND APPLICATION

The following procedures describe the general methodologies that will be used in the field to process, handle, pack, and ship fish tissue samples to the laboratory for tissue preparation and chemical analysis for PFAS.

3 EQUIPMENT

The following equipment and materials will be available, as required, to process whole fish samples:

- Work documents (e.g., field sampling plan, health and safety plan);
- Measuring board or ruler;
- Top-loading electronic and suspended-weight spring balances;
- Forceps or knife;

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- Storage envelopes and glass vials;
- Heavy duty aluminum foil and freezer paper;
- Tape (e.g., duct, strapping, masking or freezer, and clear packing);
- Sealable plastic bags and indelible ink markers;
- Cleaning and decontamination materials;
- Potable water;
- Insulated coolers with ice;
- Forms (e.g., chain-of-custody, custody seal, address label, and air-bill);
- Camera; and
- Field notebook.

4 FIELD NOTES

Field notes will be recorded during processing of fish samples, and at a minimum, will include the following:

- Names of field processing crew and oversight personnel;
- Date and time of processing;
- Sample identification numbers that correspond to fish species, sampling date, and collection location;
- Body lengths and/or weights, and number of organisms per sample;
- Gross external abnormalities and visible parasites;
- Bony structures collected for aging (where applicable); and
- Photographs (if necessary).

5 PROCESSING, HANDLING, PACKING, AND SHIPPING

The following identifies the procedures that will be used to process, handle, pack, and ship fish samples:

5.1 Processing

1. All samples will be given a unique sample identification number that will be recorded in the field notebook, and that corresponds to the fish species, sampling date, and collection location.
2. Chain-of-custody forms, custody seals, address labels, and air-bill forms will be completed. Chain-of-custody forms will identify the tissue sample preparation procedure and chemical analysis. A copy of the completed chain-of-custody form and air-bill form will be retained by the sampler.
3. To begin processing, sediments, soil, and other debris will be removed from the fish, as needed, by hand-picking or by rinsing with potable water.

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4. Fish will be measured and/or weighed following project-specific requirements, but will generally include total length and weight measurements of each individual in a sample.
5. Individual and composite fish samples will have sufficient sample mass, as possible, to meet the minimum sample mass requirements for chemical analysis.
6. Photographs will be taken, as required, and any external abnormalities or visible parasites will be noted in the field notebook.
7. Hard body parts (scales, spines and/or otoliths) will be removed from fish, as needed, if it does not compromise the integrity of the sample. If sample integrity is compromised, the laboratory may instead be asked to remove the bony structure. The structure will be archived for possible aging at a later date.
8. Fish samples will be wrapped in heavy-duty aluminum foil (shiny side out) or placed in a sealable plastic bag and then wrapped in freezer paper and secured with masking/freezer tape to maintain sample integrity. The sample identification number will be written on each package with a waterproof marker.
9. Samples will be placed into large sealable plastic bags in preparation for packing.
10. All equipment will be cleaned with a laboratory grade detergent and a potable water rinse as required or immediately following processing.

5.2 Handling

1. Specify in the field notebook and on the chain-of-custody form the tissue sample preparation procedure (e.g., skin-on/scales-off fillets, whole body grinding) and chemical analysis (e.g., PFAS) the laboratory will follow.
2. Designate sampling personnel responsible for sample custody. Note: If the designated sampling person relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the chain-of-custody form to document the sample custody transfer.

5.3 Packing

1. Coolers used for transport will be duct-taped at the drain plug on the outside and inside of the cooler.
2. Ice will be packaged in sealable plastic bags (double-bagged with the outer seal duct-taped) and placed in the bottom of the cooler. The sealed fish samples will be placed inside the cooler with enough room for additional ice bags to be placed on top.
3. The completed chain-of-custody form will be placed into a plastic bag and duct-taped to the inside of the cooler lid.
4. The cooler will be closed and fastened with duct tape around the seam of the lid to prevent water leakage and with strapping or duct tape around the entire cooler to prevent it from opening during transport.

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5. A completed custody seal will be placed across the seam of the cooler lid. A completed address label will be placed on top of the cooler. Both will be taped-over using clear packing tape.

5.4 Shipping

1. Samples with holding time requirements will be shipped to the laboratory by hand or by express carrier within the specified timeframe. The signed and dated chain-of-custody forms should be included in the cooler. The express carrier will not be required to sign the chain- of-custody forms. The sampler should retain the express carrier receipt or bill of lading.
2. The laboratory will be notified of the shipment and will be contacted following the arrival date to ensure that delivery has occurred. When the samples are received by the laboratory, the laboratory personnel shall complete the chain-of- custody forms by recording receipt of samples, and then check the sample identification numbers on the containers against the chain-of-custody forms.

5.5 Special Considerations for PFAS Sampling

The detection of PFAS compounds at very low concentrations can be influenced by common PFAS-containing materials that may be present during sample processing. Therefore, sample processing protocols are to be strictly followed by the sampling personnel. To minimize the potential for cross-contamination, attention will be given to sampling materials, decontamination procedures, as well as clothing and personal care products used by sampling personnel. Some examples of products to avoid and that are acceptable are provided below.

Products to Avoid

- Materials containing polytetrafluorethylene (PTFE or Teflon), polyvinylidene fluoride (PVDF), polyvinyl fluoride (PVF), fluorinated ethylene propylene (FEP) and perfluoropolyether (PFPE)
- Clothing or boots containing Gore-Tex
- Clothing washed with fabric softener containing PFAS
- PFAS chemically treated clothing or insect/stain resistance and ultraviolet (UV) protection
- Personal care products (cosmetics, shampoo, sunscreens, dental floss, etc.) containing PFAS
- PFAS treated paper towel
- Plastic clipboards or notebooks made with PFAS treated paper
- Pre-wrapped food or snacks, carry-out food, fast food

Note: When staff requires a break to eat, they should remove their gloves and move to the designated area for food and beverage consumption. When finished, staff should wash their hands and put on a fresh pair of powderless nitrile gloves before returning to the sample processing area.

Materials That are Acceptable

- High density polyethylene (HDPE) or polypropylene (PP) coolers and buckets

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- Synthetic and natural fibers (preferably cotton)
- Any boots made of polyurethane and PVC
- Well-laundered clothes without fabric softener from time of purchase
- Powderless nitrile gloves
- Untreated wooden measuring board or stainless-steel meter stick
- Stainless steel processing table, tray, electronic balance boat, and/or fillet knife
- Alconox, Liquinox, or Citranox
- Polypropylene scrub brush
- PFAS-free DI water
- Low-density polyethylene (LDPE) plastic freezer bags (Ziploc) and aluminum foil
- Ballpoint pen, pencil or fine-point Sharpie marker
- Rite in the Rain notebooks
- Aluminum or Masonite clipboard with loose paper (non-waterproof, non-recycled)
- Bottled water and hydration drinks (Gatorade)
- Sunscreen (Banana Boat, Coppertone, Neutrogena), OFF Deep Woods, Sawyer Permethrin

Items That May Need Screening

- Municipal potable water (if used to rinse fish or cleaning)
- Aluminum foil

Powderless nitrile gloves should frequently be changed any time there is an opportunity for cross-contamination of the sampling including, but not limited to, the following activities:

- After handling any sample, including QA/QC samples such as field reagent blanks or equipment rinse blanks.
- After the handling of any non-dedicated sampling equipment, contact with non-decontaminated surfaces, or when judged necessary by field personnel.
- During and after decontamination of non-dedicated sampling equipment.

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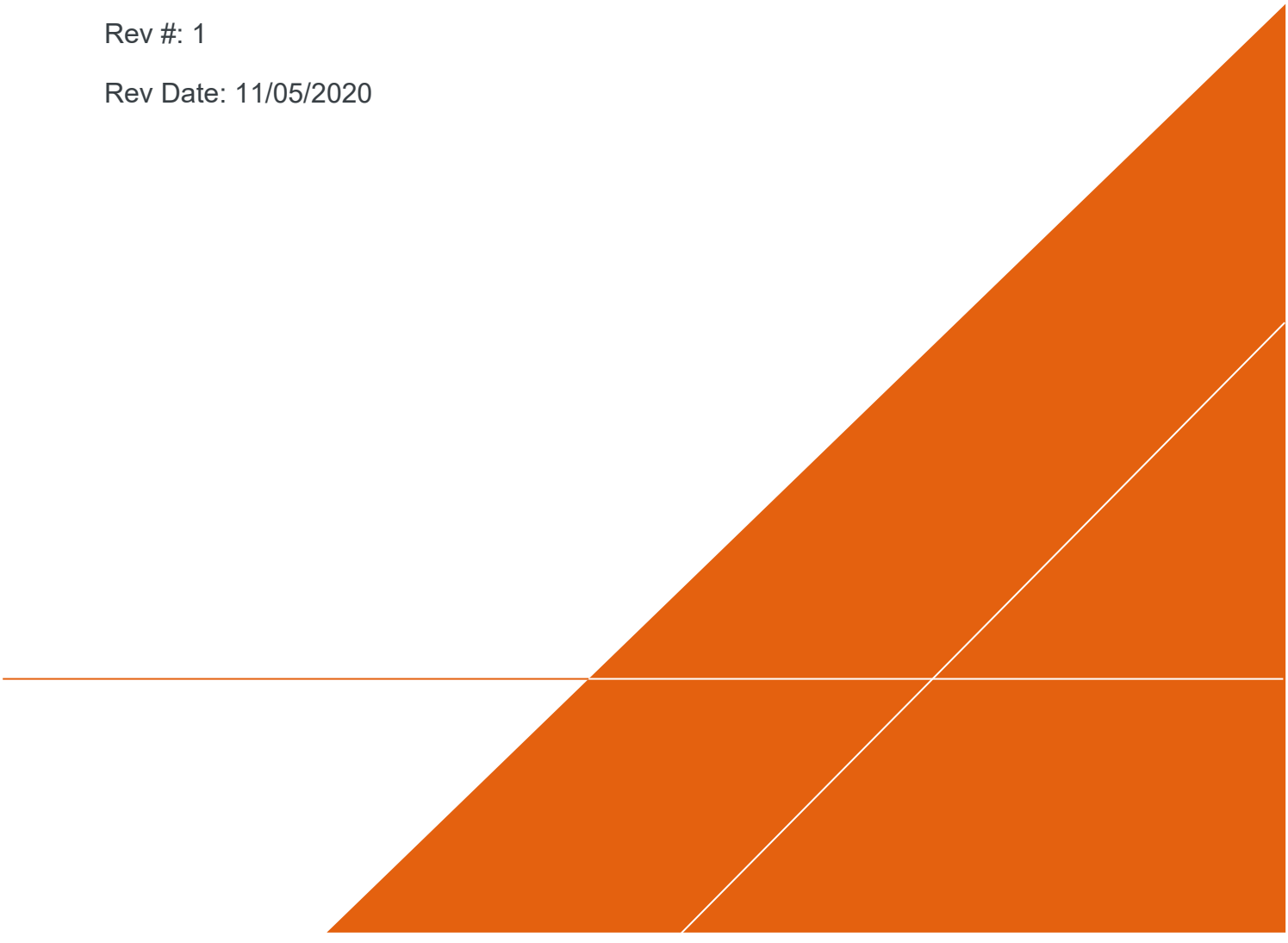
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SOP # P-19

MINI-PIEZOMETER INSTALLATION AND PFAS POREWATER SAMPLING

Rev #: 1

Rev Date: 11/05/2020



SOP # P-19

APPROVAL SIGNATURES

Prepared by:		11/05/2020
	Amar Wadhawan (Senior Engineer)	Date:
Technical Expert Reviewed by:		11/05/2020
	Shannon Dunn (Technical Expert)	Date:

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SOP # P-19

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2 SCOPE AND APPLICATION

A Mini-piezometer will be installed into the sediments in the near shore area of the Site, and a pressure transducer will be installed inside the piezometer. The purpose of a mini-piezometer is to hold the water level around the pressure transducer and provide accurate groundwater-level readings, as well as allow for collection of porewater.

3 EQUIPMENT LIST

- ¾-inch inner diameter Solinst 615N stainless-steel screen point with 6-inch screened section;
- 5-ft long ¾-in ID galvanized pipe (drinking water grade);
- Additional pipe galvanized sections, as needed;
- galvanized pipe couplings;
- 1-inch-diameter drill bit;
- drill;
- threaded pipe end cap;

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SOP # P-19

- **PFAS-free pipe joint sealant;**
- Water level probe;
- dual-channel pressure transducer and temperature probe; and
- bailer**.**

4 PROCEDURE

Mini-Piezometer Construction:

1. Field-verify the location of the mini-piezometer. For a groundwater-surface water investigation, the mini-piezometer will be co-located with a stilling well. The water depth should adequately cover the transducer as it hangs in the mini-piezometer to minimize the risk of the water level falling below the bottom of the transducer. The mini-piezometer should be accessible so that the transducer can be accessed for data downloads.
2. Assemble the mini-piezometer prior to entering the surface water body.
3. Decon all materials prior to assembly with Alconox and DI water. Use pipe cleaner for pipe sections.
4. Attach pipe to top of screen point utilizing the PFAS free joint sealant (do not put a shorter section directly above screen, since the additional coupling will hurt the seal).
5. Attach additional pipe sections utilizing the pipe couplings and the sealant for piezometer top to rise about 2 feet above water surface;.
6. Drill a 1-inch hole in the end cap through which the transducer will be fed.
7. Mark each assembled piezometer 2 feet above top of screen (~3.5 feet above point) using electrical tape. (This is the reference point for driving the piezometer. When finished, tape should mark should level with streambed.)

Mini-Piezometer Installation and Development:

1. Use a boat or barge or wade to access the location and lift the mini-piezometer into place. Lower it to within 3 inches of the sediment surface.
2. Temporary mini-piezometers will be installed at least one day prior to porewater sampling.
3. At each location
    - Verify location in stream as flagged during reconnaissance. Measure off distance from bank noted on flagging.
    - Install mini-piezometer to 2.5 feet below the sediment surface, referencing the tape mark on standpipe.
        - Push manually or gently tap with post-pounder
        - Avoid wrenching or twisting the pipe.
    - If location will not advance to depth (e.g., hits a cobble)
        - Remove mini-piezometer

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- Inspect screen point for damage.
- Select new location within 5-10 feet directly upstream or downstream and reattempt

- Clearly write the location ID on the piezometer side in permanent marker.

4. Collect coordinates of each piezometer location after installation using a field tablet or cell phone. Document the coordinates in the field notes from that day.
5. Develop the mini-piezometer per the following steps:
   - Measure and record
     - Depth to water inside piezometer (groundwater level) from top of pipe
     - Depth to water outside piezometer (to surface water) from top of pipe
     - Stream depth adjacent to piezometer (from streambed to water surface)
   - Use ½-inch diameter disposable bailer to purge the well point of approximately 3 volumes (about 0.3 gal / 1.2 L / 12 full bailers)
   - Bail slowly to avoid drawing sediment into well and limit drawdown. Note if water is recharging quickly.
   - In notes, record if water is visibly turbid and if water clears up.
   - Repeat measurements inside/outside piezometer
   - Close the mini-piezometer with screw top cap
   - If location does not recharge and/or water-level inside piezometer is not higher than surface water, call task manager to discuss
6. Using a water-level probe, determine the water level in mini-piezometer and record in the field notebook. Secure the end cap on the top of the mini-piezometer. Feed the dual-channel probe through the hole in the end cap, measuring the length of cable as it is let out. Hang the transducer at least 1 foot below the water level. The probe should hang sufficiently below the water level so that the water level does not fall below the probe during the period of data collection.
7. Once the probe is in place, secure the probe cable to the end cap and to a second location on piezometer. All water levels measured are relative to the installation height of the probe. Any vertical movement of the probe will invalidate the data collected.
8. Following the manufacturer's instructions, connect the probe to the computer housing the data collection software. Record the initial depth reading from the probe. This depth reading, along with the initial measured water level, will be used as the baseline to calibrate the probe to all future data collection. Steps 6 through 8 should be completed in rapid sequence in order to calculate the correct baseline. To verify the calculation, take a second surface-water level reading off the side of the dock.
9. Once the probe baseline depth has been verified, set the collection intervals and period of data collection using the probe software and start the probe datalogger. Disconnect the probe from the computer.
10. Return to the probe, as necessary, to download data.

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11. Define a measuring point at the top of the mini-piezometer and have that measuring point surveyed. The elevation of the mini-piezometer will be necessary to convert the pressure transducer water depth measurements to groundwater elevations.

Porewater Sampling:

1. Piezometers will be sampled from the furthest downstream location first and working upstream.
2. Check that piezometer has not been disturbed:
   - Cap is in place
   - Piezometer is not bent-over or loose
3. Un-cap piezometer and allow to equilibrate
4. Measure and record:
   - Depth to water inside piezometer (groundwater level) from top of pipe
   - Depth to water outside piezometer (to surface water) from top of pipe
   - Stream depth adjacent to piezometer (from streambed to water surface)
5. Collect porewater sample using a dedicated bailer
   - No pre-purging is required.
   - Deploy bailer gently, purging from top of water column until sufficient water collected to sample (+/- 12 bailers full).
   - If water-level is drawing down, slow down pace.
   - Collect porewater samples using laboratory supplied bottleware, sealed in dedicated ziplock bags, and placed in a cooler with ice following collection.
6. To prevent cross contamination, sampling equipment must be deconned between each sample location using potable water and Alconox soap.

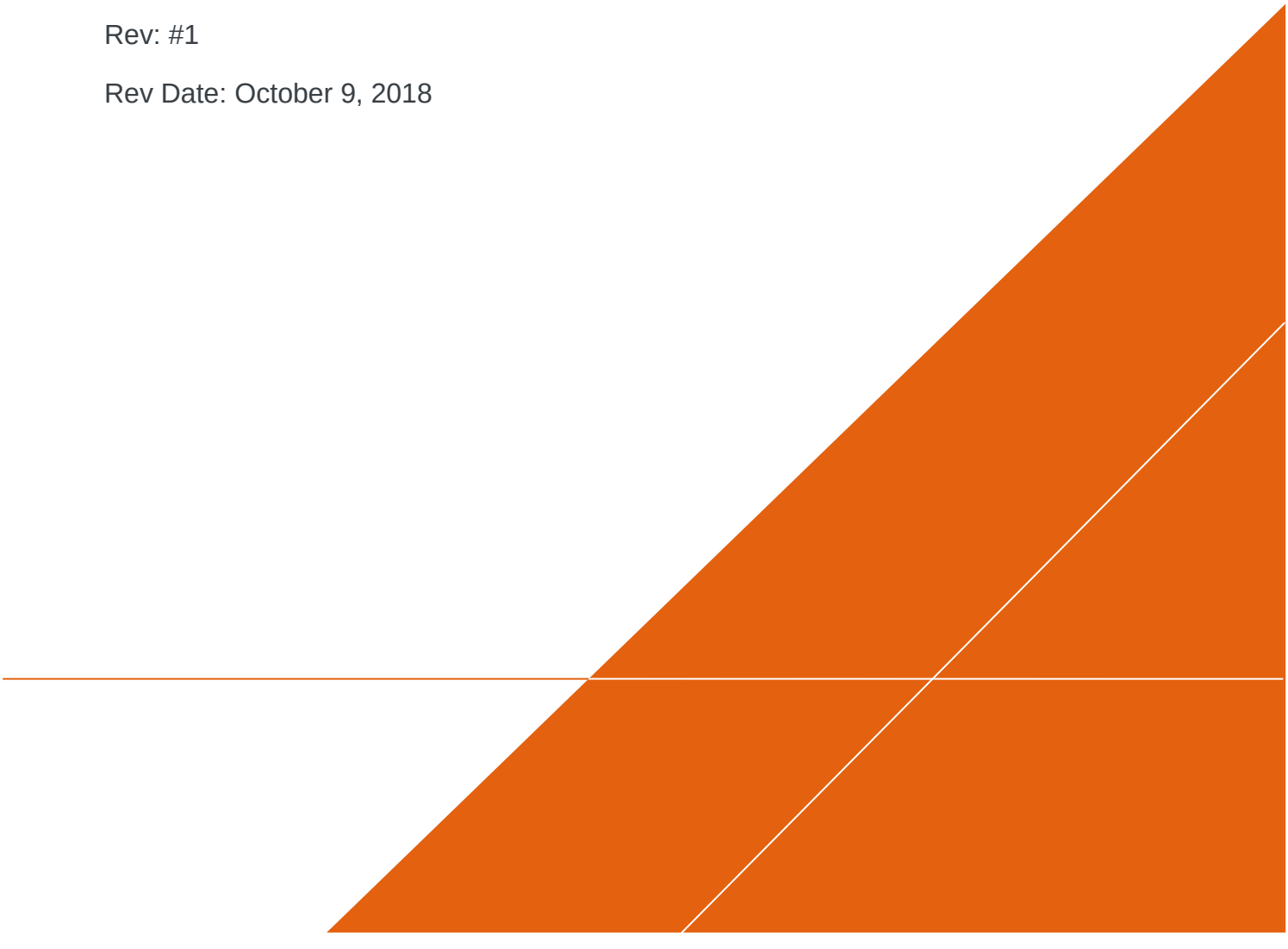
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SOP # P-20

TGI - GEOPROBE® HYDRAULIC PROFILING TOOL (HPT)

Rev: #1

Rev Date: October 9, 2018



SOP # P-20

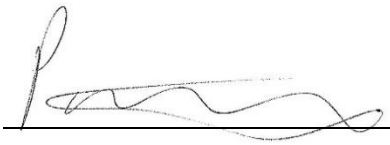
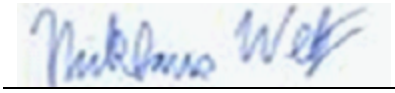
VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 2013	8	Procedures for Use of the Geoprobe® Hydraulic Profiling Tool (HPT)	Joe Quinnan
1	October 9, 2018	8	TGI – Geoprobe® Hydraulic Profiling Tool (HPT)	Nick Welty

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SOP # P-20

APPROVAL SIGNATURES

Prepared by:		Oct 9, 2018
	Patrick Curry, PG	Date:
Technical Expert Reviewed by:		Oct 9, 2018
	Nicklaus Welty, PG	Date:

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2 SCOPE AND APPLICATION

This document provides a technical guidance instruction (TGI) for collecting and analyzing data with the Geoprobe® Hydraulic Profiling Tool (HPT). The general principles of the tool operation are described, as are the field procedures, post processing of the HPT data and general principles of data interpretation.

The HPT provides a continuous profile of relative soil permeability at the centimeter scale. The resulting profile can be used to correlate hydrogeologic units across a site and guide vertical aquifer profile (VAP) groundwater sampling. With knowledge of depositional setting, the HPT profiles can be used to infer hydrofacies and add geologic interpretation to guide interpolation between the soundings. The HPT is advanced through an unconsolidated aquifer using a standard direct push drilling rig. The HPT tool is attached to the end of a drill string and enables a continuous metered injection of small volumes of water (typically between 200 to 300 milliliters per minute) during advancement of the probe. At the same time, the fluid backpressure due to injection into the formation, as well as the flow rate, are measured and logged at a high frequency. After correcting for atmospheric and hydrostatic pressure effects, the flow

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and pressure data are plotted as relative hydraulic conductivity by recognizing that hydraulic conductivity (K) is proportional to flow divided by pressure (Q/P). An example HPT log is provided as **Attachment 1**.

The HPT also includes a dipole that logs the electrical conductivity of the soil to assist with correlating stratigraphy between HPT borings. Increasing clay content may correspond to increasing electrical conductivity. Other useful documents are provided on the Geoprobe website (http://geoprobe.com/hpt-technical-documents).

The ability of the HPT to resolve relative permeability of soils, and achieve both the depth and sampling

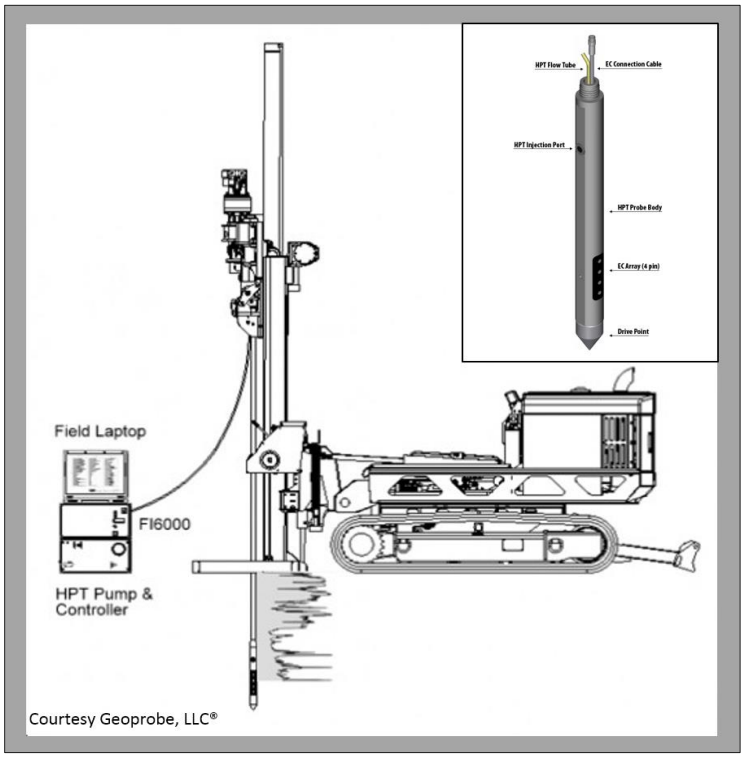


Figure 1. Typical drilling setup for hydraulic profiling rig. The HPT or APS probe is advanced into the subsurface using a direct push drilling rig.

goals for a project, is governed by the geologic setting. With the introduction of the 8040 series Geoprobe, the depth capabilities of direct push drilling have been extended to 100 feet or more in some geologic settings. However, for sites that require characterization deeper than 100 feet it is recommended that the tooling be tested at the site and confirmed to achieve the target depth. The HPT is very effective when utilized in aquifers with units of contrasting permeability. Sites dominated by very low-K soils (clay) or very high-K soils (well sorted sands and gravels) will provide only a maximum or minimum undifferentiated pressure and flow response and are not well-suited for the application of HPT. The typical range of K that provides a distinctive HPT response is 10^{-4} to 10^{-2} centimeters per second (cm/sec).

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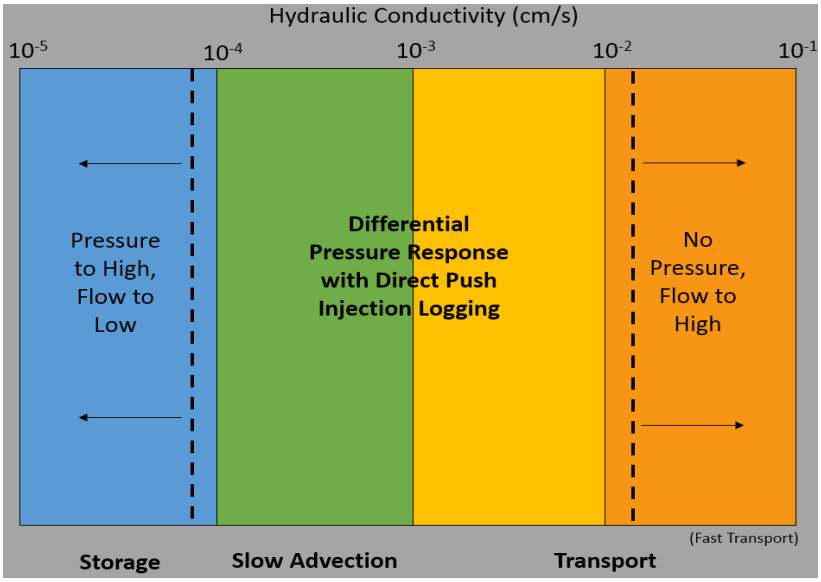


Figure 2. Range of hydraulic conductivity (permeability) that provides a unique response at standard injection rates.

3 PERSONNEL QUALIFICATIONS

Oversight of HPT drilling should be provided by an experienced geologist that is familiar with the general principals of hydrogeology. The Geoprobe® software package Direct Image® Viewer (DI Viewer) can be used to evaluate HPT data, provide final logs, and produce data in spreadsheet format for manipulation in Microsoft® Excel or other 3D modeling programs. Review of final HPT logs should be completed by a senior level geologist with familiarity with HPT design and function.

4 EQUIPMENT LIST

The advantage of drilling with HPT is the ability to communicate the boring results to the project team in near real-time. The project team can then collaborate on the decisions (such as what intervals to groundwater sample) and modify the work plan as needed to best accomplish the goals of the investigation. Therefore, unlike traditional drilling methods, the only equipment required of the field personnel is that which facilitates preparation and transmittal of the HPT data, including:

- Field Book
- If real-time evaluation and data compilation is required - laptop computer and Satellite Internet hotspot capability for transmitting HPT data via email
    - Requires Geoprobe DI Viewer software package
    - USB thumb drive

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- Cell Phone – when real-time entry is not required - can be used to photograph logs in the field and transmit to the project team via text or email

5 CAUTIONS

Prior to beginning field work, the ARCADIS utility clearance policy must be review and implemented. The ARCADIS utility clearance policy is outlined on the Health and Safety Team Site. (https://thesourceus.arcadissource.com/HS/Documents/Utility Clearance HS Standard.pdf)

The amount of water added to a given aquifer by the HPT is very small (typically 200-300 ml/min at an average drilling of 2 centimeters per second); however, if desired or required, fluorescein dye can be added to HPT injection water and monitored for during follow-up groundwater sampling. The general use of tracers to track drilling fluids is summarized in the Use of Visible Tracer in Drilling Fluid to Obtain Representative Groundwater Samples During Drilling TGI available on the ARCADIS Source website (https://arcadiso365.sharepoint.com/TEAMS/US_envsoplibrary/SitePages/Home.aspx).

Grouting of HPT boreholes requires removing the HPT tooling, re-drilling the hole to final depth with drilling rods and drive-point and injecting grout during the removal of the rods. Specifications of materials used for grouting will be selected to meet state and/or federal requirements, if any, as well as project quality objectives. For aquifers without significant confining units, natural collapse may be sufficient to abandon the borehole.

HPT should not be used within source zones where dense non-aqueous phase liquid (DNAPL) is suspected or possible. As HPT cannot detect potentially mobile DNAPL, it is recommended to use the methods outlined in the Arcadis' DNAPL contingency plan when evaluating DNAPL sites. Typically, the best approach for evaluating a DNAPL source zone uses methods such as dye-laser induced florescence (Dye-LIF), continuous whole-core soil sampling with NAPL dye testing, or a combination of both.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with HPT drilling will be performed in accordance with a site-specific Health and Safety Plan (HASP), a copy of which will be present on site during all drilling activities.

7 PROCEDURE

Pre-Field Activities

Before completing an HPT investigation, the project team should review existing boring logs and have a general understanding of what to expect for HPT response. Whenever possible, the first HPT boring should be completed in the vicinity of a continuously sampled and logged soil boring where there is reasonable confidence in the logged lithology. If beginning an investigation near an existing boring is impractical, or if there are no pre-existing borings, a calibration boring should be completed adjacent to the first HPT boring to provide a lithologic correlation to the HPT response curve. It is critical to account for the calibration process whenever planning to use HPT. Calibration soundings allow accurate interpretation of the HPT data, so they must be accounted for in project schedules and budgets. Soil

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description for the calibration boring should adhere to the Soil Description TGI located in The Source SOP catalog (https://arcadiso365.sharepoint.com/TEAMS/US_envsoplibrary/SitePages/Home.aspx).

In general, the completion of HPT borings on a transect (or transects) at regularly spaced intervals provides the best results for aquifer characterization. Transects should be completed either perpendicular or parallel to groundwater flow within the groundwater plume or area of interest. This approach provides a high-resolution cross-section of hydrostratigraphic units controlling groundwater flow. The spacing and depth of the borings and the length of the transect should be selected based on considerations such as the size of the plume, the goals of the investigation, and budget.

If HPT is to be used in combination with VAP sampling a provision should be made to complete measurements of absolute hydraulic conductivity for comparison to the HPT data. Hydraulic conductivity measurements could be based on sieve analysis, slug testing of VAP intervals, or specific capacity testing completed during VAP interval pumping.

Communication

A clear line of communication between the geologist providing oversight and the HPT operator should be established prior to drilling. The monitor that provides the HPT readout should be positioned so as to be viewable by both the ARCADIS geologist and the drilling personnel. Following completion of the HPT drilling, the HPT data should be copied to a disc or thumb drive and transferred to the Arcadis geologist's laptop for analysis and then emailed to the project team for discussion, or photographed an emailed or tested to the team via cell phone.

General HPT Drilling Methodology

The HPT is attached to a standard direct push drill string. The trunk line, supplying injection water and relaying information to and from the tool, is threaded through the drilling rods. Older versions of the HPT system use the "Direct Viewer" monitor that has a small LCD readout showing the HPT response. Newer versions are connected directly to a laptop and the real-time information is displayed through the laptop monitor. Setup of the HPT will be handled by the drilling subcontractor.

Before an HPT boring begins, pre-test calibration is performed to ensure the HPT pressure and EC responses are consistent with expected values. Arcadis field staff should ensure this process is completed and documented in the field notes. The HPT is then advanced into the subsurface with the direct push rig at an average rate of 2 centimeters per second (cm/sec). The typical injection rate is 200-300 milliliters per minute (ml/min).

Once below the water table a "dissipation test" should be completed to verify the elevation of the water table. During a dissipation test the drilling is paused and the HPT flow is turned off. The pressure response is then recorded as it returns to a stable baseline reading consistent with ambient hydrostatic pressure. The dissipation test results are used post drilling to correct the HPT pressure curve for hydrostatic pressure effects. The test is also required for the Geoprobe DI Viewer® software to determine the estimated hydraulic conductivity profile curve (Est K). It is recommended that dissipation tests be completed in a low-pressure response region of the aquifer (corresponding to higher K soils) to expedite the return to static conditions. At least two dissipation tests should be completed per borehole; one within a relatively shallow portion of the aquifer and second test within a deeper interval of the aquifer near to the total depth of the boring. Note that the dissipation tests should be performed above and below

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apparent confining units. This data can be used post investigation to evaluate vertical gradient at the site and is helpful for understanding connectivity between permeable zones.

Following completion of the HPT boring, post-test calibration will be performed to verify HPT performance and quantify sensor "drift", if any, during borehole advancement. Arcadis field staff should ensure this process is completed and documented in the field notes.

Grouting of HPT boreholes requires removing the HPT tooling, re-drilling the hole to final depth with the drilling rods and a drive-point and then injecting grout while pulling the rods out of the borehole. Specifications of materials used for grouting will be selected to meet state and/or federal requirements, if any, as well as project quality objectives. For aquifers without significant confining units, natural collapse may be sufficient to abandon the borehole.

Post Processing of HPT Data

Interpretation of the HPT data should be completed by a geologist familiar with the principles of hydrostratigraphy and hydrogeologic interpretation. Correlation of HPT response to geologic units should consider existing soil descriptions and nearby boring logs, as well as absolute K measurements completed during the HPT field activities.

Post-processing of the HPT response data can be completed using the DI Viewer software. A copy of the raw HPT files is required to manipulate the data using DI Viewer. The DI Viewer software can be used to produce a variety of logs for the final project deliverable. Once the dissipation test data is manipulated and the pressured data corrected for hydrostatic effects, the Est K profile can be generated for display alongside the HPT pressure, flow and EC curves. As mentioned above, a dissipation test is required for the DI Viewer software to determine an Est K curve for the boring. The Est K is a product of the Q/P curve corrected by an empirical relationship developed by Geoprobe using the relationship of Q/P and correlated absolute K measurements collected within the central US.

Any or all of the datasets can be exported from DI Viewer to a text based or Excel format for further manipulation, or used to import the curves into logging programs (e.g. gINT) or 3D modeling platforms such as Earth Volumetric Studio (EVS). Project teams should contact the Smart Characterization Community of Practice team members for help or advice on how best to manipulate HPT data.

The DI Viewer Est K profile is a good approximation of hydraulic conductivity within the appropriate window (~10^{-4} to 10^{-2} cm/sec), but should not be relied upon as an absolute value of hydraulic conductivity. When possible, hydraulic testing should be combined with an HPT investigation to verify hydraulic conductivity and help calibrate the HPT Est K results. Post processing of the data can include a comparison of the Q/P curve to absolute hydraulic conductivity measurements collected from the site such as slug tests or sieve analysis.

Vertical Aquifer Groundwater Sampling

The HPT Est K or pressure curves are typically used to target zones for VAP sampling. In most cases, the most efficient way to complete an HPT/VAP investigation is to complete the HPT profile first and then drill an adjacent borehole with standard Geoprobe screen-point tooling to collect the VAP samples. The screen-point should be advanced to a higher permeability (low pressure or higher Est K) zone of interest and opened to collect a groundwater sample. VAP sampling strategies are beyond the scope of this TGI, however, there are two ways to collect a series of VAP samples: top-down sampling or bottom-up sampling.

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Sampling top-down requires pulling the tooling after each sample interval followed by decontaminating the tooling, resetting the sampler, and then advancing the tooling to the next planned interval. Bottom-up sampling consists of driving the sampling device to the bottom of the target aquifer, opening the sampler, and then stopping at the additional prescribed sample intervals during retrieval of the sampler. With bottom-up sampling, a greater purge volume is required to ensure a representative groundwater sample; however, the overall time savings is significant relative to top-down sampling. There are several general rules that guide the decision to complete top-down or bottom-up sampling. These rules require answering the following questions:

1) Are the impacts at the top or bottom of the aquifer, or unknown?
2) Are confining layers present in the aquifer that could affect mass distribution?
3) Is there potential for DNAPL to be present in the aquifer?

If the dissolved phase mass is situated at the top of the aquifer, and zone of interest is free of confining units and there is no potential for DNAPL, then bottom-up sampling is a reasonable approach with limited potential for cross-contamination.

8 WASTE MANAGEMENT

Project-specific requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures, or groundwater collected during VAP sampling will be collected and contained on-site in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

9 QUALITY ASSURANCE

Following the processing of the HPT data, a senior review should be completed by a geologist familiar with the operation and application of the HPT, and should include a thorough review of the HPT dissipation tests, calibration data, and a review of the final deliverable.

10 REFERENCES

Not Applicable.

11 ATTACHMENTS

Attachment 1 - Geoprobe Hydraulic Profiling Tool - HPT Attachment 1 Example Log

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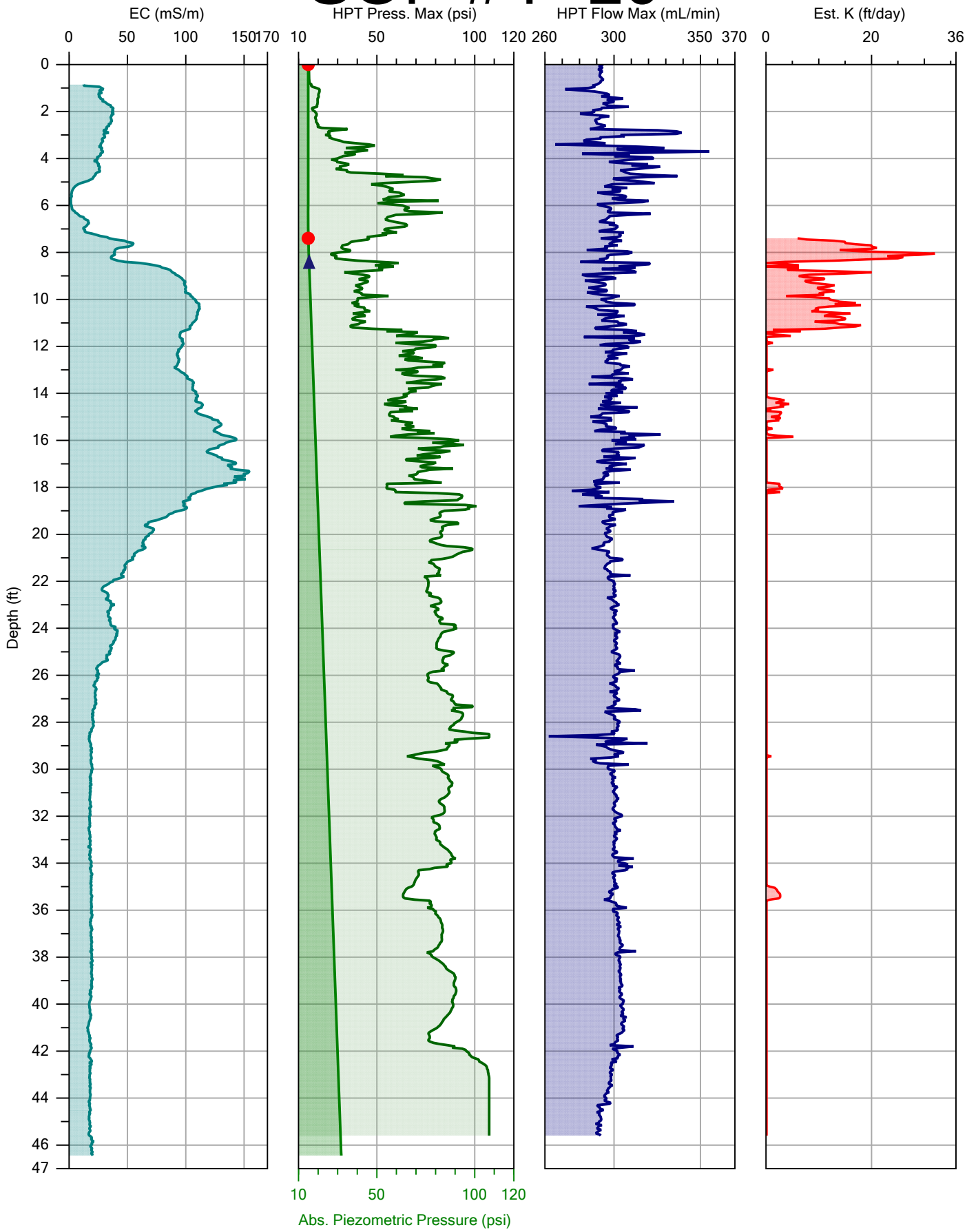
SOP # P-20

ATTACHMENT 1

Geoprobe Hydraulic Profiling Tool - HPT Attachment 1 Example Log

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SOP # P-20



			File: HPT-19.HPT
Company: Matrix Environmental		Operator: A. Kirsch	Date: 10/31/2015
Project ID: Livonia Ford Transmission		Client: Arcadis	Location:

Appendix C

Project Planning Session Summaries

BEM SYSTEMS

900 W 5th Ave, Suite 101
Anchorage, Alaska 99501
Telephone: 907-792-4531

Meeting Minutes – CDRL B009

DATE: 28 August 2020

Date of Meeting: 19 August 2020

Subject: Kickoff Meeting for Remedial Investigation for PFAS at Various Site at Eielson Air Force Base, Alaska, Contract Number No. FA8903-16-D-0041, Task Order FA8903-20-F-1108

Attendees:

AFCEC:	Kristina Smith (Remedial Project Manager), Michael Boese (Technical Division), Ted Holly (Installation POC), Roy Willis (Team Lead), Dawn Rodriguez, Joseph Price, Kathleen Bradley (Hydrologist), Shannon Garcia (Risk Assessment), Seb Gillette (Chemist), and Hunter Anderson (Lysimetry/ Source evaluation)
BEM Systems, Inc.:	Mark Nardolillo (CEO/Corporate Sponsor), Chris Pisarri (Project Manager), Artie Wickham (Assistant Project Manager), and Lesa Zimnawoda (Deputy Technical Lead).
Arcadis U.S., Inc.:	Courtney Ingersoll (Deputy Program Manager), Joe Quinnan (Quality Assurance/Quality Control Manager), Ginna Demetrios (Deputy Project Manager), Thomas Darby (Technical Lead), Jay Erickson (Field Team Lead), Lauren Quig, Lauren Henderson, Marissa McCann, and Theresa Olechiw

As outlined in the attached slides, BEM Systems, Inc. (BEM) and Arcadis U.S. Inc. (the BEM Team) presented a high-level overview of the remedial investigation, communication, and data needs. Salient discussion points and action items are noted below.

Introductions were conducted by Chris Pisarri (BEM Team Project Manager) and outlined in the project organization chart presented.

Discussion regarding the Triad Training included the following:

- AFCEC anticipated that the training would require ½ to full day. It is preferred that the training be conducted in segments to maintain engagement. In person is preferred but due to COVID-19, it is most likely not possible.
- An outline will be completed with a schedule for the different days of the training. This will allow for input from attendees.
- The training should occur prior to submittal of project planning documents to ensure a better understanding of communication structure and the need for fast decision making. It is preferred that the training occur December 2020, January 2021, or February 2021.
- It was suggested that the training not spend a lot of time on concept but focus on how the data will be presented and what everyone's role is for concurrence on decision making. Make sure their role in interpreting the data is clear, so they will be comfortable making quick decisions.

AFCEC voiced concern on presentation of data and ease of access due to past issues with

dashboards. The BEM Team said that they will work out possible access restrictions prior to the 2021 field event. The BEM Team is cognizant of the security/ firewall challenges and plan on testing the dashboard early to ensure proper working function prior to the 2021 RI field work.

During discussion of the proposed QAPP Addendum for supporting a Fall 2020 field sampling event, AFCEC CZTE was concerned that the SOW specified all field work would be completed during one field season (May-October 2021) and if sampling occurs in 2020, that would not align with the requirements in the Government's SOW. A summary of several follow-up discussions regarding this concern is provided in the Action Items section of these meeting notes.

It was confirmed that the BEM Team received access to ERPIMS data. Mr. Anderson (AFCEC) said that he has the ERPIMS data in an Access database and can send to the BEM Team upon request.

AFCEC CZTE voiced concern that this project is to be completed in one season and that lysimeters are preferred over SPLP samples. The BEM Team, AFCEC CTZE, and Installation staff will have a follow-up meeting to address CZTE's concern regarding the elimination of lysimeters and the results obtained from SPLP analysis and what impacts that could have on USAF's cleanup responsibilities/liability.

CZTE Presentation on their Involvement in Phase I Remedial Investigations:

The CZTE Team then presented their involvement in Phase I Remedial Investigations. Introductions were conducted by Seb Gillette (CZTE Chemist) along with a discussion of requirements for PWS. The presentation was for informational purposes only and CZTE is involved throughout the RI process. Any questions for the CZTE team should be routed through Eielson AFB.

There is a 2013 CSM available for Eielson AFB and also some additional data that may be available. The PFOS/ PFOA Team has maps, contact Ms. Bradley (CZET Hydrologist) for available GIS layers. Staff at Eielson AFB previously provided the 2013 CSM to the BEM Team.

CZTE indicated that SPLP is not an optimal way to measure leaching to groundwater. They recommended homogenizing and splitting the soil samples for both PFAS and SPLP analysis. They also recommend geotechnical analysis to confirm the physical and chemical properties of the underlying soil lithologies. Sieve analysis and point permeability will require DQOs and a description on how the data will be used. The use of lysimeters will be discussed at a later date.

CZTE indicated when entering data into ERPIMS, there are different well type codes. For example, temporary/ grab groundwater samples have a different well code than permanent monitoring wells. CZTE indicated that proper coding should be utilized for all data uploaded to ERPIMS.

Prior to penetrating a confining layer, the government needs to be contacted. The BEM Team asked if discontinuous permafrost is considered a confining layer. CZET said that is a Base decision. The BEM Team explained the discontinuous presence of permafrost and also discussed the presence of some low-permeable soil lenses, but no true defined confining layer. CZTE indicated that it appears that the BEM Team is following the intent of the recommendation and that these issues could be discussed at future scoping meetings.

Stormwater also needs to be evaluated as a transport mechanism. The sampling strategy needs to be documented in UFP-QAPP Worksheet #17.

Some chemistry requirement that were discussed included:

- The mobile lab needs to be accredited.
- Determine how flagged data affects decision making.

- Make sure LOQs are well below the screening levels.

A discussion on Risk Assessments included:

- It is required when designing the sampling plan that risk assessment be considered.
- Recommend collecting samples between 1 and 10 feet bgs for human receptors. These data can also be used for ecological risk.
- To the extent possible the BEM Team should meet analytical DQOs for both remedial actions and risk assessments to reduce the need for follow-on sampling.
- Also consider future risk exposure areas and see if makes sense adding them to the scope.
- Make sure there are clear DQOs on biota samples (fish). For example, sampling for minnows is not appropriate since they are not often consumed by humans.

The BEM Team stated that the surface water and sediment sampling events are based on high and low flow events and not specific storm events, e.g. after a rainfall event. CZTE indicated that is acceptable.

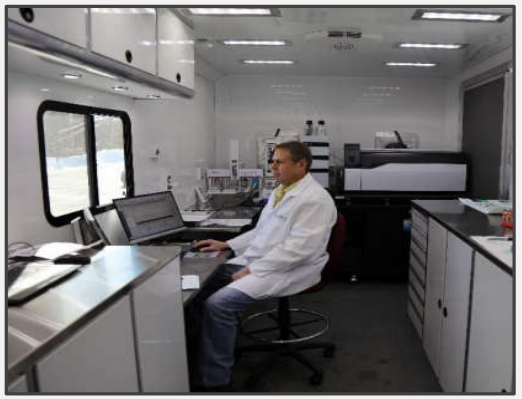
The Base POCs indicated that for any contract related issues, Mr. Tracy Kissler is the AFCEC Contracting Officer Representative.

Action Items:

1) AFCEC and BEM Team will setup a scoping call with the regulators (ADEC and USEPA Region 10) to discuss required review time for the QAPP addendum. **BEM - 01 September 2020 - COMPLETE**
2) The BEM Team will complete an outline and schedule for the Triad Training that will be conducted between December 2020 and February 2021.
3) The BEM Team will setup and test a dashboard to ensure accessibility and ease of use prior to commencement of the 2021 Field Season.
4) BEM will confirm with the Base POCs and the AFCEC COR that the Fall 2020 sampling event is authorized under current contract terms and that a modification is not required – **COMPLETE**: Sampling in the Fall is allowed and a modification is not required if the result provides betterment of the pending RI study and does not result in the Government incurring additional cost. If sampling is unable to be completed Fall 2020 due to regulatory pushback or review times extend out past the end of September, sampling will be completed early Spring 2021.
5) CZTE to send the Access Database containing Eielson AFB ERPIMS. - **COMPLETE**
6) AFCEC and BEM discuss if lysimeters is preferred over SPLP samples – **COMPLETE:** SPLP samples will work but further discussion may be required.
7) CZTE to provide GIS layers for Eielson AFB - **ONGOING**.
8) AFEC provide 2013 CSM – **COMPLETE**.
9) AFCEC confirm that discontinuous permafrost is not a confining layer and does not require government notification prior to penetrating.
10) BEM Team will complete a communication plan for the project after the Fall 2020 Sampling Event.
    - A decision tree matrix will be included for field work triad decision making.

Remedial Investigation for PFAS at Various Sites

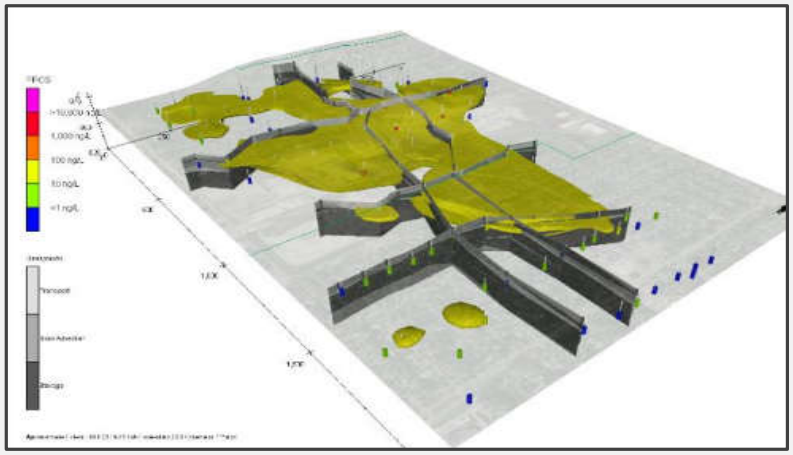
Eielson Air Force Base, AK

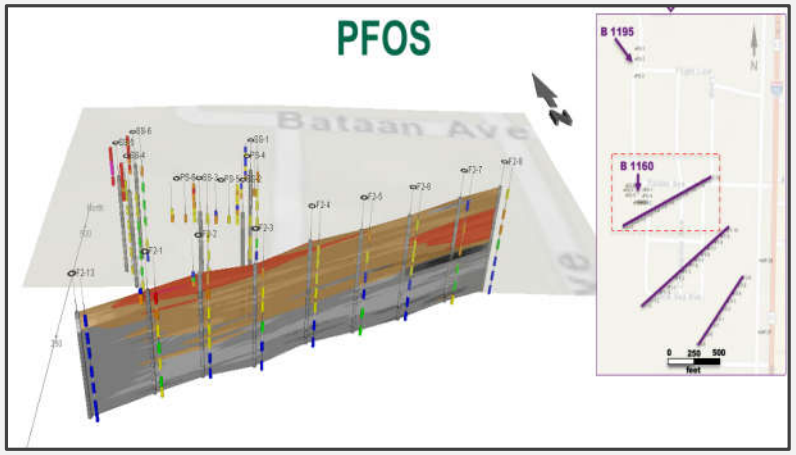


Submitted by

BALANCED ENVIRONMENTAL MANAGEMENT

BEM SYSTEMS





AGENDA

- Purpose
- Kickoff Meeting Objectives
- Team Introductions
- Project Organization Chart
- **Stakeholder Engagement and Expectations**
- Historical Work Summary
- Summary of 2019 and 2020 Investigations
- **Dynamic Workflow and Communication Elements**
- **Scope Overview**
- **Schedule**
- **Data Needs / Site Logistics**
- Next Steps

PURPOSE

Conduct Basewide Remedial Investigation by:

- Delineation of nature and extent of PFOS/PFOA

Currently only Base Scope awarded. No options awarded yet.



Meet AFCEC's Phase I RI objectives

KICKOFF MEETING OBJECTIVES

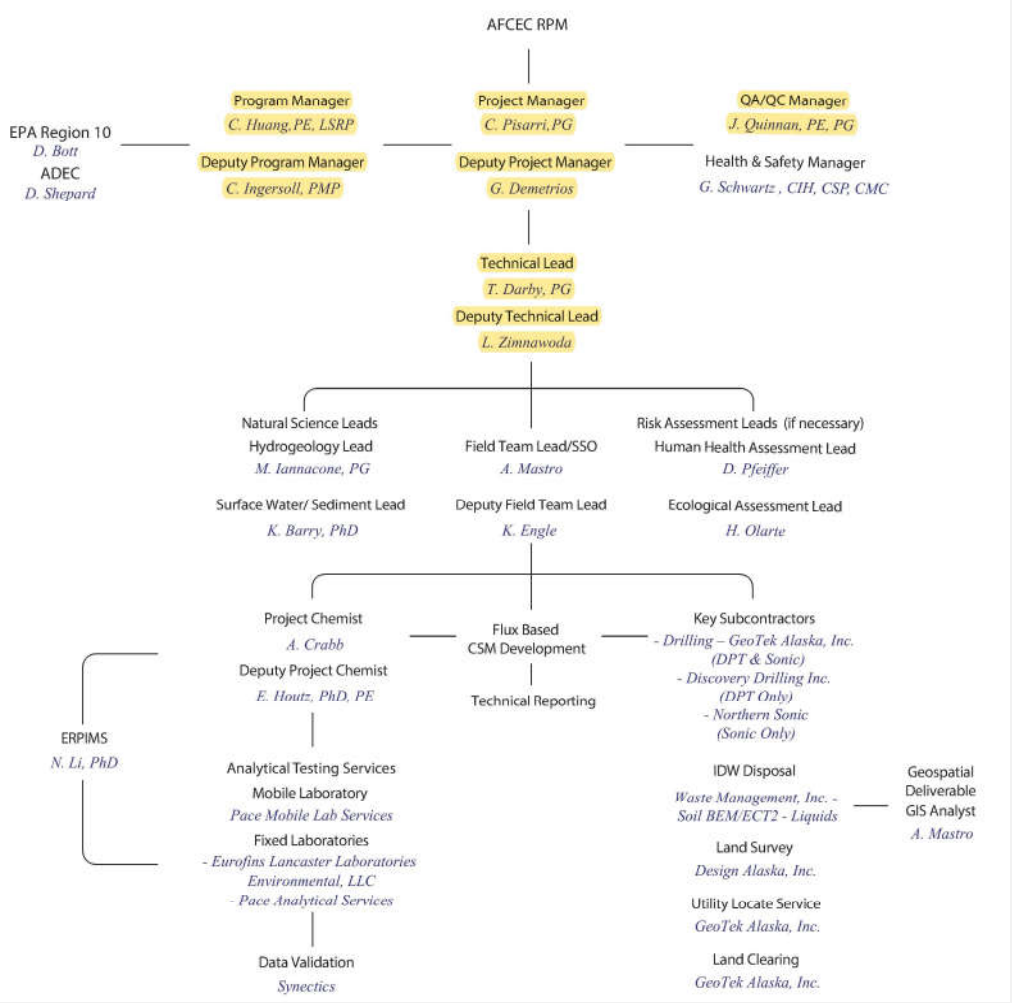
- Establish Points-of-Contacts for Communications
- Establish Consensus on Dynamic Workflow and Communication Process for Adaptive Characterization
- Data needs based upon recent studies:
  - Data from Recent PFAS Investigations (conducted by others)
  - Verify Completeness of Data in ERPIMS
  - Evaluate Geospatial Data
- Discuss means to obtain regulatory approval for Fall Supplemental Sampling Event (sediment, surface water, and groundwater)
- Schedule
- Site Access and logistics

TEAM INTRODUCTION

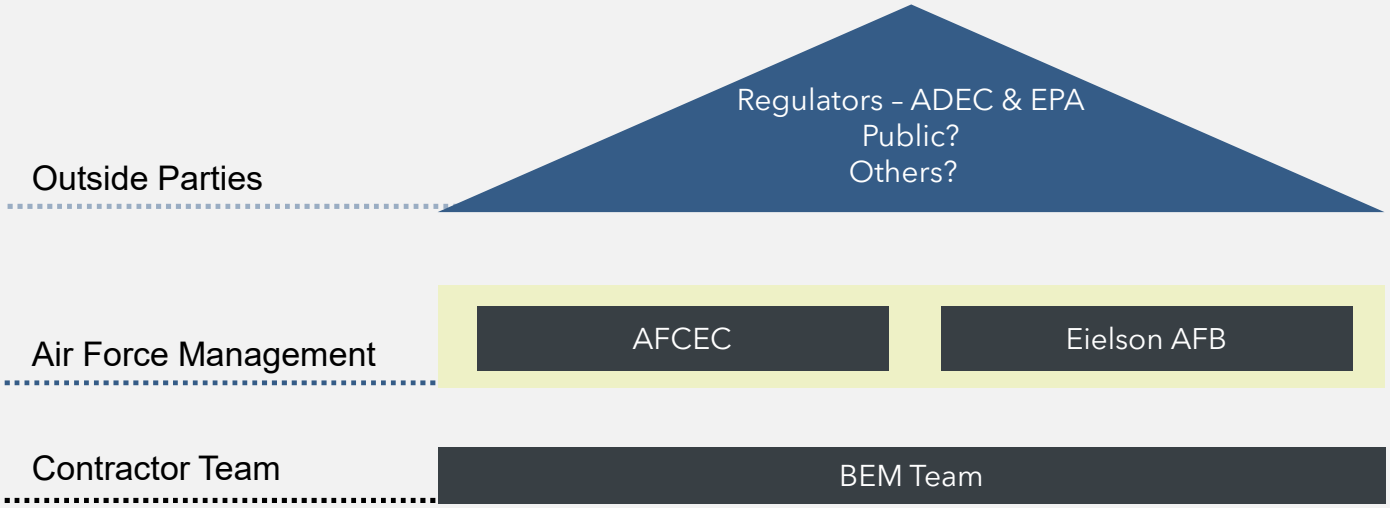
- AFCEC
- Eielson Air Force Base
- BEM
- Arcadis



PROJECT ORGANIZATION CHART

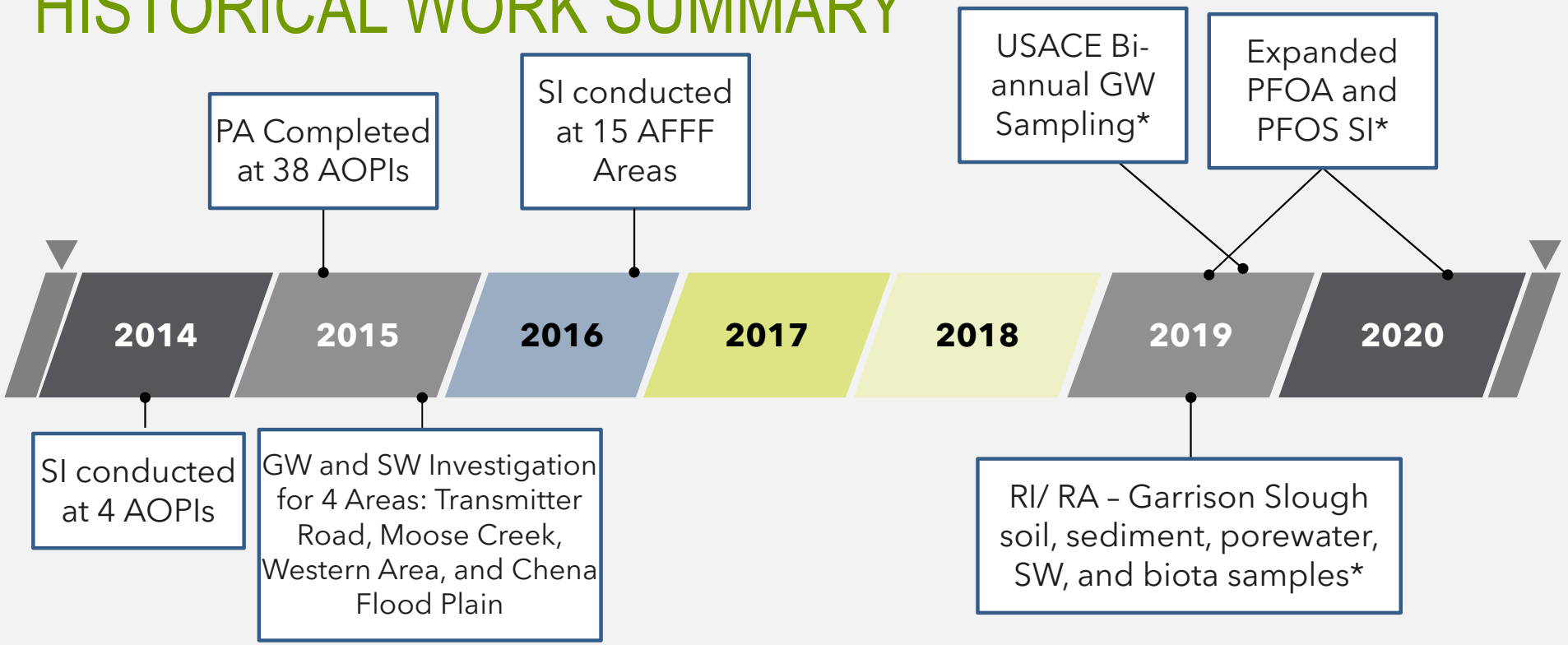


STAKEHOLDER ENGAGEMENT & EXPECTATIONS



- **Understanding Stakeholders and Communication is Key to Project Delivery**

HISTORICAL WORK SUMMARY



*Details regarding the 2019 and 2020 Investigations are provided on the next slide

Completed activities identified AFFF source areas and PFAS extending past the Community of Moose Creek

Summary of 2019 and 2020 Investigations

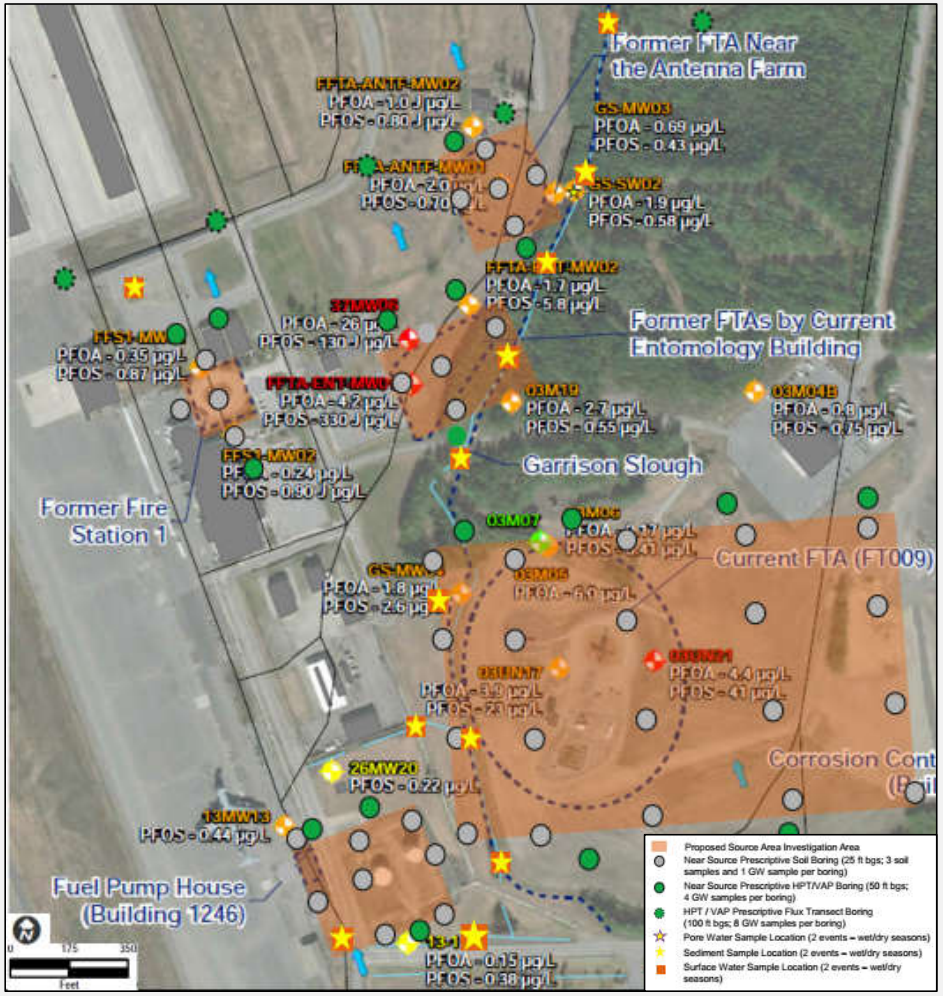
Investigation	Media	Details	2019 Analytical Data	2020 Analytical Data	Data Gap
Expanded PFOA and PFOS SI	Soil	AFFF Area 5 and AFFF Area 9	Preliminary analytical data and figures	None provided	Final 2019 and 2020 analytical data
	Groundwater	Temporary and Permanent wells base perimeter and downgradient	Preliminary analytical data and figures	None provided	Final 2019 and 2020 analytical data
	Groundwater	Nested Wells installed in 2018. Provided information indicates only 2 shallow GW intervals are scoped for sampling.	None provided	None provided	Sampling completed and final data available
	Surface Water/ Sediment	Sampling at select bodies of water	No sampling completed	None provided	Final 2020 analytical data
USACE Bi-Annual Groundwater Monitoring	Groundwater	12 nested wells and 8 additional existing wells	Received Fall 2019 analytical data. Have not received Spring 2019 analytical data	None provided	Final Spring 2019, Spring 2020, and Fall 2020 groundwater analytical data
Garrison Slough RI/ RA	Groundwater, porewater, surface water, sediment, biota, and soil	Sampling conducted on base	Received preliminary analytical data	None provided	Final 2019 and 2020 analytical data

- **All data uploaded to ERPIMS and sample locations uploaded to Geodatabase?**
- **Any other PFAS data available?**

- **New data will be integrated into the CSM and help finalize prescriptive scope**

DYNAMIC WORKFLOW and COMMUNICATION ELEMENTS

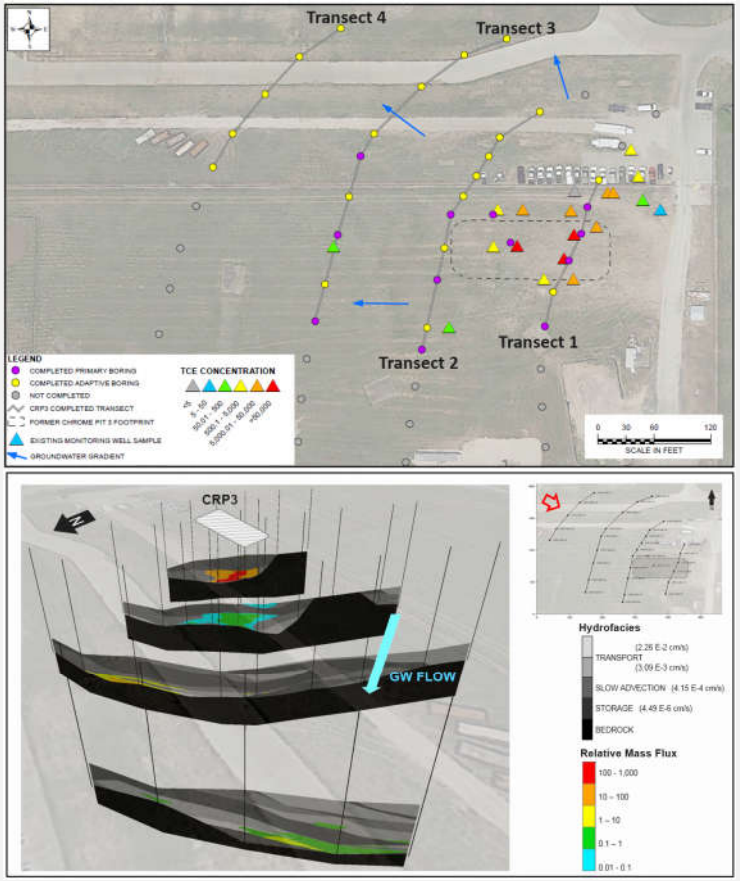
- Multiple elements of work completed concurrently – **developing communication strategy is key to maintaining schedule**
- Refine prescriptive scope based on CSM review and Fall 2020 groundwater, surface water, and sediment sampling
- Implement prescriptive scope, as detailed in QPP
- Real-time data review and CSM updates
- **Conduct milestone review with stakeholders on prescriptive scopes, as completed**, to determine step-outs or zoom-ins
- Establish concurrence on adaptive strategy
- Implement adaptive scope
- Repeat milestone discussion
- Establish concurrence that field objectives are achieved



- **Communication strategy with AFCEC & regulators is key to maintaining schedule**

COMMUNICATION ELEMENTS AND TRIAD TRAINING SESSION

- Apply an interactive online application using ArcGIS
  - 3D visualizations of source areas and groundwater plume information
  - Plan view maps with links to analytical and geological data supporting the interpretations
- Provide client and stakeholders access to view the data and obtain concurrence: **Educate stakeholders with Triad Training**
  - Triad approach represents 3 elements: project planning, dynamic work strategies, and innovative rapid sampling and analytical technologies.
  - Triad Training Session to be conducted prior to development of QPP. Preferred schedule?
  - Conducted in segments or 1 event?
  - Weekly discussions during field work to allow for collaboration and fast decision making



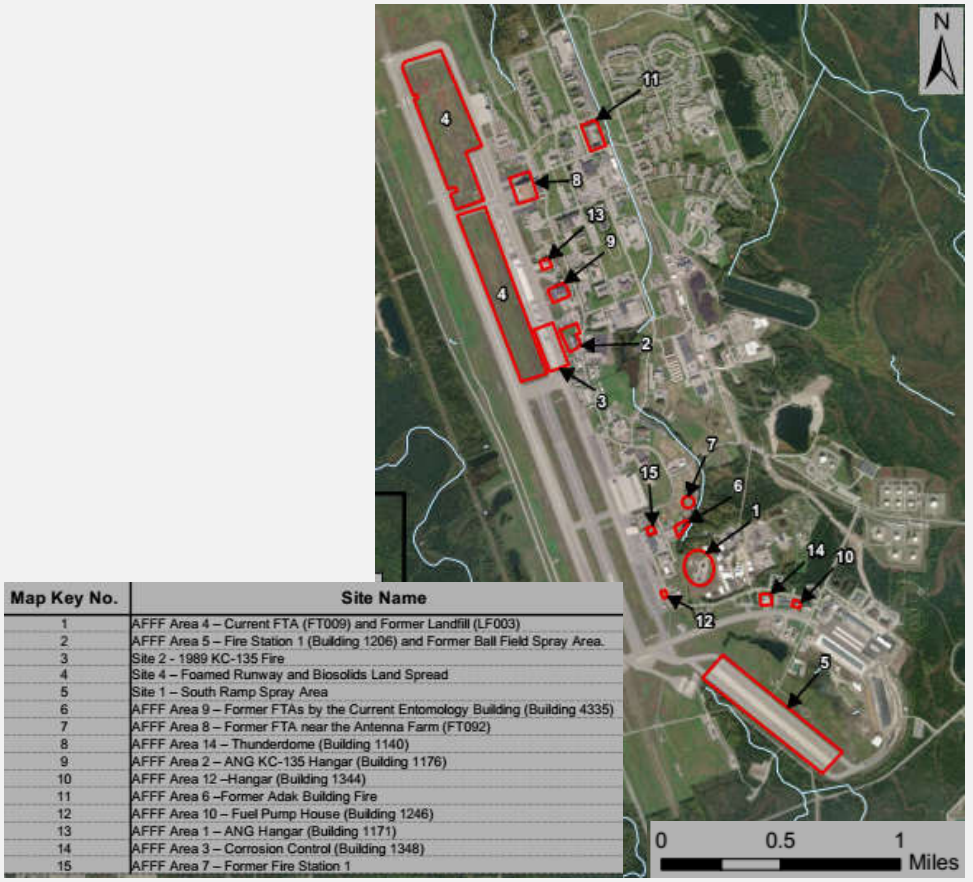
Graphics from AFCEC Stratigraphic Flux Guidance Document

Digital 3D-CSM provides interactive platform for building concurrence

Scope Overview

BASE EFFORT SOW

AFFF Area	Source Area Soil Borings (~25 ft bgs)[1]	VAP Borings (~50 ft bgs)[2,3]	MW Samples[4]	Co-located SW/Sed Samples (2 events)
AFFF Area 1	4	2	2 existing MWs	1
AFFF Area 2	3	2	2 existing MWs	2
AFFF Area 3	4	3	2 existing MWs	3
AFFF Area 4	20	6	3 existing MWs	4
AFFF Area 6	9	4	2 existing MWs	4
AFFF Area 7 and 2 subsites	15	8	6 existing MWs	7
AFFF Area 10	8	3	2 existing MWs	2
AFFF Area 12	4	2	2 existing MWs	3
AFFF Area 14	4	3	2 existing MWs	1
Site 1	14	4	3 existing MWs	4
Site 3	7	3	3 existing MWs	1
Site 2	6	3	2 existing MWs	2
Site 4	12	4	3 existing MWs	--
Basewide and Off-site	20 (Adaptive)	4 VAP Transects: 30 100 ft VAPs and 25 150 ft VAP	16 existing MWs, 25 new shallow MW, and 20 sets of 4 nested MWs	46 co-located SW & sed samples (15 SW locations will also include pore water samples). Fish tissue will be collected at 20 locations (4 samples per location).

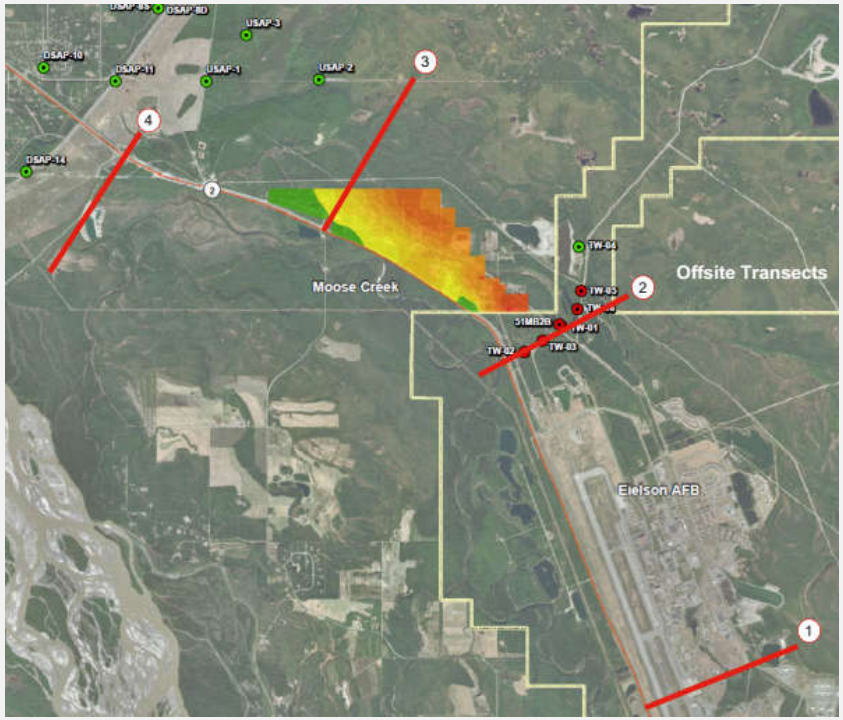


Map Key No.	Site Name
1	AFFF Area 4 – Current FTA (FT009) and Former Landfill (LF003)
2	AFFF Area 5 – Fire Station 1 (Building 1206) and Former Ball Field Spray Area.
3	Site 2 - 1989 KC-135 Fire
4	Site 4 – Foamed Runway and Biosolids Land Spread
5	Site 1 – South Ramp Spray Area
6	AFFF Area 9 – Former FTAs by the Current Entomology Building (Building 4335)
7	AFFF Area 8 – Former FTA near the Antenna Farm (FT092)
8	AFFF Area 14 – Thunderdome (Building 1140)
9	AFFF Area 2 – ANG KC-135 Hangar (Building 1176)
10	AFFF Area 12 –Hangar (Building 1344)
11	AFFF Area 6 –Former Adak Building Fire
12	AFFF Area 10 – Fuel Pump House (Building 1246)
13	AFFF Area 1 – ANG Hangar (Building 1171)
14	AFFF Area 3 – Corrosion Control (Building 1348)
15	AFFF Area 7 – Former Fire Station 1

[1] Three (3) soil samples and one (1) groundwater sample will be collected from each soil boring.
[2] Four (4) groundwater samples will be collected from each 50-foot VAP boring, 8 GW samples from each 100-foot VAP boring, and 12 GW samples from each 150-foot VAP boring.
[3] HPT borings will be completed adjacent to the 50-foot and 100-foot VAP borings.
[4] Monitoring well locations may be adjusted in final scope pending receipt of additional data.

OPTIONAL TASKS SOW

Option	Description	Scope
1a through 1e	Near-Source Soil Borings	10 DPT Borings 30 soil samples 10 GW samples
2a through 2e	Hydraulic Profiling Tool	Advance 10 HPT borings to a max depth of 75 feet bgs or refusal
3a through 3t	SPLP Sampling	Collect and analyze one soil sample for SPLP PFAS analysis
4a through 4e	50 ft VAP borings	5 VAP borings 20 GW samples
5a through 5e	100 ft VAP borings	10 VAP borings 80 GW samples
6a through 6e	150 ft VAP borings	10 VAP borings 120 GW samples
7a through 7e	Surface Water and Sediment Sampling	Collect and analyze co-located surface water and sediment samples from 10 locations



Proposed Fall 2020 Sampling Scope

- Groundwater Sampling (50 Wells)
  - Provide update on distribution from 2015 results
  - Collect PFAS data from wells previously unsampled
  - Provide new data in deeper wells or wells along the edges of identified PFAS extents
- Surface Water / Sediment / Porewater (80 Co-located with 15 porewater)
  - Verify existing impacts and fill data gaps for suspect areas not sampled previously
  - Delineate nature and extent of PFAS during dry season conditions
  - Evaluate transport pathways and flux from likely source area, mixing processes in downstream area, and background concentrations in upstream areas

Fall sampling event data provides more robust CSM for finalizing RI scope

PROJECT SCHEDULE SUMMARY

FY2020 Q4

- QAPP/ HSP Addendum – Late August/ Early September
- **Sample Existing Wells and Surface Water / Sediment – September**
- Regulatory Scoping Meeting - September

FY2021 Q1

- Evaluate data collected in Q3/Q4 2020
- Project Review Meeting – November
- Triad/ Scoping Meeting

FY2021 Q2/ Q3

- AFCEC & Regulatory Approval of Final QPP – April
- Mobilization for Base Scope – May
- Exercise Optional CLINs – as needed
- Triad Implementation

FY2021 Q4

- Complete Base Scope - October
- Submittal of Draft RI Report

FY2022

- Approval of ERPIMS data uploads
- Approval of Final CSM
- Approval of Final RI Report Finalize Project documents

- **Recommend implementing initial GW/SW/SED to refine base scope work plan: minor delay in QAPP schedule offset by better initial planning**

DATA NEEDS

- **Access to electronic data**
  - ERPIMS
  - GIS/CAD (to include utilities layer)

SITE LOGISTICS

- **COVID19 awareness**
- **Base access (e.g., badging)**
- **Restricted access areas (e.g. flight lines)**
- **OPSEC**
- **IDW**
- Utilities
- Dig permits
- Natural/cultural resources sites
- UXO
- ROE/surrounding property owners
- Egress
- Job trailer site

- **Timely information needed to maintain schedule**

Next Steps



Action Items

- Air Force to provide electronic data access
- QAPP / HSP Addendum for Fall 2020 GW/SW/SED sampling
  - Establish Schedule for SI QAPP Addendum Submission
  - Regulatory review timeframe for SI QAPP Addendum Approval
  - Coordinate logistics with Base staff, including ROE as necessary
- Detail communication process in the PMP

BEM SYSTEMS

900 W 5th Ave, Suite 101
Anchorage, Alaska 99501
Telephone: 907-792-4531

Final Meeting Minutes – CDRL B009

DATE: 14 September 2020

Date of Meeting: 01 September 2020

Subject: Scoping Meeting for Remedial Investigation for PFAS at Various Sites at Eielson Air Force Base, Alaska, Contract Number No. FA8903-16-D-0041, Task Order FA8903-20-F-1108

Attendees:

AFCEC:	Kristina Smith (Remedial Project Manager), Michael Boese (Technical Division), Roy Willis (Team Lead), Dawn Rodriguez, Joseph Price, Kathleen Bradley (Hydrologist), Shannon Garcia (Risk Assessment), Seb Gillette (Chemist), and Hunter Anderson (Lysimetry/ Source evaluation)
Regulatory Agencies:	Dustan Bott (USEPA Project Manager) and Dennis Shepard (ADEC Project Manager)
BEM Systems, Inc.:	Mark Nardolillo (CEO/Corporate Sponsor), Chris Pisarri (Project Manager), Lesa Zimnawoda (Deputy Technical Lead), and Artie Wickham (Lead Hydrogeologist).
Arcadis U.S., Inc.:	Courtney Ingersoll (Deputy Program Manager), Joe Quinnan (Quality Assurance/Quality Control Manager), Ginna Demetrios (Deputy Project Manager), Thomas Darby (Technical Lead), Lauren Quig, Marissa McCann, and Theresa Olechiw

As outlined in the attached slides, BEM Systems, Inc. (BEM) and Arcadis U.S. Inc. (the BEM Team) presented a high-level overview of the remedial investigation, communication, and data needs. Salient discussion points and action items are noted below.

Introductions were conducted by Chris Pisarri (BEM Team Project Manager) and outlined in the project organization chart presented.

Discussion regarding the Triad Training included the following:

- ADEC asked for additional information on the Triad Training Sessions including if the training will be virtual to present the data, figures, and CSM. ADEC mentioned that a similar approach was used on a Galena Project. The BEM Team responded that currently the training will be virtual due to COVID-19, but it is preferred to be conducted in person. It will most likely be a virtual training with video chat. The training will include an introduction to the Triad Approach and how it will apply to the Eielson project.

ADEC asked if the plan is just to analyze for PFOS, PFOA, and PFBS or if the list of 24 PFAS compounds will be analyzed for.

- The BEM Team responded that PFOS, PFOA, and PFBS are the primary analytes that will evaluated since there are current standards but will be analyzing for the full 24 PFAS compound list.
- ADEC is interested in the transport of the other PFAS compounds as well as PFOA, PFOS,

and PFBS. The BEM Team mentioned that they have begun evaluating the prevalence of the full 24 PFAS compound list across the different media type and this will be expanded upon receipt of all most recent data.

- BEM Team also mentioned that the mobile laboratory will be utilized to provide quick turn-around screening data for a portion of the 24 PFAS compound list but all decision making samples will be sent to an off-site fixed laboratory and analyzed for the full 24 PFAS compound list. Also, 5% of the total number of samples analyzed with the mobile laboratory will be split and sent to the fixed lab.

A discussion then began regarding the figure shown on Slide 16. The figure showed current proposed transect locations that will be updated once all final data is provided, including completion of the Fall 2020 Groundwater sampling event as part of this contract. ADEC asked about the area shaded green on Slide 16 figure, showing that samples collected from the area detected PFAS compounds at concentrations less than the associated screening levels. The area is located near the bluff and northwest of Moose Creek.

- The BEM Team said that the shading is based on previous off-base sampling of private groundwater wells. ADEC mentioned that the data is old. The BEM Team was aware and that is why the 2019/2020 data collected by other contractors as well as the proposed Fall 2020 groundwater sampling event will help revise the current CSM and assist with better placement of the prescriptive sampling locations and transects proposed for 2021.

The BEM Team presented the proposed Fall 2020 groundwater sampling locations on Slides 19 and 20. ADEC asked for clarification on the black and white monitoring well symbols shown on the slides. Those monitoring wells were either sampled in 2019 and 2020 or are proposed for sampling Fall 2020 under another contract and by another consultant. The figures will be revised for the QAPP Addendum with additional clarification.

Additional questions and discussion points are provided below:

- ADEC asked if the Triad Training will also present the plan for the 2021 Remedial Investigation. ADEC also asked if the training will include discussion of field results, step out sample locations, and recap the scope of work.
    - The BEM Team said that the training will focus mainly on laying out the approach, help identify any concerns, and provide a matrix to aid quick decision making and consensus between stakeholders.
    - The training will also talk about methods and communication strategy for effective decision making.
- USEPA asked how any field changes will be documented.
    - BEM Team said that the Triad Training and QPP will layout the process and that any major changes will be documented using the Field Change Form. They also plan on holding frequent scoping meetings at decision points to receive consensus and input from all stakeholders. The data will be presented online to allow all stakeholders time to review prior to any scoping meetings.
    - ADEC asked if the process will provide opportunity for the ADEC review. ADEC also mentioned that documents are often reviewed by multiple experts at the USEPA and if additional EPA staff will be invited to the Triad Training and Scoping meetings.
        - BEM Team said that the data will be presented online to allow all

stakeholders time to review prior to any scoping meetings. Also, the original plan for the Triad Training was to have it live and have it open to all with an interest to attend but now due to COVID-19, attendance will be more limited. BEM Team will reach out to all stakeholders and ask who they would like invited.

- EPA noted that the Triad Approach sounds like a useful vehicle. BEM Team agreed and said that it provides folks a chance for input/insight on the process.

Action Items:

1) BEM Team submit the Draft QAPP Addendum for Fall 2020 Groundwater Sampling. **BEM Team – 04 September 2020 – COMPLETE.**
2) AFCEC, ADEC, and EPA Review the Draft QAPP Addendum and provide comments. **AFCEC, ADEC, and EPA – 18 September 2020.**
3) Working Meeting to discuss AFCEC and Agencies Comments. **AFCEC, ADEC, EPA, and BEM Team – 21 September 2020.**
4) BEM Team submit the Draft-Final QAPP Addendum. **BEM Team – 23 September 2020.**
5) AFCEC, ADEC, and EPA Review the Draft-Final QAPP Addendum and provide comments. **AFCEC, ADEC, and EPA – 30 September 2020.**
6) BEM Team submit the Final QAPP Addendum. **BEM Team – 01 October 2020.**
7) BEM conduct Fall 2020 Groundwater Sampling. **BEM Team – 02 October to 14 October 2020.**

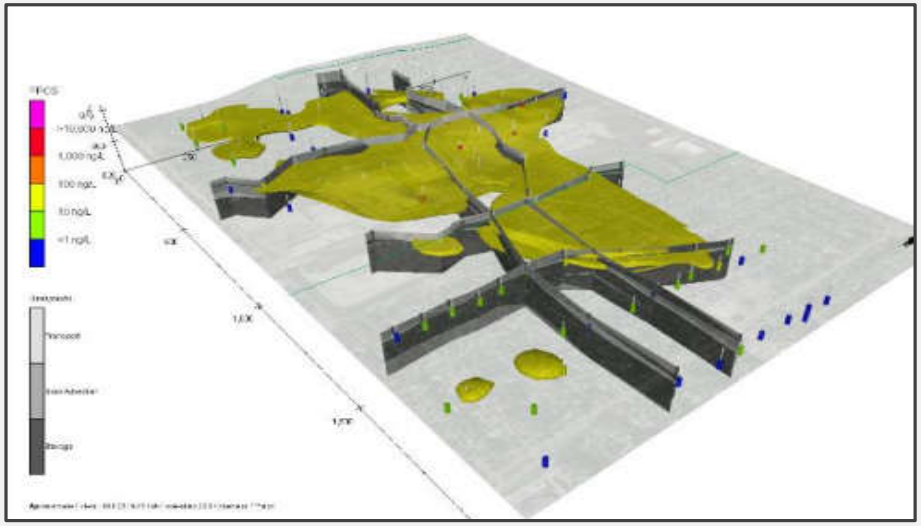
Remedial Investigation for PFAS at Various Sites

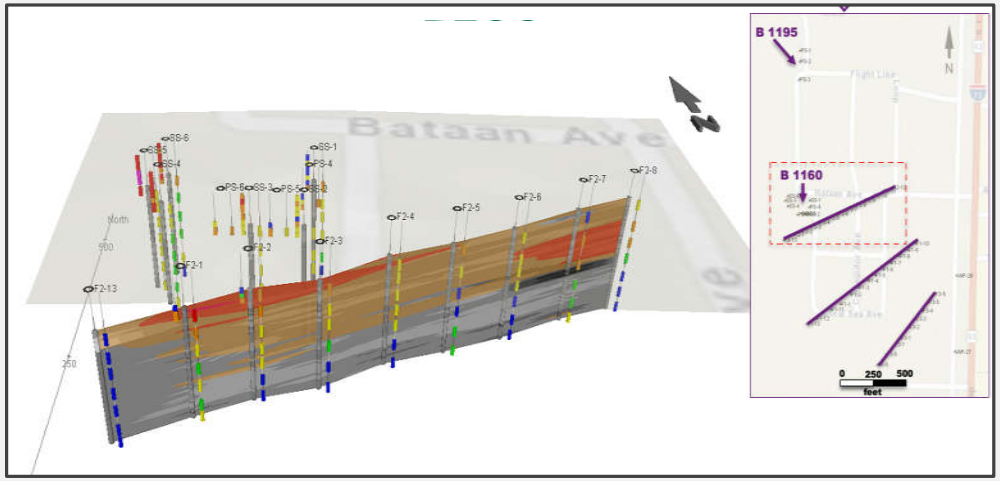
Eielson Air Force Base, AK



Submitted To

Submitted by
BALANCED ENVIRONMENTAL MANAGEMENT
BEM SYSTEMS





Contract Number: FA8903-16-D-0041
Delivery Order: FA8903-20-F-1108

AGENDA

- Meeting Objectives
- Purpose of the Investigation
- Team Introductions
- Project Organization Chart
- Stakeholder Engagement During RI Implementation
- Historical Summary of PFAS Investigations and Assessments
- Summary of 2019 and 2020 Investigations
- Overview of RI Dynamic Workflow
- **Fall Groundwater Sampling Event Scope Overview**
- **Groundwater QAPP Addendum Crosswalk**
- **Project Schedule**

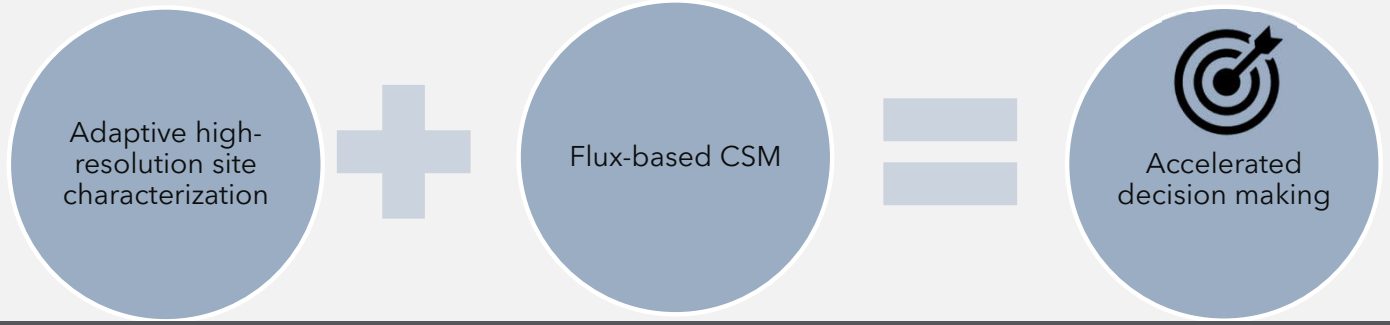
MEETING OBJECTIVES

- Present the Need and Purpose of the Investigation
- Team Introductions and Points-of-Contacts for Communications
- Establishment of TRIAD-type Training Sessions
- Summarize Primary Findings from Previous Investigations
- Introduction of Dynamic Workflow Process for Adaptive Site Characterization
- Establishment of Stakeholder Engagement Process
- Discuss Proposed Fall Sampling Event (Groundwater Collection)
- Conduct Overview of QAPP Addendum Crosswalk
- Discuss QAPP Addendum Review and RI Project Schedule

PURPOSE OF INVESTIGATION

Conduct Basewide Remedial Investigation at Eielson AFB by:

- Delineation of nature and extent of PFAS within multiple media within a single field season
- Assess impacts at validated AFFF source areas as well as Basewide conditions
- Utilize innovative technologies for more efficient investigative approach that improves the quality of data for future decision making



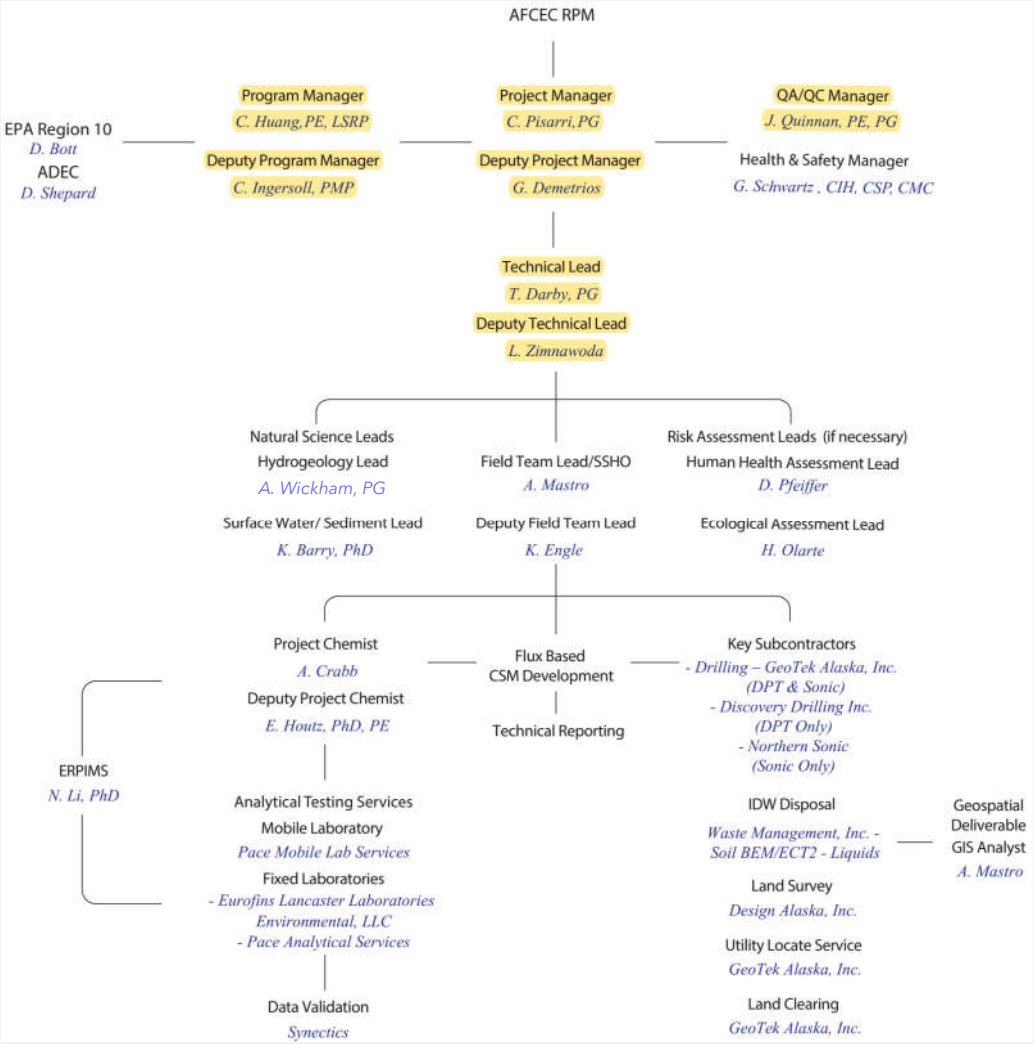
Meet AFCEC's Phase I PFAS RI objectives

TEAM INTRODUCTION

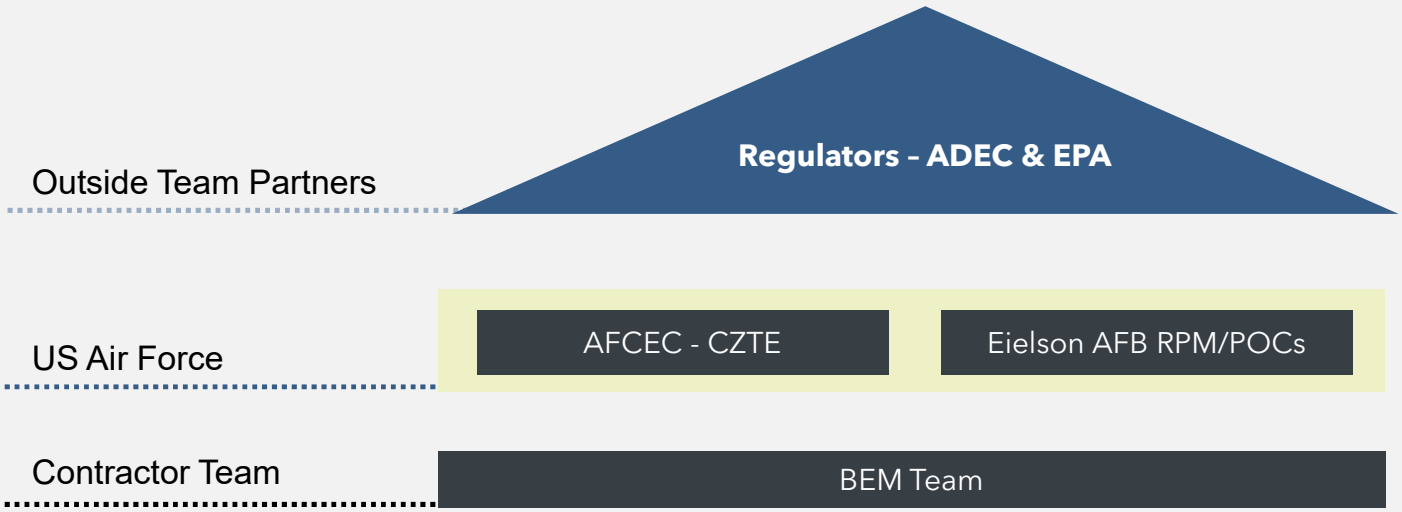
- **354th CES Eielson AFB**
- **AFCEC CZTE**
- **ADEC**
- **EPA**
- **BEM**
- **Arcadis**



EIELSON AFB, PFAS RI PROJECT ORGANIZATION CHART



STAKEHOLDER ENGAGEMENT & EXPECTATIONS – EIELSON AFB, PFAS RI



Understanding of the Project Objectives and Clear Communication are Key to Project Delivery

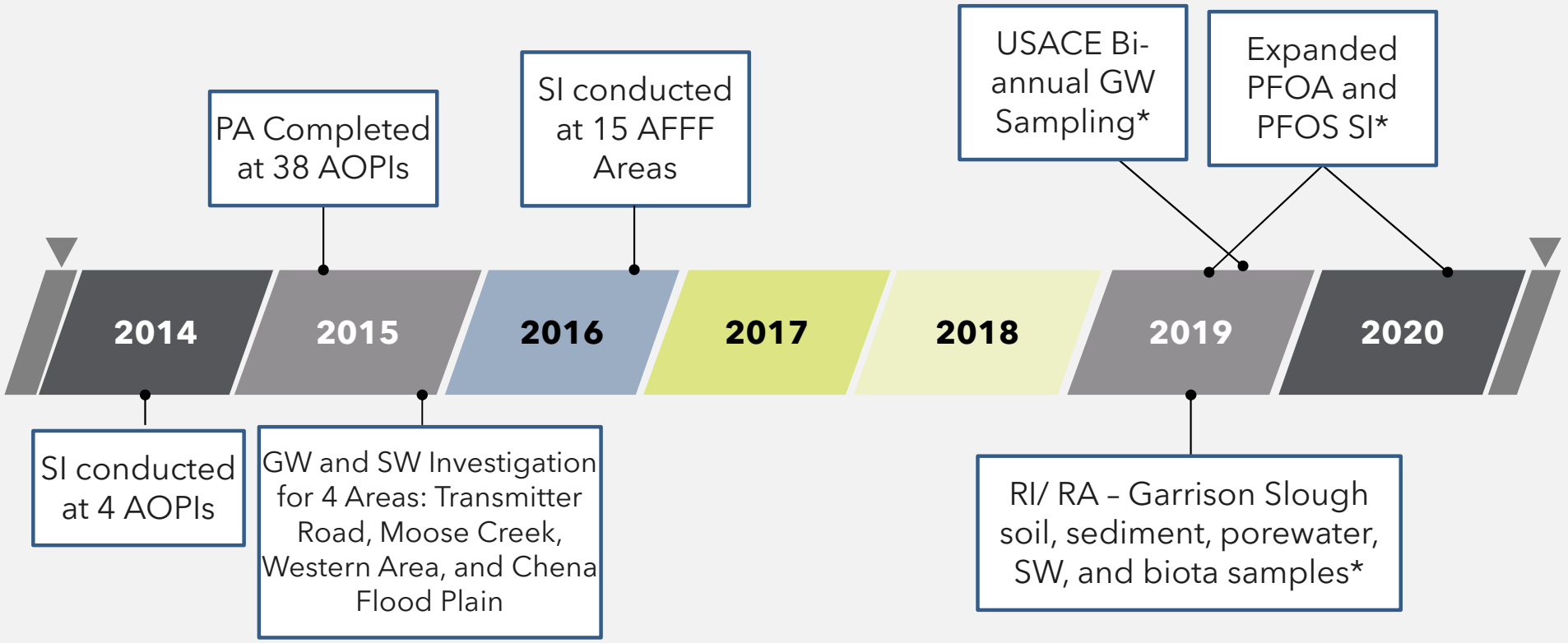
TRIAD-Approach Training Sessions for Decision-Making Communication Process

Decisive Communication and Concurrence will be key for the success of the RI:

- Reduce and eliminate downtime including review cycles
- Selection of adaptive boring locations and well locations to eliminate data gaps
- Mechanism for data sharing and technical discussions
- Verification of assessment findings/delineation confirmation prior to demobilization

Proposing two to three live-stream video training sessions geared toward building partnerships and decision-making procedures – Dec 2020/Jan 2021 timeframe

EIELSON AFB HISTORICAL PFAS ASSESSMENT SUMMARY



*Details regarding the 2019 and 2020 Investigations are provided on the next slide

Completed activities identified AFFF source areas and PFAS extending past the Community of Moose Creek

SUMMARY OF 2019 & 2020 INVESTIGATIONS

Investigation	Media	Details	2019 Analytical Data	2020 Analytical Data	Data Gap
Expanded PFOA and PFOS SI	Soil	AFFF Area 5 and AFFF Area 9	Preliminary analytical data and figures	None provided	Final 2019 and 2020 analytical data
	Groundwater	Temporary and Permanent wells base perimeter and downgradient	Preliminary analytical data and figures	None provided	Final 2019 and 2020 analytical data
	Groundwater	Nested Wells installed in 2018. Provided information indicates only 2 shallow GW intervals are scoped for sampling.	None provided	None provided	Sampling completed and final data available
	Surface Water/ Sediment	Sampling at select bodies of water	No sampling completed	None provided	Final 2020 analytical data
USACE Bi-Annual Groundwater Monitoring	Groundwater	12 nested wells and 8 additional existing wells	Received Fall 2019 analytical data. Have not received Spring 2019 analytical data	None provided	Final Spring 2019, Spring 2020, and Fall 2020 groundwater analytical data
Garrison Slough RI/ RA	Groundwater, porewater, surface water, sediment, biota, and soil	Sampling conducted on base	Received preliminary analytical data	None provided	Final 2019 and 2020 analytical data

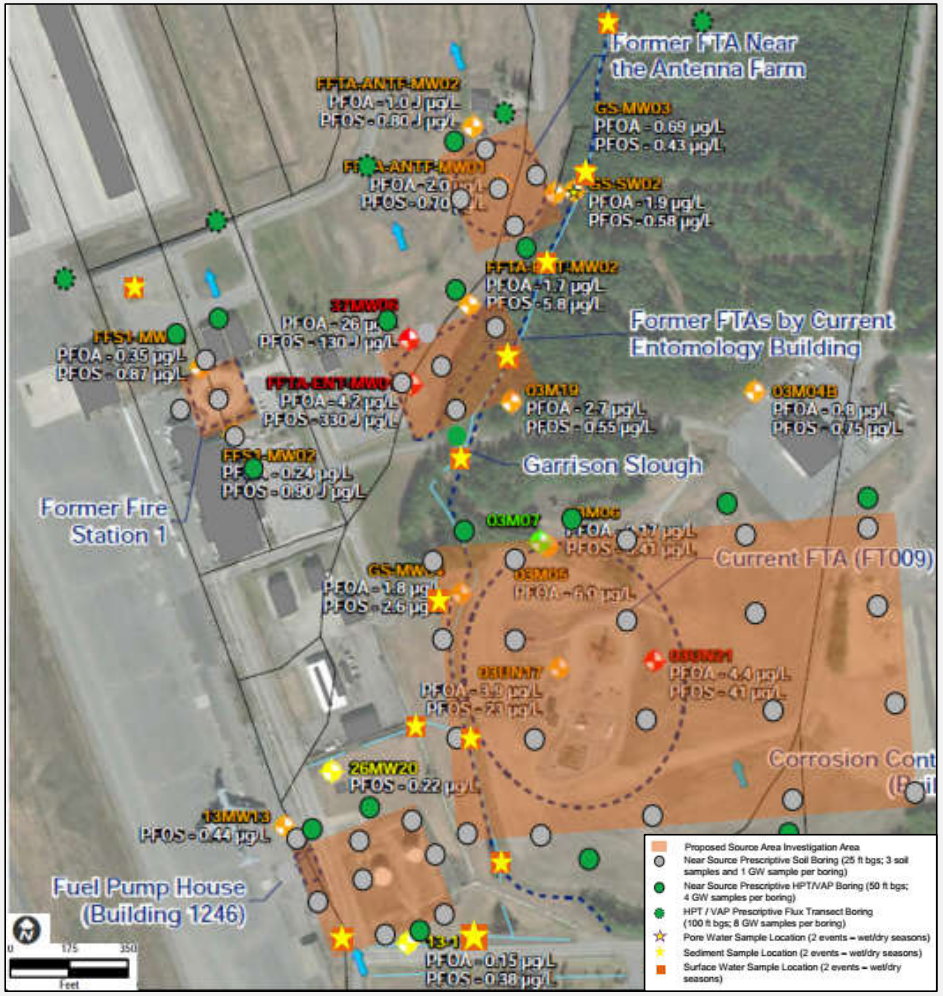
- **New data will be integrated into the CSM and help finalize prescriptive scope**

DYNAMIC WORKFLOW INTRODUCTION



DYNAMIC WORKFLOW ELEMENTS

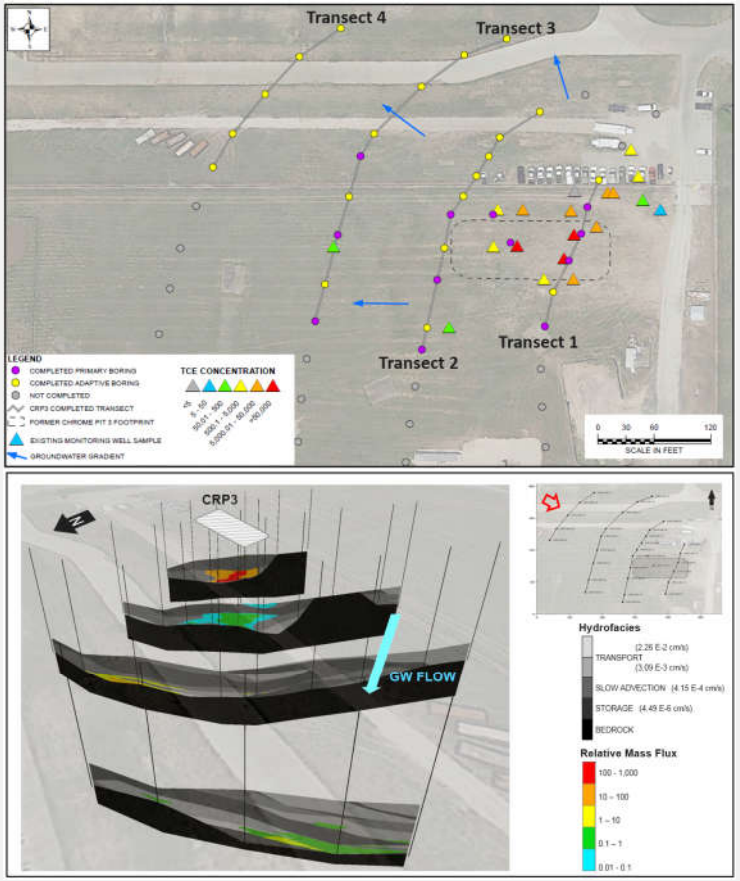
- Multiple elements of work completed concurrently – **developing communication strategy is key to maintaining schedule**
- Refine prescriptive scope based on CSM review and Fall 2020 groundwater
- Implement prescriptive scope, as detailed in QPP
- Real-time data review and CSM updates
- **Conduct milestone review with stakeholders on prescriptive scopes, as completed**, to determine step-outs or zoom-ins
- Establish concurrence on adaptive strategy
- Implement adaptive scope
- Repeat milestone discussion
- Establish concurrence that field objectives are achieved



Communication strategy with AFCEC & regulators is key to maintaining schedule

COMMUNICATION ELEMENTS AND TRIAD TRAINING SESSION

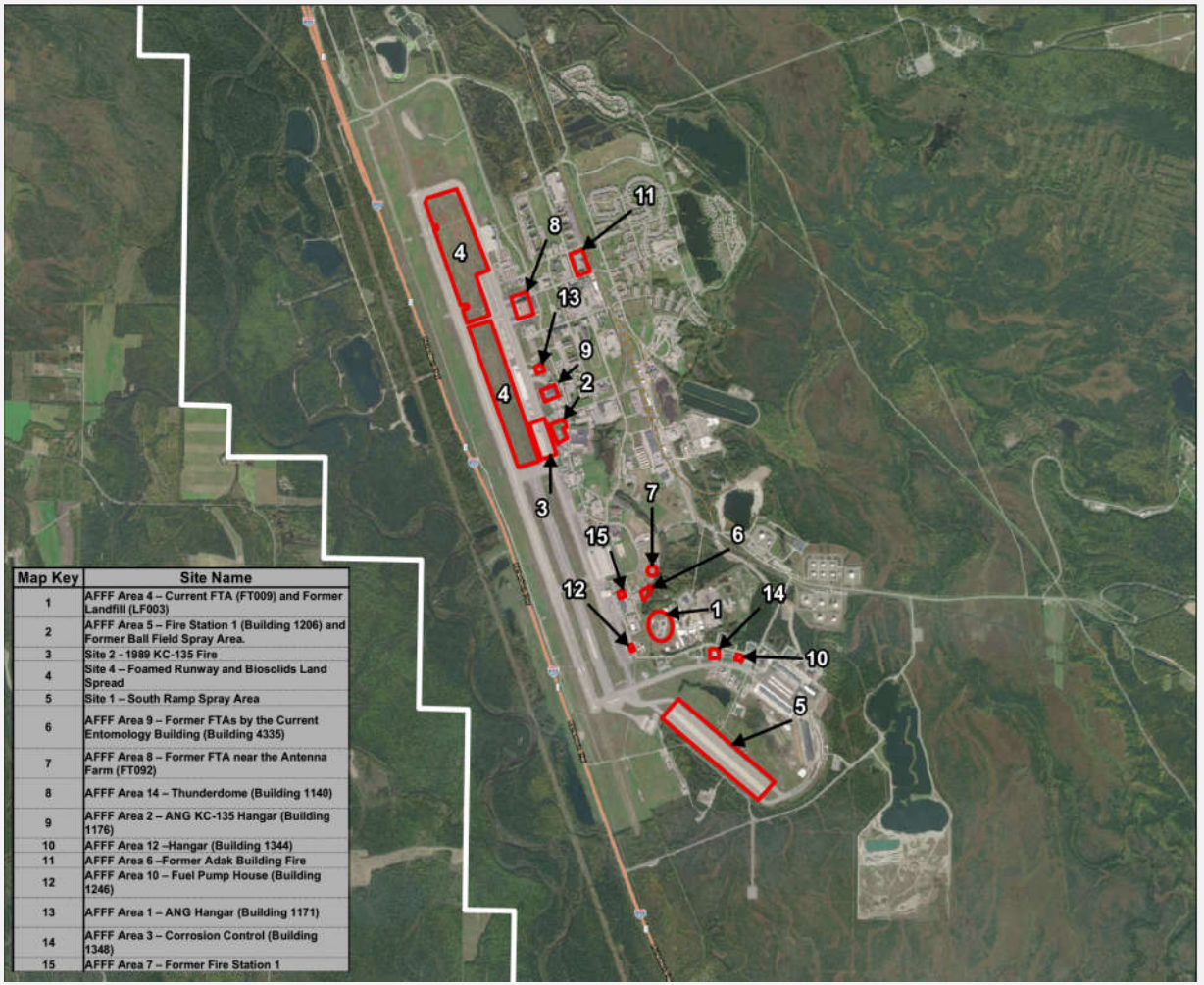
- Apply an interactive online application using ArcGIS
  - 3D visualizations of source areas and groundwater plume information
  - Plan view maps with links to analytical and geological data supporting the interpretations
- Provide client and stakeholders access to view the data and obtain concurrence: **Educate stakeholders with Triad Training**
  - Triad approach represents 3 elements: project planning, dynamic work strategies, and innovative rapid sampling and analytical technologies
  - Triad Training Session to be conducted prior to development of the RI QPP
  - Weekly discussions during field work to allow for collaboration and fast decision making
  - **Verification of meeting project metrics prior to demobilization**



Graphics from AFCEC Stratigraphic Flux Guidance Document

Digital 3D-CSM provides interactive platform for building concurrence

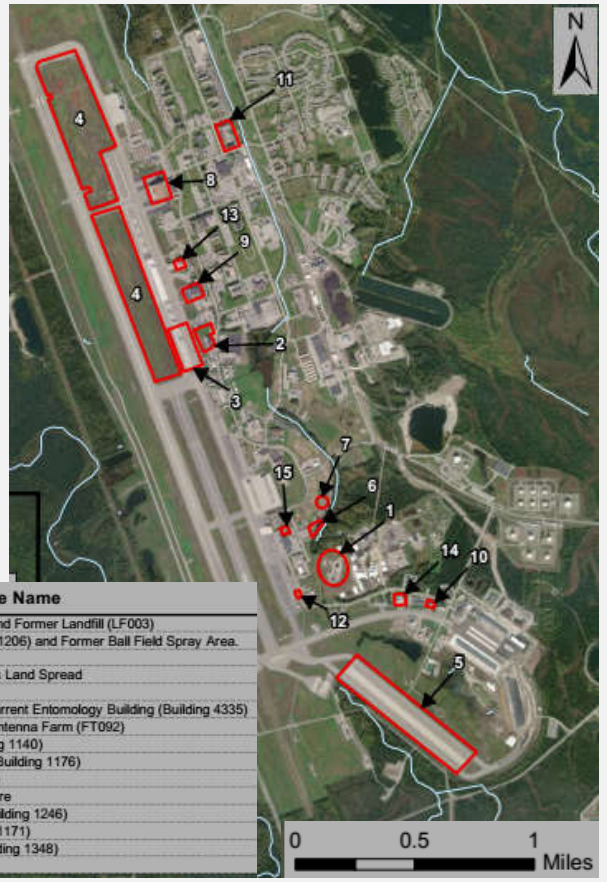
Eielson PFAS RI Scope Overview



Map Key	Site Name
1	AFFF Area 4 – Current FTA (FT009) and Former Landfill (LF003)
2	AFFF Area 5 – Fire Station 1 (Building 1206) and Former Ball Field Spray Area.
3	Site 2 - 1989 KC-135 Fire
4	Site 4 – Foamed Runway and Biosolids Land Spread
5	Site 1 – South Ramp Spray Area
6	AFFF Area 9 – Former FTAs by the Current Entomology Building (Building 4335)
7	AFFF Area 8 – Former FTA near the Antenna Farm (FT092)
8	AFFF Area 14 – Thunderdome (Building 1140)
9	AFFF Area 2 – ANG KC-135 Hangar (Building 1176)
10	AFFF Area 12 –Hangar (Building 1344)
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12	AFFF Area 10 – Fuel Pump House (Building 1246)
13	AFFF Area 1 – ANG Hangar (Building 1171)
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15	AFFF Area 7 – Former Fire Station 1

BASE AWARD RI FIELD EFFORT SOW

AFFF Area	Source Area Soil Borings (~25 ft bgs)[1]	VAP Borings (~50 ft bgs)[2,3]	MW Samples	Co-located SW/Sed Samples (2 events)
AFFF Area 1	4	2	2 existing MWs	1
AFFF Area 2	3	2	2 existing MWs	2
AFFF Area 3	4	3	2 existing MWs	3
AFFF Area 4	20	6	2 existing MWs	4
AFFF Area 6	9	4	2 existing MWs	4
AFFF Area 7 and 2 subsites	15	8	5 existing MWs	7
AFFF Area 10	8	3	2 existing MWs	2
AFFF Area 12	4	2	2 existing MWs	3
AFFF Area 14	4	3	3 existing MWs	1
Site 1	14	4	1 existing MWs	4
Site 3	7	3	5 existing MWs	1
Site 2	6	3	--	2
Site 4	12	4	--	--
Basewide and Off-site	20 (Adaptive)	4 VAP Transects: 30 100 ft VAPs and 25 150 ft VAP	22 existing MWs, 25 new shallow MW, and 20 sets of 4 nested MWs	46 co-located SW & sed samples (15 SW locations will also include pore water samples). Fish tissue will be collected at 20 locations (4 samples per location).

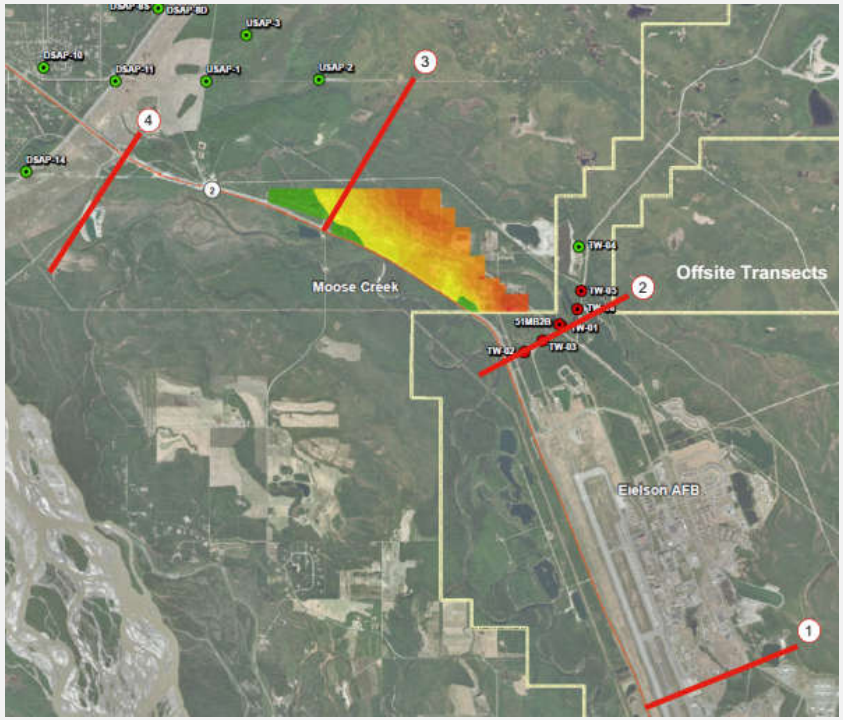


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[1] Three (3) soil samples and one (1) groundwater sample will be collected from each soil boring.
[2] Four (4) groundwater samples will be collected from each 50-foot VAP boring, 8 GW samples from each 100-foot VAP boring, and 12 GW samples from each 150-foot VAP boring.
[3] HPT borings will be completed adjacent to the 50-foot and 100-foot VAP borings.

OPTIONAL TASKS FOR RI SOW

Option	Description	Scope
1a through 1e	Near-Source Soil Borings	10 DPT Borings 30 soil samples 10 GW samples
2a through 2e	Hydraulic Profiling Tool	Advance 10 HPT borings to a max depth of 75 feet bgs or refusal
3a through 3t	SPLP Sampling	Collect and analyze one soil sample for SPLP PFAS analysis
4a through 4e	50 ft VAP borings	5 VAP borings 20 GW samples
5a through 5e	100 ft VAP borings	10 VAP borings 80 GW samples
6a through 6e	150 ft VAP borings	10 VAP borings 120 GW samples
7a through 7e	Surface Water and Sediment Sampling	Collect and analyze co-located surface water and sediment samples from 10 locations



PROPOSED FALL FY20 GROUNDWATER SAMPLING SCOPE



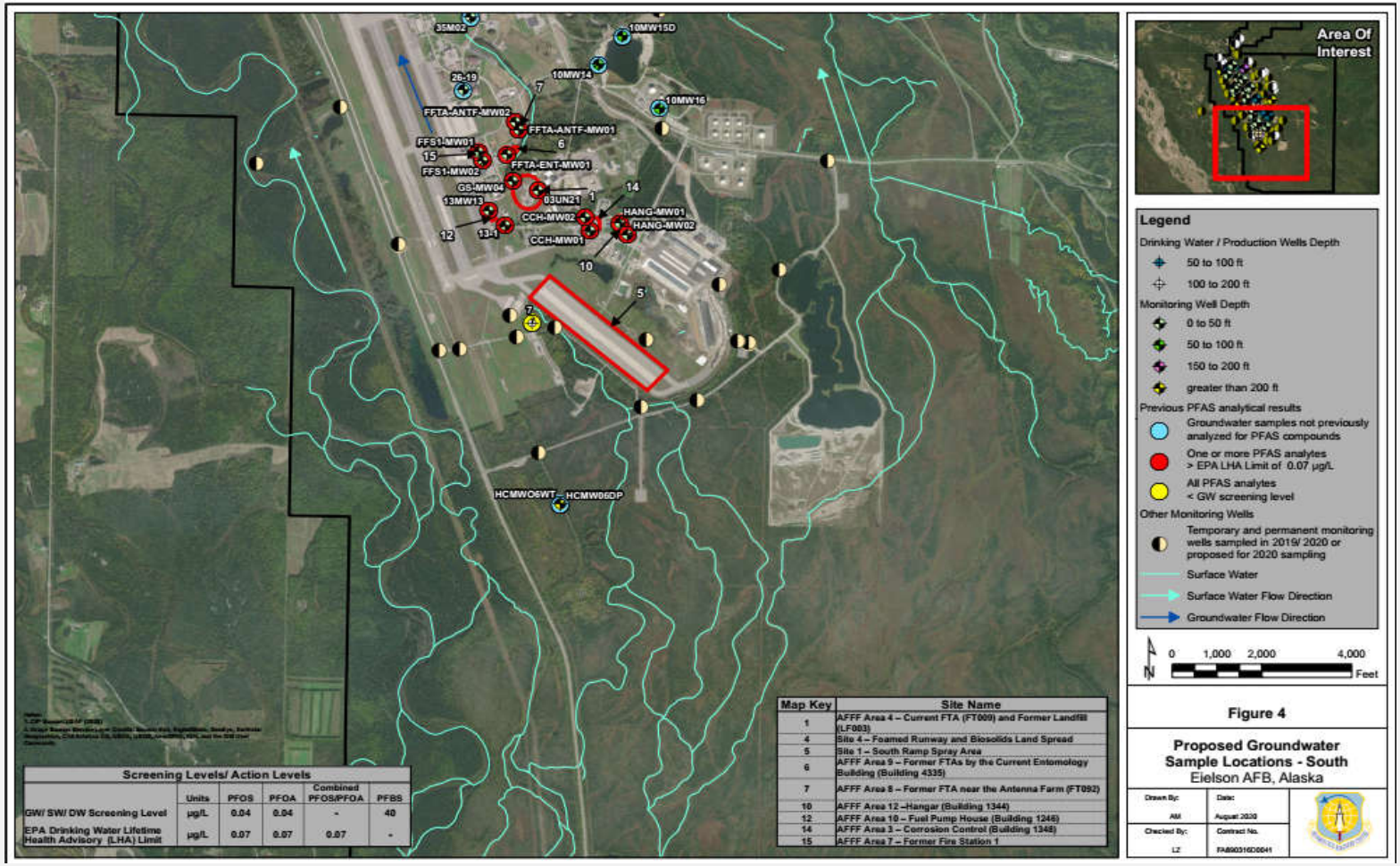
Proposed Fall 2020 Groundwater Sampling Scope

Groundwater Sampling (50 Existing Wells)

- Provide update on PFAS distribution from 2015 and 2016 results
- Collect PFAS data from wells previously unsampled
- Provide new data in deeper wells or wells along the edges of identified PFAS extents
- Collect additional data for preliminary F&T modeling

Fall sampling event data provides more robust CSM for finalizing RI scope

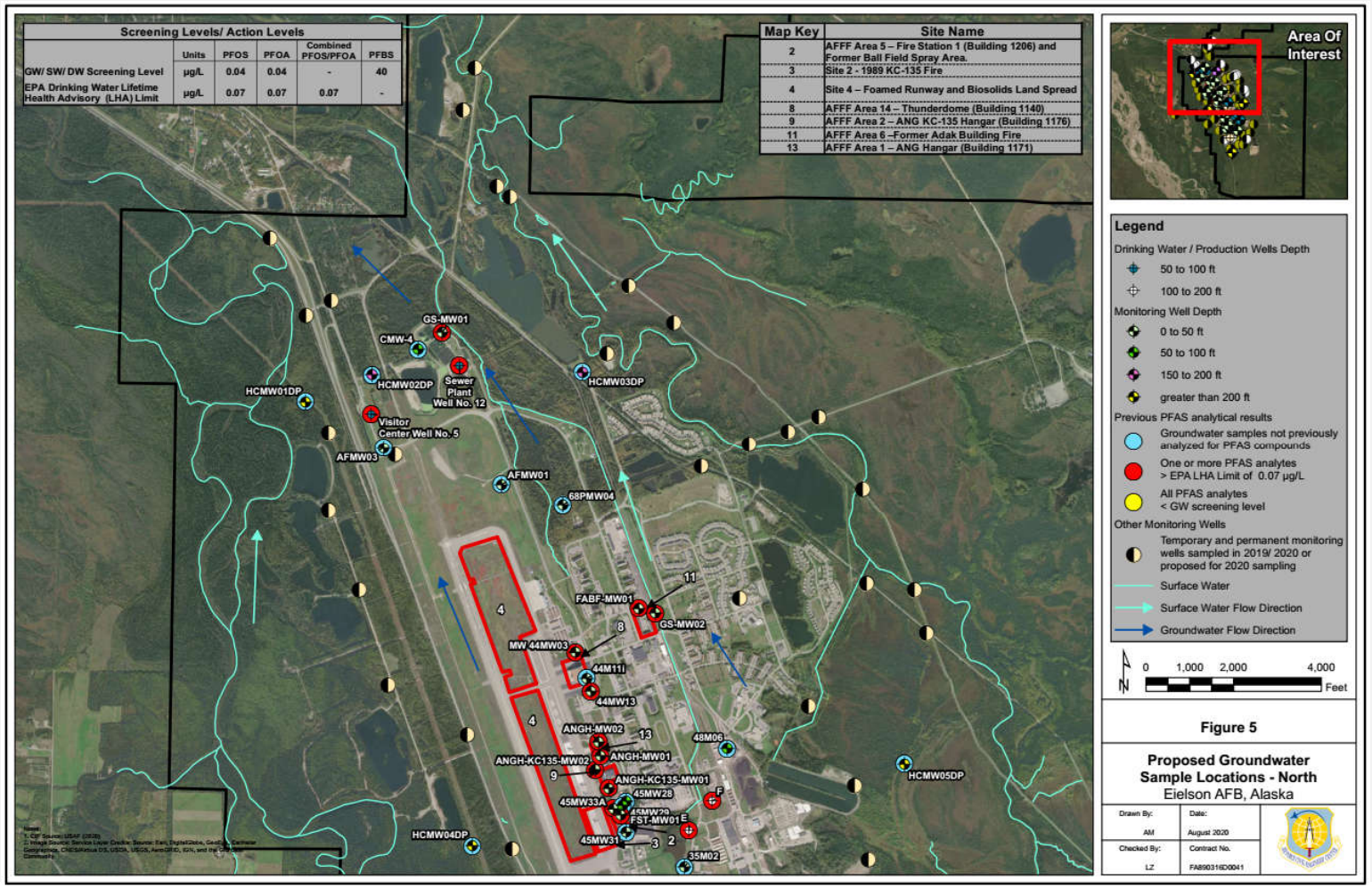
Proposed GW Sampling Locations – South Area



Map Key	Site Name
1	AFFF Area 4 – Current FTA (FT009) and Former Landfill (LF003)
4	Site 4 – Foamed Runway and Biosolids Land Spread
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Screening Levels/ Action Levels	Units	PFOS	PFOA	Combined PFOS/PFOA	PFBS
GW/ SW/ DW Screening Level	µg/L	0.04	0.04	-	40
EPA Drinking Water Lifetime Health Advisory (LHA) Limit	µg/L	0.07	0.07	0.07	-

Proposed GW Sampling Locations – North Area



QAPP ADDENDUM CROSSWALK



QAPP Addendum Crosswalk – Eielson AFB

- Crosswalk illustrates what worksheets will be included in the QAPP Addendum and will aid in a streamlined review process.

- Total of 27 worksheets will be included in the Addendum, however all worksheets in the Addendum are related to three topics:
  - Company or personnel changes = 13 worksheets (1–8, 29, 31, 32, 33, and 37)
  - Laboratory change = 9 worksheets (15, 19, 23-28, 30)
  - New Scope of Work = 5 worksheets (9, 14, 16, 17, and 20)

- Primary changes = Expanded PFAS list (24) & implement the Fall GW sampling scope

QAPP Addendum Crosswalk – Part 1

Optimized UFP-QAPP Worksheets		Expanded SI WP (Sundance 2019)	Eielson AFB QAPP Addendum
1 & 2	Title and Approval Page		✓ Project-specific personnel and signatures
3 & 5	Project Organization and QAPP Distribution		✓ BEM Team organizational information
4, 7 & 8	Personnel Qualifications and Sign-off Sheet		✓ BEM Team personnel experience
6	Communication Pathways		✓ Project-specific communication information
9	Project Planning Session Summary		✓ Project-specific planning sessions
10	Conceptual Site Model	✓	

QAPP Addendum Crosswalk – Part 2

Optimized UFP-QAPP Worksheets		Expanded SI WP (Sundance 2019)	Eielson AFB QAPP Addendum
11	Project/Data Quality Objectives		✓ Project-specific DQOs added
12	Measurement Performance Criteria	✓	
13	Secondary Data Uses and Limitations	✓	
14 & 16	Project Tasks & Schedule		✓ Project-specific schedule
15	Project Action Limits and Laboratory-Specific Detection / Quantitation Limits		✓ PFAS-specific criteria added
17	Sampling Design and Rationale		✓ Project-specific sampling design developed
18	Sampling Locations and Methods		✓ Project-specific sampling design developed
19 & 30	Sample Containers, Preservation, and Hold Times		✓ PFAS-specific criteria added

QAPP Addendum Crosswalk – Part 3

Optimized UFP-QAPP Worksheets		Expanded SI WP (Sundance 2019)	Eielson AFB QAPP Addendum
20	Field QC	✓	✓ Project-specific information
21	Field Standard Operating Procedures (SOPs)	✓	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	✓	
23	Analytical SOPs		✓ Lab-specific information
24	Analytical Instrument Calibration		✓ Lab-specific information
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection		✓ Lab-specific information
26 & 27	Sample Handling, Custody, and Disposal		✓ Lab-specific information
28	Analytical Quality Control and Corrective Action	✓	✓ Lab-specific information

QAPP Addendum Crosswalk – Part 4

Optimized UFP-QAPP Worksheets		Expanded SI WP (Sundance 2019)	Eielson AFB QAPP Addendum
29	Project Documents and Records		✓ Project-specific personnel
31, 32 & 33	Assessments and Corrective Action		✓ Project-specific personnel
34	Data Verification and Validation Inputs		✓ Project-specific information added
35	Data Verification Procedures		✓ Project-specific information added
36	Data Validation Procedures	✓	✓ PFAS-specific criteria added
37	Data Usability Assessment		✓ Project-specific responsible personnel

PROJECT SCHEDULE



PROJECT SCHEDULE SUMMARY

FY2020 Q4

- QAPP/ HSP Addendum – Early September
- QAPP Review Schedule – see next slide
- **Sample 50 Existing Wells**

FY2021 Q1

- Evaluate Data Collected in Q4 2020
- Project Review Meeting of GW Sampling Event – November
- Triad/ Scoping Meeting in Dec 2020/Jan 2021 Timeframe submission of Draft QPP

FY2021 Q2/ Q3

- AFCEC & Regulatory Approval of Final QPP – April
- **Mobilization for Base Scope – May**
- Exercise Optional CLINs – as needed
- Triad Implementation

FY2021 Q4

- Complete Base Scope and Optional CLINs
- Prepare ERPIMS Submission
- Complete CSM
- End of Season Wrap-up Prior to Demobilization

FY2022

- Approval of ERPIMS data uploads
- Approval of Final CSM
- Approval of Draft/Final RI Report
- Finalize Project Documents

- **Recommend implementing initial GW sampling to refine base scope work plan: minor delay in QAPP schedule offset by better initial planning and sample placement**

September- October 2020

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 Scoping Meeting AF Provides Pre-Draft QAPP Addendum and APP Comments	2 BEM Team incorporates comments	3 AF Reviews Comments	4 AF Approves Pre-Draft QAPP Addendum and APP and submits to Agencies	5
6	7 HOLIDAY	8 Agencies Review	9 Agencies Review	10 Agencies Review	11 Agencies Review	12
13	14 Agencies Review	15 Agencies Review	16 Agencies Review	17 Agencies Review	18 Agencies provide comments	19
20	21 *Working Meeting to discuss Agencies Comments*	22 BEM Team Incorporate Comments	23 Submit Draft-Final QAPP	24 AF and Agencies Review Draft-Final	25 AF and Agencies Review Draft-Final	26
27	28 AF and Agencies Review Draft-Final	29 AF and Agencies Review Draft-Final	30 AF and Agencies Provide Comments	1 BEM Team incorporate comments and Submit Final QAPP Addendum	2 Mobilize	3 Mobilize
4	5 Field Work	6 Field Work	7 Field Work	8 Field Work	9 Field Work	10 Field Work
11 Field Work	12 Field Work	13 Field Work	14 Demobilize	15	16	17

Near-Future Action Items

- Submission of Draft QAPP Addendum for Fall Sampling Event
- Regulatory Review and Approval of QAPP Addendum
- Establish Field Schedule and Logistics with Base POCs
- Implement Data Collection and Analysis
- Obtain Results of FY20 GW Assessments
- Establishment of TRIAD Training Session Dates for RI QPP
- Conduct TRIAD Training Sessions Prior to Draft RI QPP Submission

BEM SYSTEMS

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Final Meeting Minutes – CDRL B009

DATE: 27 January 2021

Date of Meeting: 21 January 2021

Subject: Discussion on Vertical Aquifer Profile (VAP) Transects 4 and 5 Locations Remedial Investigation for PFAS at Various Sites at Eielson Air Force Base, Alaska, Contract Number No. FA8903-16-D-0041, Task Order FA8903-20-F-1108

Attendees:

AFCEC:	Kristina Smith (Remedial Project Manager), Michael Boese (Technical Division), and Roy Willis (Team Lead)
BEM Systems, Inc.:	Chris Pisarri (Project Manager), Kevin Gallagher (Assistant Project Manager), and Lesa Zimnawoda (Deputy Technical Lead).
Arcadis U.S., Inc.:	Thomas Darby (Technical Lead)

A meeting was held with AFCEC and the BEM Team (BEM and Arcadis) on 21 January 2021 to discuss the locations for VAP Transects 4 and 5. AFCEC lead the discussion with the following comments:

- During the expanded SI, groundwater samples were collected around Chena Slough on both sides of the railroad tracks and further west.
- There were a lot of changes to the proposed sample locations during the field event. BEM requested the coordinates for the Phase 4 Expanded SI sample locations. The USAF will forward the coordinates to the BEM Team upon receipt.
- Chena Slough on the northside of the flood plain used to be connected to Moose Creek prior to conduction of the flood diversion project.
- There is potential that that the PFAS groundwater plume originating from Eielson AFB has the crossed the dam and preferential pathways need to be determined to figure out plume behavior.

AFCEC recommended moving Transect 5 closer to the Moose Creek Bluff. BEM Team recommended shortening Transect 4 either at the Bluff or at the intersection. AFCEC followed up that it is unknown how far the Bluff extends (aquitard).

The BEM Team also mentioned that the contamination to the west along the flood plains is most likely driven by surface water contamination. The BEM team recommended that we use Transects 3 and 4 during the prescriptive phase and then determine the best location for Transect 5 during the adaptive phase.

BEM mentioned that east of the surface water pond to add some VAP borings to determine the old surface water pathway and that there were previously some exceedances in that area. AFCEC stated that the Expanded SI targeted those areas and that the surface water body was constructed in the last five (5) years. It is also unknown where the majority of the contamination extends in this part of the study area and it may have dispersed due to diffusion.

BEM asked if the Eielson Groundwater Model (Ahtna, 2020) used any tracers. AFCEC said that no tracers were used but there were transducers installed in the nested wells. AFCEC recommended installing transducers in monitoring wells installed near Moose Creek Bluff. There are discussions of expanding the groundwater model to the vicinity of Moose Creek Bluff. BEM stated that the adaptive phase will allow the team to go back and fill in any data gaps. The BEM Team stated that Transect 4 will be adjusted. Stepping into Moose Creek Bluff will allow for a shorter transect and better understanding of contaminant transport in this area.

AFCEC stated that the Phase 4 Expanded SI data will be available the week of 25 January 2021 and data will be provided upon receipt. It may be useful to wait on placement of Transect 5 until the Phase 4 data can be evaluated. The BEM Team asked how the location of Transect 5 should be addressed during the presentation and AFCEC said just to mention that we are waiting on review of the Phase 4 data prior to finalizing the location of VAP Transect 5.

AFCEC is concerned that the groundwater plume is expanding or if it is in a steady state. They are wanting to determine, if the plume is expanding, how long until the plume exceeds the EPA LHA. BEM recommended a future meeting with the Groundwater Modeling team (Ahtna/Geosyntec) to discuss the modeling data and it's uses for predicting PFAS-contaminant transport rates upon which the LHA may be exceeded.

It was then discussed that Transect 5 should be placed along the road as a place holder (see attached figure). During the RI field activities, Transect 4 will be completed and then the data reviewed to determine the most-appropriate installation location for Transect 5. The Expanded SI Team believes that there is upwelling in the vicinity of Transect 4 proposed location (attached). Figures 8 and 14 in the PFAS RI QAPP were revised as shown on the attached figure.

AFCEC also stated that the UFP-QAPP format is difficult to follow for obtaining an understanding of the purpose of all the sample types. They recommended including a summary table that clearly states the purpose behind each sample for providing data to support the RI.

Action Items:

Item	Responsible Party	Suspense
Provided Expanded SI Phase 4 sample locations and results.	AFCEC	Week of 25 January 2021
Revise Figure 8 and 14 of the UFP-QAPP to show new proposed locations of Transects 4 and 5	BEM Team	26 January 2021
Include a table in the UFP-QAPP to state the purpose behind each sample	AFCEC	29 January 2021 (included in submittal of Draft QAPP)

BEM SYSTEMS

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Final Meeting Minutes – CDRL B009

DATE:	08 February 2021
Date of Meeting:	27 January 2021
Subject:	Triad Training No. 2 Remedial Investigation for PFAS at Various Sites at Eielson Air Force Base, Alaska, Contract Number No. FA8903-16-D-0041, Task Order FA8903-20-F-1108
Attendees:	
AFCEC:	Kristina Smith (Remedial Project Manager), Michael Boese (Technical Division), Roy Willis (Team Lead), Shannon Garcia (Technical Division), Nik Drenning (RPM), and Tim Sueltenfuss (Meeting Facilitator)
ADEC:	Dennis Shepard (ADEC Project Manager) and Axel Levan
USEPA:	Dustan Bott (USEPA Project Manager), Charles Clabaugh, and Cascade Galasso-Irish
BEM Team. (BEM Systems, Inc. and Arcadis U.S., Inc.)	Mark Nardolillo (CEO/Corporate Sponsor), Chris Pisarri (Project Manager) Kevin Gallagher (Assistant Project Manager), Lesa Zimnawoda (Deputy Technical Lead), Andy Crabb (Project Chemist), Artie Wickham (Lead Hydrogeologist), Joe Quinnan (Quality Assurance/Quality Control Manager), Ginna Demetrios (Deputy Project Manager), Thomas Darby (Technical Lead), and Marissa McCann (Task Manager)
Other:	Leanne Osgood (Shannon & Wilson) and Jeff Peterson (SLR)

BEM Systems, Inc. and Arcadis U.S., Inc. (the BEM Team) presented Triad Training Session 2 on 27 January 2021. Attendees for the Triad Training included AFCEC, ADEC, EPA Region X, the BEM Team, SLR, and Shannon & Wilson. The purpose of the Triad Training was to provide the USAF staff and regulatory stakeholders with an overview of the Triad approach and how incorporation of the Triad methodology will assist in achieving AFCEC's objective of delineation of validated source areas and evaluating base wide impacts to groundwater, surface water, and soils during the implementation of the proposed Remedial Investigation (RI) at Eielson AFB. Salient discussion points and action items are noted below.

Introductions were conducted by Chris Pisarri (BEM Team Project Manager)

Discussion on Slide 19, RI Scope Elements included the following:

- EPA asked if samples from lysimeters and source area samples will be collected within the source area.
    - BEM Team responded that due to the site conditions (shallow groundwater table, seasonal frost-heave, and short field season), SPLP samples were selected as the data collection method to evaluate source strength.
    - EPA followed up with a question that within the field season if there will be any lysimeters collocated with SPLP sample locations to forecast future leaching.

- BEM Team responded that lysimeters were evaluated during the development of the technical approach for this RI and SPLP were determined to be a better fit.
- EPA mentioned that a pilot test was conducted at Grayling Army Airfield and it included comparisons between lysimeters and SPLP samples.
- The BEM Team responded that SPLP is comparable to lysimeters in evaluating source strength and that members of the BEM Team (i.e., Arcadis key staff) played a significant role in the development and analysis of the Grayling Army Airfield project. Lysimeters are less conservative approach. For Eielson, other data will also be utilized to determine source strength (soil samples, ground water samples, VAP, HPT). There are also flux transects located down gradient of Eielson AFB to evaluate transport pathways. At this stage there is not a plan to use lysimeters, which is not a compromise to data quality for the RI.
- EPA agreed that SPLP samples are a better choice and HPT will be useful in determining permeable zones. EPA also noted that the use of lysimeters can be completed during a future field season.

<u>Discussion GIS Web Application presentation included the following:</u>

- ADEC asked if data is visible once an area is zoomed into on the GIS web application.
  - BEM Team provided a demonstration.
- ADEC asked if data shown on the GIS web application included non-detect data.
  - BEM Team demonstrated by pressing on a point showing that the application includes report layers and the legend updates based on what layers are turned on.
  - ADEC followed up asking if the non-detect data includes a symbol showing if the method detection limits exceed the screening level.
  - BEM Team stated that the application does not currently but will revise to colorize the non-detects exceeding the screening levels.
- AFCEC asked if the Fall 2020 groundwater sampling event analytical data distinguishes concentrations by depth.
  - The BEM Team stated that there is also a plan to include a filter to sort each sample location by depth. It will be set up so a matrix is selected and then sort by depth.
  - BEM Team also stated that during the March/ April Triad Session 3 this function will be included. This session will include a tutorial on available functions.
- AFCEC asked what the orange dot with a white center symbolized.
  - BEM Team responded that the white dot represents the location where data was collected while the orange circle represents the result. The view can be customized by selecting or turning off the various layers.
- AFCEC requested a printout of Site 1 South Ramp Area with a scale. They want to include data within the southern plume boundaries, specifically south ramp area.
  - ADEC requested that the analytical results present the sum of PFOS/ PFOA in comparison to the EPA LHA.
  - BEM Team responded that they would provide the analytical results in the format requested by ADEC and will discuss the specifics after the meeting.

<u>Discussion on Slide 37, Adaptive Source Characterization Decision Logic – Step Out 2:</u>

- ADEC mentioned that the source area borings are shallower than the transect borings. Will the vertical delineation DQO be met with these shallower borings?

- The BEM Team stated that there will also be a 3D EVS model showing lateral and vertical extent. As data is received the approach can change based on the results. If determined that PFAS contamination is present beyond the 25 foot boring target depth, adaptive borings may be installed to determine the vertical extent.
- BEM Team also noted that EVS models will be completed for each source area as well as the transects and other areas of interest.
- ADEC followed up stating that there is concern about preferential pathways in the downgradient transects. This can be evaluated once data is available.

Discussion of Eielson PFAS RI Project Dashboard presentation included the following:

- It was asked how stakeholders were to be informed when there are updates to the CSM or other pertinent data updates.
  - There are options and it was asked what is preferred: daily emails or automatic emails sent out when milestones are met.
    - It was mentioned that it is preferred that emails sent out when data was available for review prior to the next weekly/ biweekly meeting. These updates will provide input for the upcoming weekly/ biweekly meetings.
- BEM Team requested a date to coordinate with ADEC and EPA to test their connectivity to the project dashboard. The BEM Team indicated that a connectivity test has been conducted with DoD and they were able to access the dashboard through their computers.
  - EPA mentioned that they will most likely be able to access if DoD was able.
- The BEM Team asked for input on the type of progress charts the stakeholders would like to see.
  - ADEC mentioned that it would be useful to have progress broken out based on each source area, transect, and monitoring wells by depth.
  - The BEM Team stated that these progress charts can be connected to the site map on the home page.

Follow-up Questions:

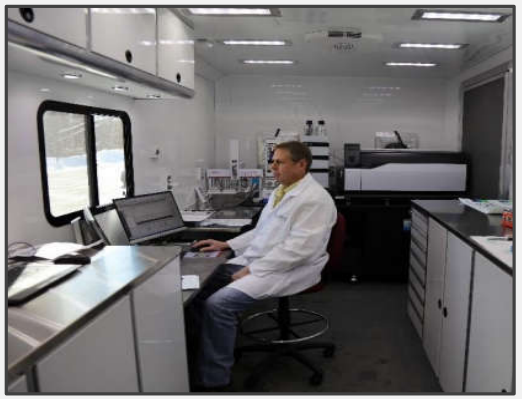
- ADEC requested access to the geodatabase.
  - The BEM Team stated that a geodatabase is required as part of the project and to send a request to AFCEC.

Action Items:

Item	Responsible Party	Suspense
AFCEC requested a printout of Site 1 South Ramp Area with a scale. They would like to include the data within the southern plume boundaries, specifically south ramp area.	BEM Team	29 January 2021 (PDF of the area with historical data and Fall 2020 data was provided as well as KMZ files). **Complete**.
Dashboard Access Test	BEM Team, EPA, and ADEC	5 February 2021. **Complete**
Provide ADEC with a copy of the Geodatabase	AFCEC	August 2022 (at completion of the project).

Implementing the Triad Approach for the Eielson AFB PFAS RI

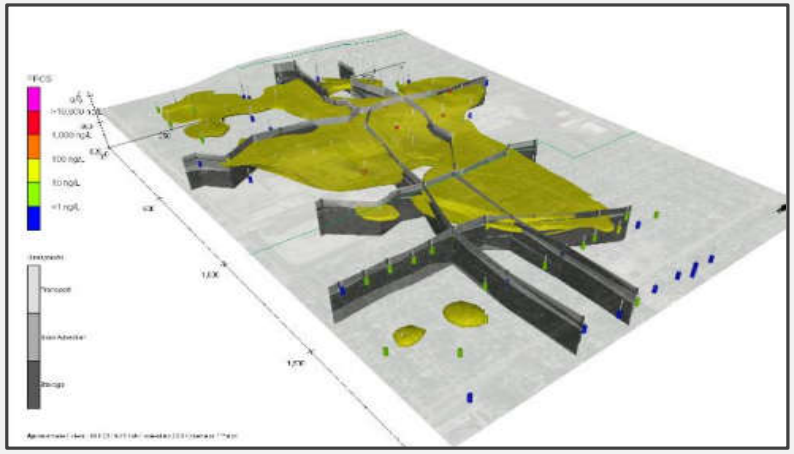
Training Session 2

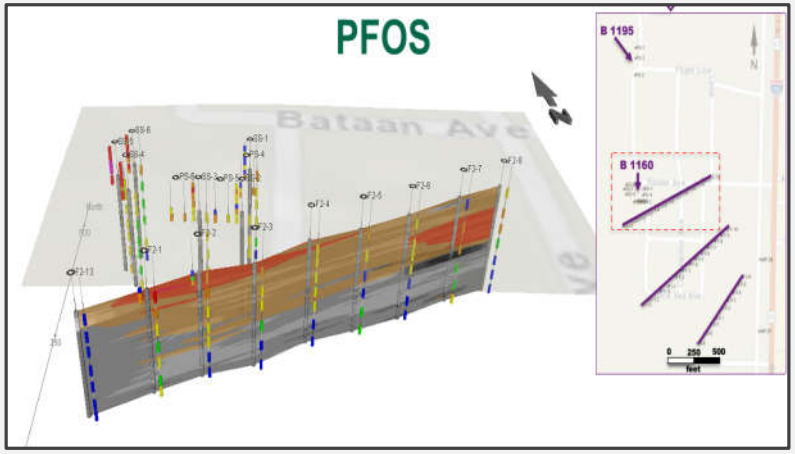


Submitted by

BALANCED ENVIRONMENTAL MANAGEMENT

BEM SYSTEMS





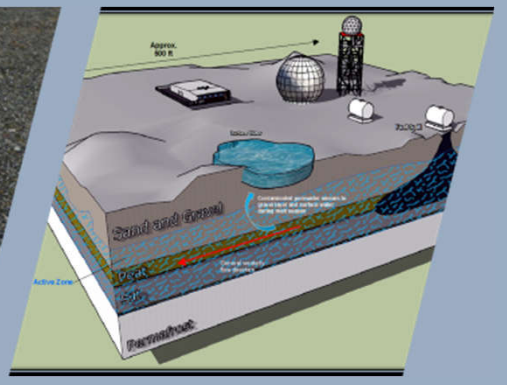
BEM ARCADIS

Training Outline

- RI Objectives and DQOs
- RI Terminology and Proposed Approach
- Session 1 Recap
  - Triad Pillar 1 Systematic Planning
  - Triad Pillar 2 Dynamic Work Strategies
  - Triad Pillar 3 Real Time Measurement Technologies
- RI Implementation
  - RI Scope Overview
  - CSM
  - Validated Source Areas / Scope Review
  - Communication & Decision-Making
- Interactive Dashboard Demonstration
- Closing and Next Steps
- Discussion
- Follow up Meeting - Project Dashboard Training and Project Work Plan Discussion







Eielson PFAS RI Objective

- Determine the vertical and lateral extent of PFAS in impacted media from USAF primary and secondary releases
- Determine their potential contribution to the Installation's PFAS groundwater plumes, and
- Collect data needed to support a future risk assessment *within a* ***single field season*** using innovative techniques following the Triad approach.

Eielson PFAS RI DQOs (QAPP Worksheet #11)

- *Use the Triad Approach to characterize the nature and extent of PFOS, PFOA, and PFBS using Prescriptive and Adaptive sampling*
  - *Expedited analysis for PFOS, PFOA, and PFBS by mobile lab*
  - *Definitive data using Table B-15 for 24 PFAS compounds (DOD QSM 5.3)*
- *Evaluate soil, sediment, groundwater, porewater, surface water and biota for PFAS in conformance with OSD Memorandum and DoD Instruction*
- *Update of the dCSM*
- *Rank & prioritize source areas based upon stratigraphic flux*
- *Provide high-quality / defensible data to support future risk assessment and remedial alternative evaluations*

Eielson PFAS RI Sampling Terminology

Prescriptive Approach

1. Pre-established sample locations based upon review of previous data
2. Prescriptive sample and boring locations presented on QAPP figures
3. Definitive sample analysis by fixed laboratory for 24 PFAS compounds listed in Table B-15
4. Screening level samples analysis by mobile laboratory (PFOS, PFOA, PFBS)

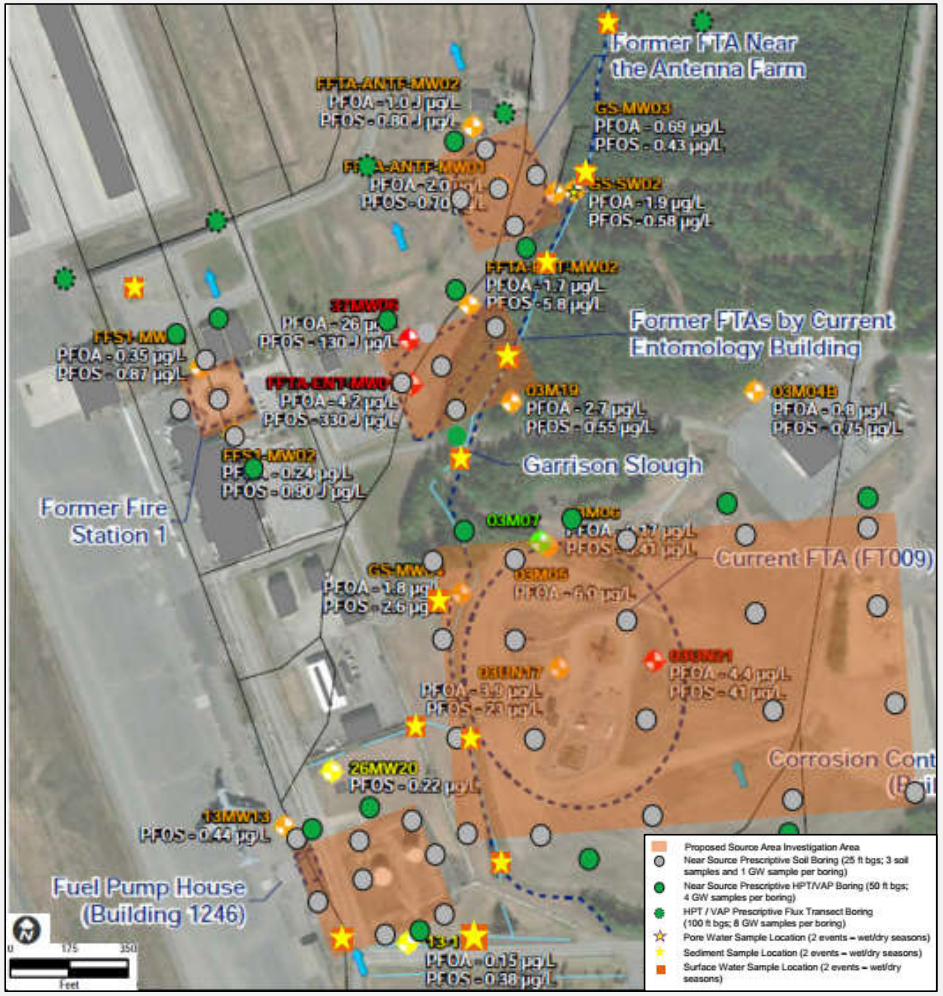
Adaptive Approach

1. Adaptive sample locations based upon prescriptive results
2. Samples collected for additional source and groundwater characterization
3. Step-out or Step-in sample locations based upon decision logic presented in **QAPP WS# 17**
4. Establish most-beneficial placement of permanent wells and confirmation samples for definitive sample collection

Data from both approaches used to update the dCSM

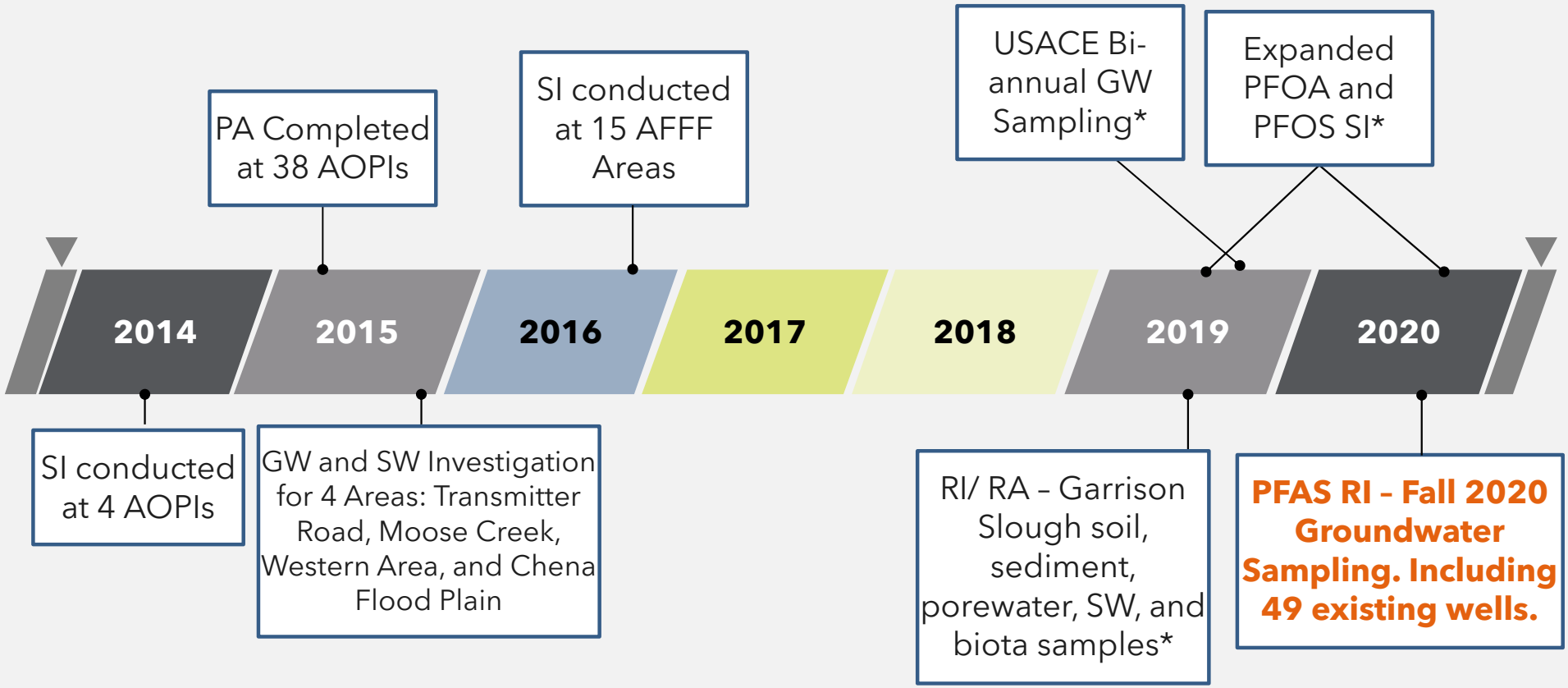
Eielson PFAS RI Triad Approach

- Multiple work elements completed concurrently
  - Source investigations at 13 validated areas (and 2 subsites)
  - Stratigraphic flux groundwater investigation
  - Surface water / sediment/ sediment porewater sampling on and off base
  - Groundwater well installation and sampling
  - Fish tissue sampling
- Implement *prescriptive* scope, as detailed on QAPP Worksheets 11, 17, & 18.
- Review of prescriptive results with AFCEC and Regulators for selection of adaptive step-outs or zoom-ins.
- Implement *adaptive* scope as described on QAPP Worksheets 11, 17, & 18.
- Real-time data review and CSM updates
- Consensus of final sample locations (i.e. monitoring wells) using **Field Change Forms**.
- Concurrence of field objective achievement prior to demobilization.



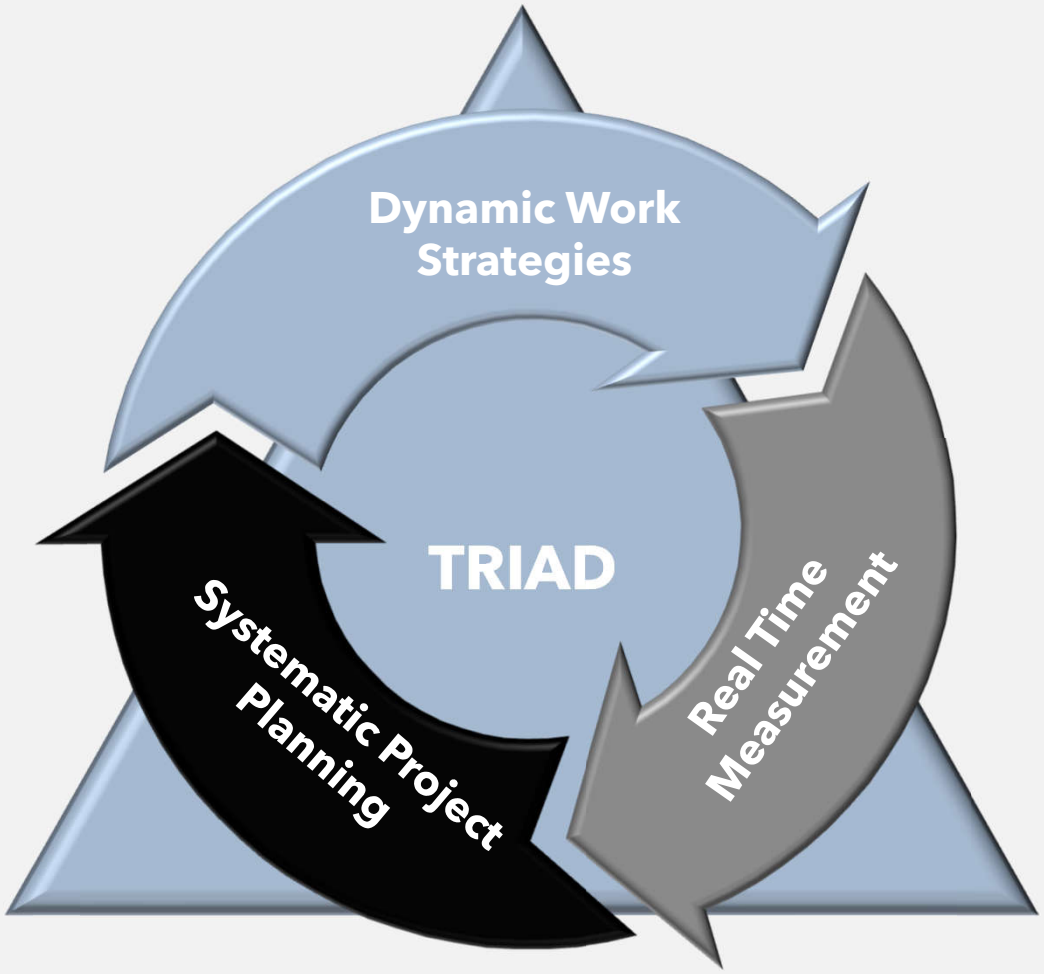
Project this complex with tight schedule milestones requires use of innovative methods

Historical PFAS Investigation Overview Summary



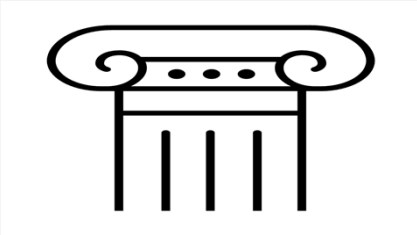
Historical investigations have identified PFAS-impacted media extending past the Community of Moose Creek

Session 1 Recap

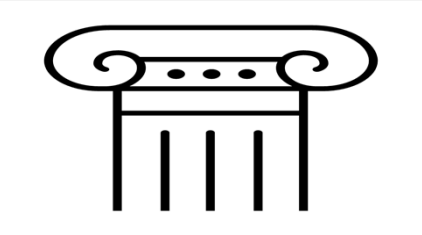


What is Triad?

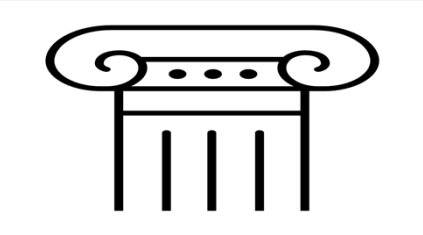
- Triad is an EPA-approved strategic process designed to reduce decision uncertainty and improve data defensibility based upon science and technology through an adaptive process in response to spatial heterogeneity.
- The process formally developed in the 1990s to early 2000s with collaboration by regulatory agencies, industry, & stakeholders.
- The Triad framework is built on **3 interactive pillars**:
  - **Pillar 1** - Systematic Project Planning
  - **Pillar 2** - Dynamic Work Strategies
  - **Pillar 3** - Real Time Measurement Technologies



Systematic Project Planning



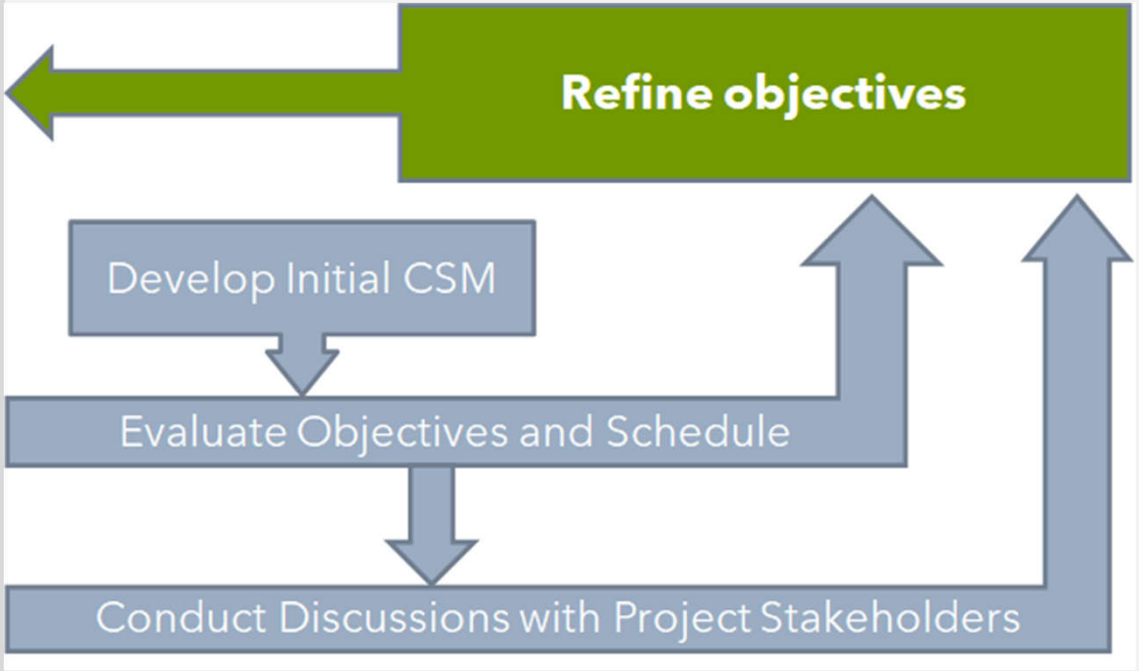
Dynamic Work Strategies



Real Time Measurement Technologies

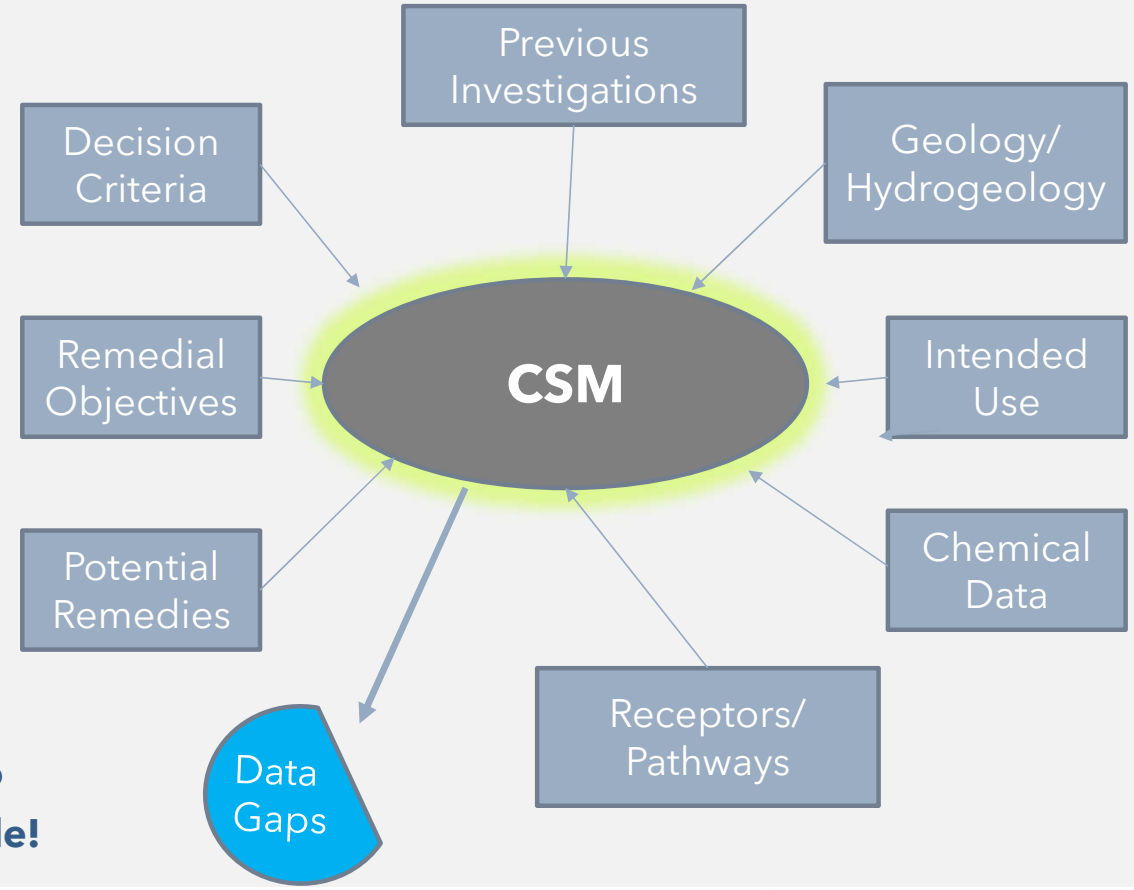
Systematic Project Planning – Initial Phase of the Process

- **Establish project objectives with de-emphasis on exact number, location and type of samples**
- Gather all information related to the objectives and develop an initial CSM
- Identify uncertainties & develop risk mitigation measures to accommodate changes
- Establish QA/QC Checkpoints & Data Acceptance Requirements
- Identify Stakeholders, and **establish communication and decision-making procedures**
- Refine the objectives



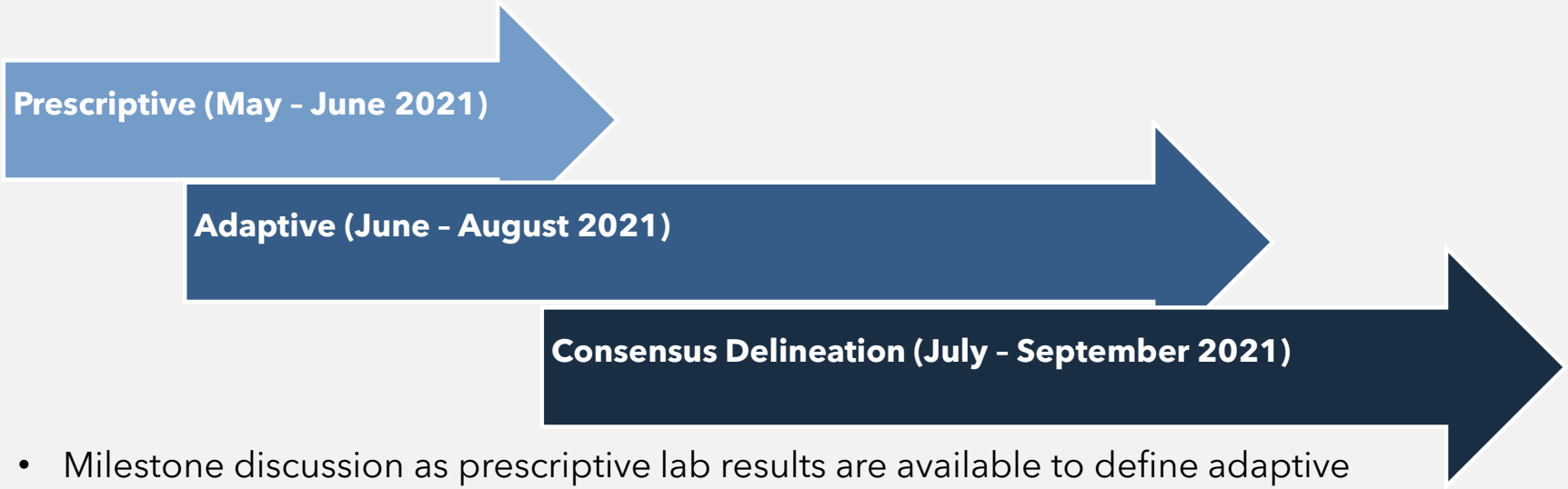
Conceptual Site Model (CSM) Development & Data Gaps

- An initial CSM should include:
  - Geographic setting
  - Geology/hydrogeology
  - Hydrology
  - Chemical data
  - Potential receptors
- What information can be leveraged?
  - Past investigations
  - Government records
  - Firsthand knowledge
  - Engineering drawings
- Knowing what we don't know is important!
  - Document data gaps as they come up
  - **Update CSM during project life-cycle!**



Stakeholder Engagement, Communication & Decision Making

- Multiple concurrent work-flows requires that stakeholder meetings match the schedule



- Milestone discussion as prescriptive lab results are available to define adaptive scope
- Implement adaptive scopes
- Conduct routine milestone discussions of adaptive data until delineation is complete

Use of Project Dashboard as Primary Means to Track Project Progress

Dynamic Work Strategies

Dynamic work-flow using the Triad Approach includes:

- Data Quality Objectives
- Sampling/Analytical Procedures
- Quality Assurance/Quality Control Procedures
- Decision-making logic
- Data management and communication

Adaptive Decision Logic (QAPP WS #17)

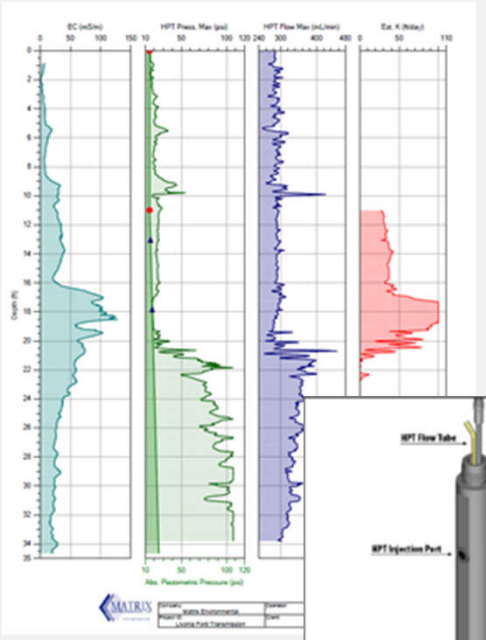
Triggering Event	Adaptive Contingency Action(s)
Source Delineation – Soil: Soil sample(s) less than screening levels (SLs) Soil sample(s) between 1 to 10 times (X) the SL Soil sample(s) greater than 10X the SL	1. Delineation Complete Step out 1 to 1.5X the boring spacing at representative locations Step out at each location 1.5 to 2X the boring spacing
Source Delineation - Groundwater: Groundwater sample(s) less than the SLs Groundwater sample(s) greater than SLs	1. If groundwater and soil results are less than SL, delineation is complete in that direction. No additional soil borings and groundwater samples. If groundwater result is greater than SL and soil result is less than SL, source delineation is complete in that direction. Evaluate downgradient sample locations to confirm that VAP transects will evaluate mass flux from this location and consider installation of VAP boring as needed.
PFAS results indicate refinement is needed: Extent not defined with sufficient precision (e.g., a sample greater than 20X the SL adjacent to non-detect [ND] value) Data suggests a non-continuous source or isolated source areas within a larger investigation area (e.g., ND values present within what was assumed to be a larger source area)	1. Step in between the ND and the exceedance locations to better evaluate distribution (approximately mid-point or as determined by the technical lead). Step in at location(s) with highest concentrations using two to three borings to evaluate extent of the more confined source area.

Provides flexibility to experts in the field allowing logic driven decisions based on information as it is acquired

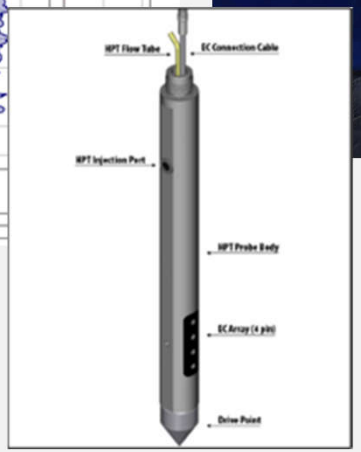
Real-Time Measurement Technologies

Types of measurement tools include:

- Mobile labs
- Fixed lab expedited turnaround
- Direct sensing tools advanced via DPT (i.e., Hydraulic Profiling Tool)







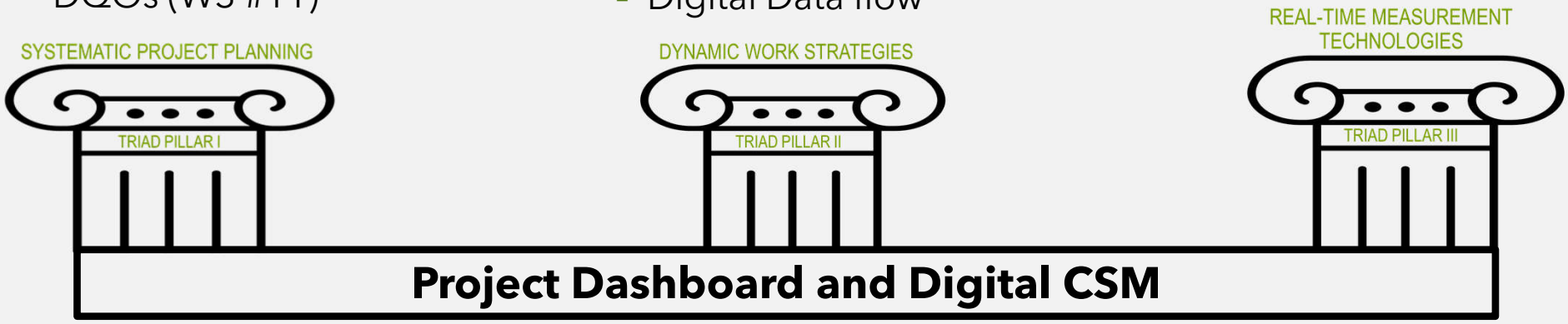
Technology is the Key Element of the BEM Team's Methodology!

TRIAD APPROACH FOR THE EIELSON PFAS RI

- QAPP
- Detailed CSM based on existing data
- DQOs (WS #11)

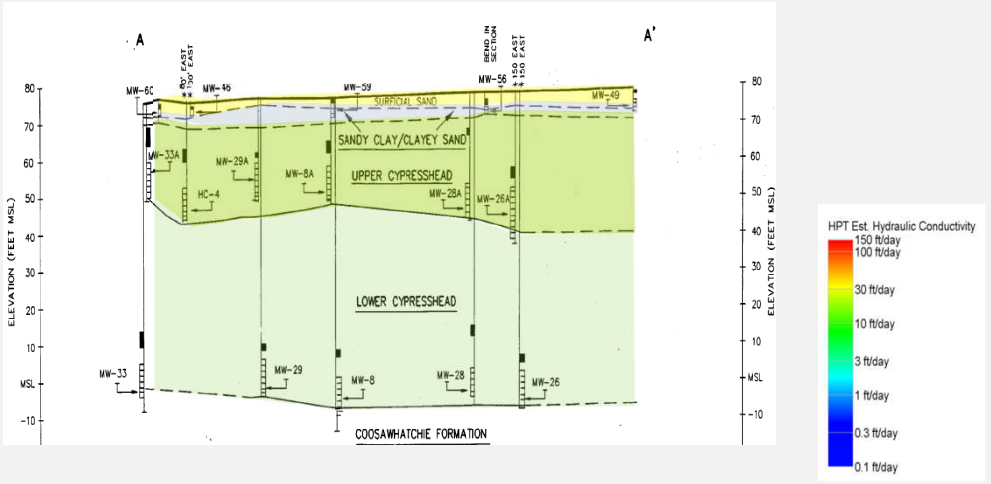
- Prescriptive and Adaptive Approach included in WS #17 of QAPP
- Developed adaptive decision logic
- Digital Data flow

- High resolution source characterization
- Stratigraphic flux approach for GW
- Mobile lab

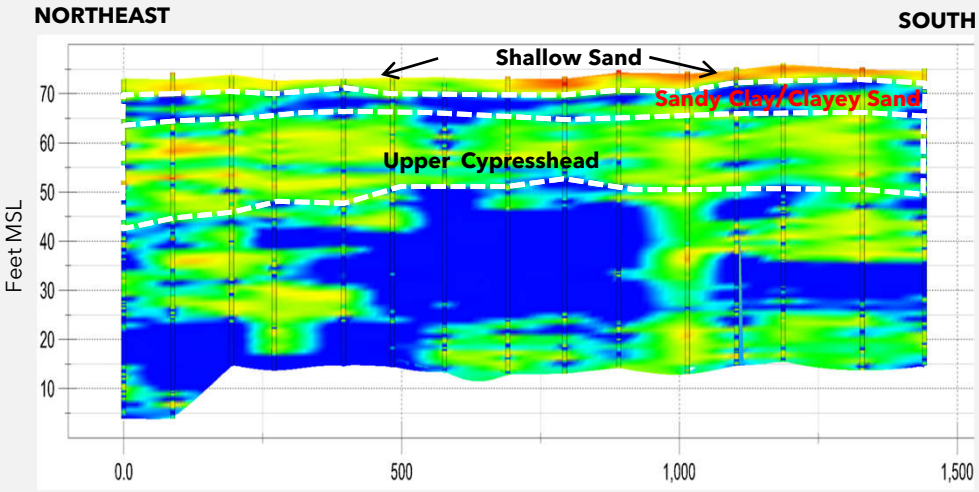


Example of Improved CSM using Innovative Approach and Tools

Old (School) Traditional CSM



Hydrofacies (New School) Correlation



Example of Cypresshead Formation:

- Upper – "massively bedded" fine sand
- Lower - greater clay and silt fraction
- Similar characteristics as Eielson, better resolution of potential flux

RI Implementation









EIELSON PFAS RI PRESCRIPTIVE PHASE QAPP WORKSHEET #18

Scope of work includes multiple media:

- **Source Area Borings**
  - Three discrete soil samples collected from vadose
  - Shallow GW below water table
- **HPT / VAP Borings**
  - Source Area HPT/VAP borings to 50 feet bgs
  - Stratigraphic Flux Transects
    - One transect mid-base
    - One transect at the downgradient base boundary
    - Three offsite
    - Depths up to 150', multiple sample intervals
- **Comprehensive SW/SED/Porewater**
  - 80 co-located SW/SED
  - 15 Porewater at select locations
- **Fish Tissue Sampling**
  - Twenty sampling locations across the base
- **Monitoring Wells**
  - Installation and sampling of 105 wells based on source / VAP results

AFFF Area (Site ID)	Source Area Soil Borings (~25 ft bgs)	VAP Borings (50 to 150 ft bgs)	Co-located SW/Sed Samples (2 events)
AFFF Area 1 (SS314P)	4	2	1
AFFF Area 2 (SS303P)	4	2	3
AFFF Area 3 (SS304P)	4	2	2
AFFF Area 4 (FT009)	20	6	5
AFFF Area 6 (SS302P)	9	4	5
AFFF Area 7 (FT092)	5	3	1
AFFF Area #8 (FT092 Subsite)	5	2	4
AFFF Area #9 (FT092 Subsite)	8	3	4
AFFF Area 10 (SS307P)	8	3	3
AFFF Area 12 (SS305P)	4	2	2
AFFF Area 14 (SS309P)	4	3	1
Site 1 (SS310P)	14	4	7
Site 3 (SS306P)	7	3	1
Site 2 (SS311P)	2	3	2
Site 4 (SS312P)	12	4	5
Transect 1	--	15 (100-foot)	--
Transect 2	--	7 (100-foot) and 16 (150 foot)	--
Transect 3	--	7 (150-foot)	--
Transect 4	--	1 (100-foot) 2 (150-foot)	--
Transect 5 (tentative location)	--	7 (100-foot)	--
Basewide and Off-site	20 (Adaptive)	--	54

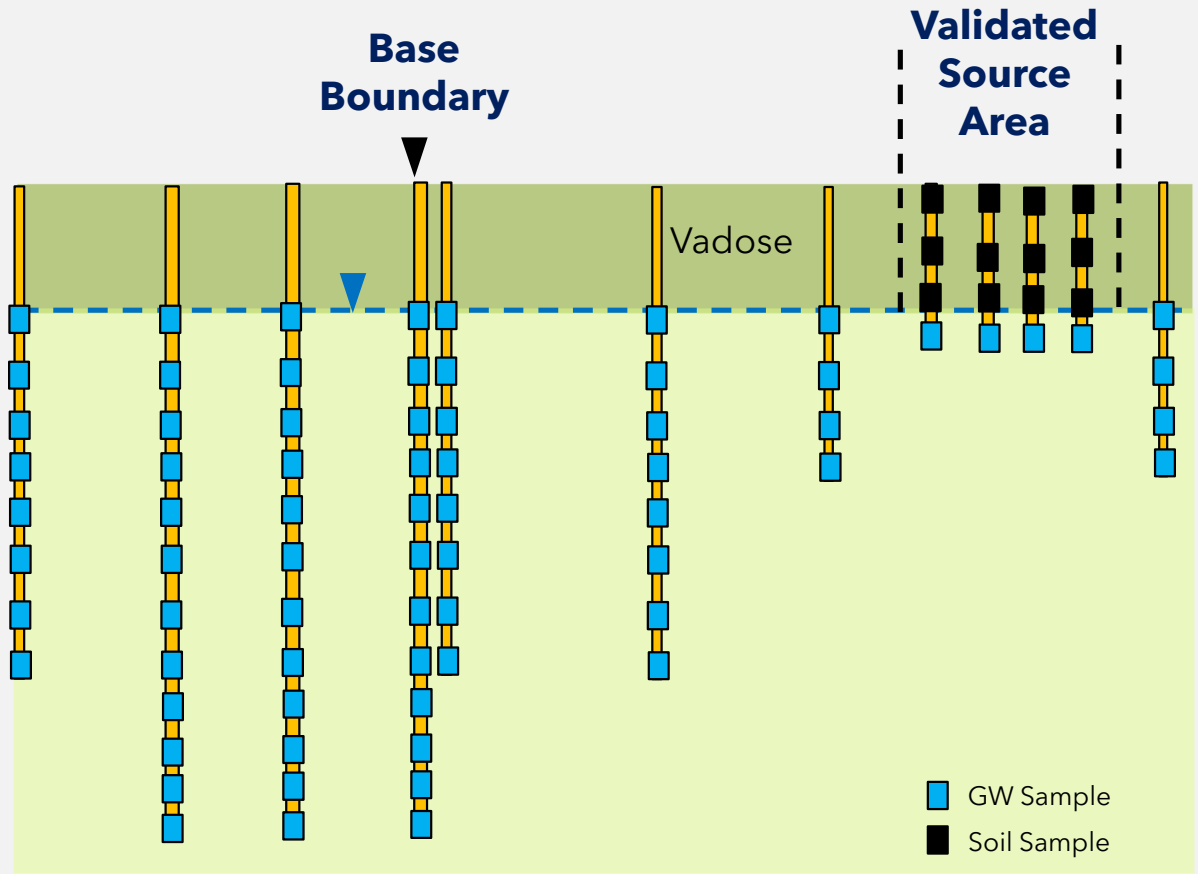
RI Scope Elements

Source Investigation

- Source Investigation borings in each validated source area
  - 3 soil samples
  - 1 shallow GW sample
- Source mass loading evaluated by and Synthetic Precipitation Leaching Procedure (SPLP) – location determined by prescriptive borings

Groundwater Delineation

- Define extent of plume with higher density sampling than MWs
- Allows optimal placement of MWs following plume delineation
- Compare mass discharge at transect to mass loading at sources



PFAS Analytical Strategy – Fixed Laboratory (Definitive)

- Provide definitive data for 24 PFAS compounds in accordance with Table B-15 (DOD QSM 5.3)
- Samples will be analyzed using a combination of standard and expedited TAT based on workflow and timing on receiving key data.
- All Fixed Laboratory Analytical Data will be validated by a 3rd Party Validator
- As available (prior to validation), analytical data will be incorporated into a digital CSM and posted on a project-specific dashboard



- <u>Samples analyzed by the fixed laboratory include:</u>
  - Samples with potential application for future risk assessments
    - surface soil,
    - representative subsurface soil and VAP groundwater,
    - fish tissue,
    - surface water, and
    - sediment
  - Final delineation samples
  - SPLP Samples
  - Physical and chemical properties samples
  - Groundwater from permanent monitoring wells
  - Analyze split samples from the mobile laboratory at 5% to validate results

PFAS Analytical Strategy – Mobile Laboratory (Screening)

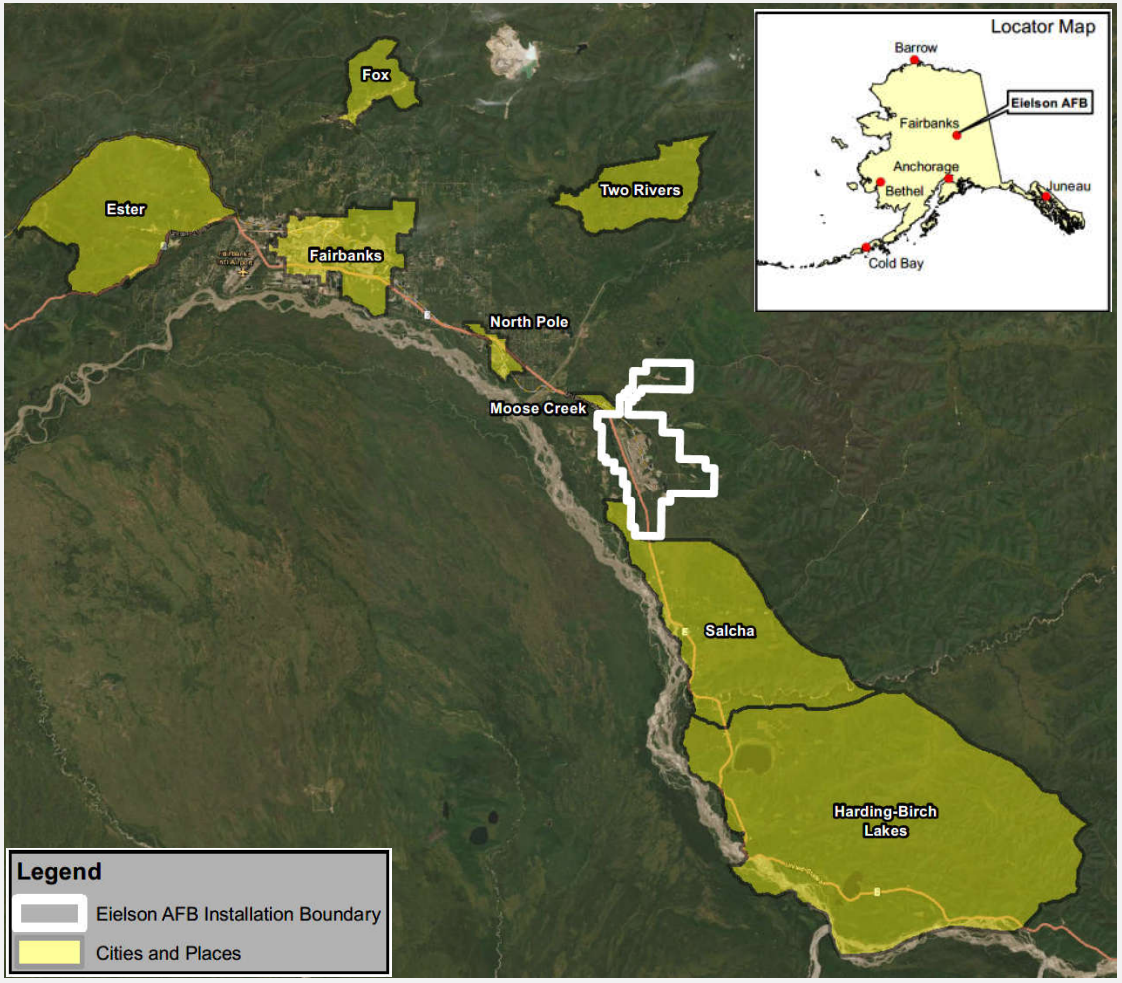
- Accelerated method used to provide screening level data for PFOS, PFOA, PFBS in multiple media.
- Results generally available next day with this method.
- Screening analytical data will be reviewed by the project chemist to ensure it meets the quality control standards
- After screening data is reviewed, it will be incorporated into a digital CSM and posted on a project-specific dashboard



- Data generated **will be used for intermediate decision** making to support adaptive characterization and recommendations for monitoring wells.
- Samples analyzed with this method include:
  - Subsurface Soil
  - VAP Groundwater
- 5% of samples will be split and analyzed by the Fixed Lab
  - Split sample data will be evaluated as a QC check on the comparability and reliability
  - Split samples will be front-loaded with 20 soil and groundwater samples to allow for an early evaluation of the mobile lab's accuracy and to make adjustments as needed.

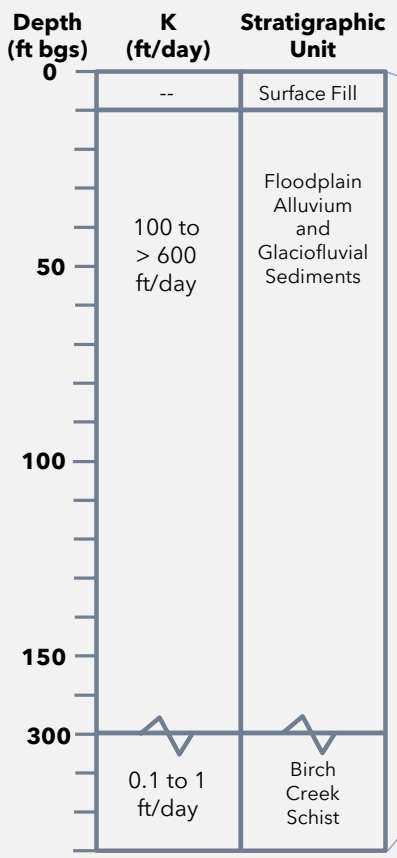
Site Location

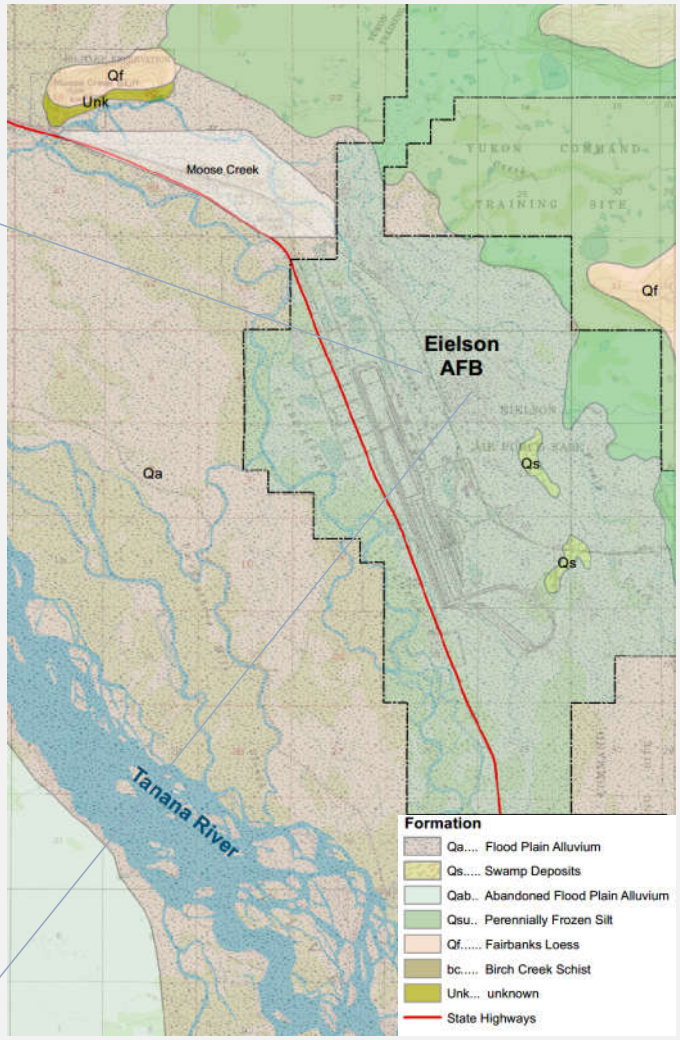
- EAFB lies ~1-mile SE of Moose Creek and ~9 miles SE of North Pole
- EAFB covers ~19,700 acres, ~3,651 acres are improved/partially improved land
- Located in the Tanana River Valley (89% alluvial floodplain, 11% uplands)
- Surface elevations range from 1,125 ft amsl (E) to 520 ft amsl (W)



Geology and Hydrogeology

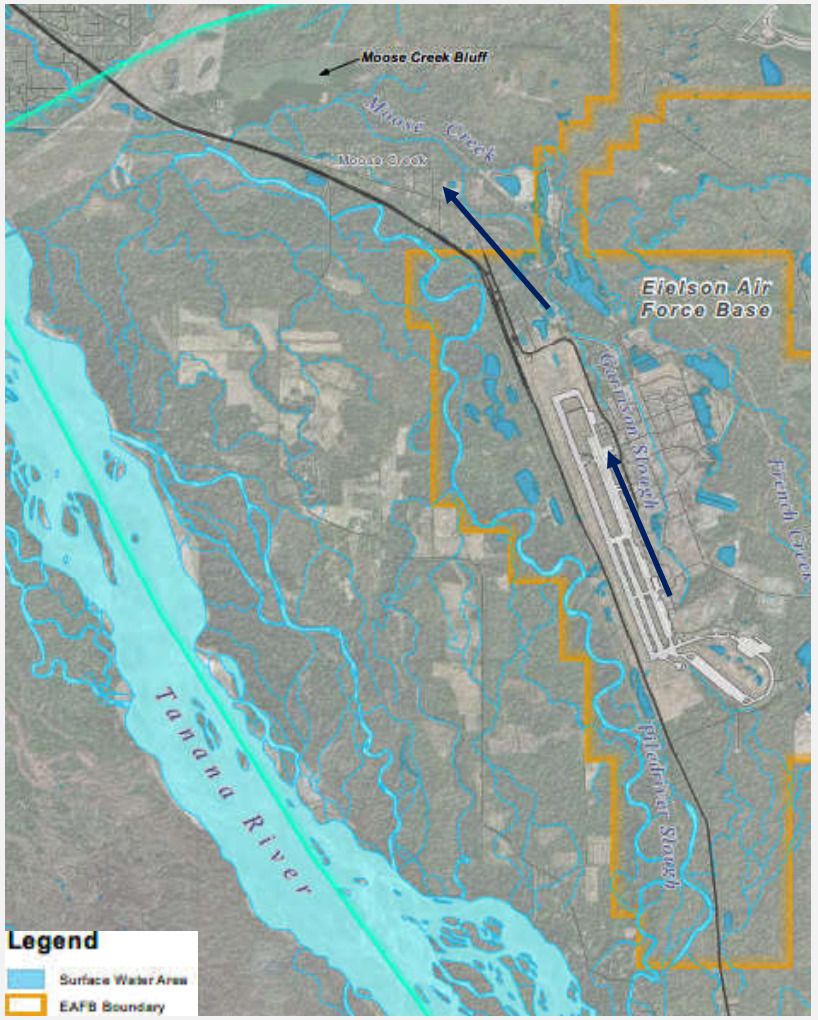
- Geology beneath the RI study area includes unconsolidated fluvial sand and gravels with interspersed lenses of silt
- Estimated at 250 to 400 feet thick
- Sediment underlain by Birch Creek Schist
- Aquifer materials is generally considered very permeable but heterogeneities in the deposition have had noted effect on groundwater flow





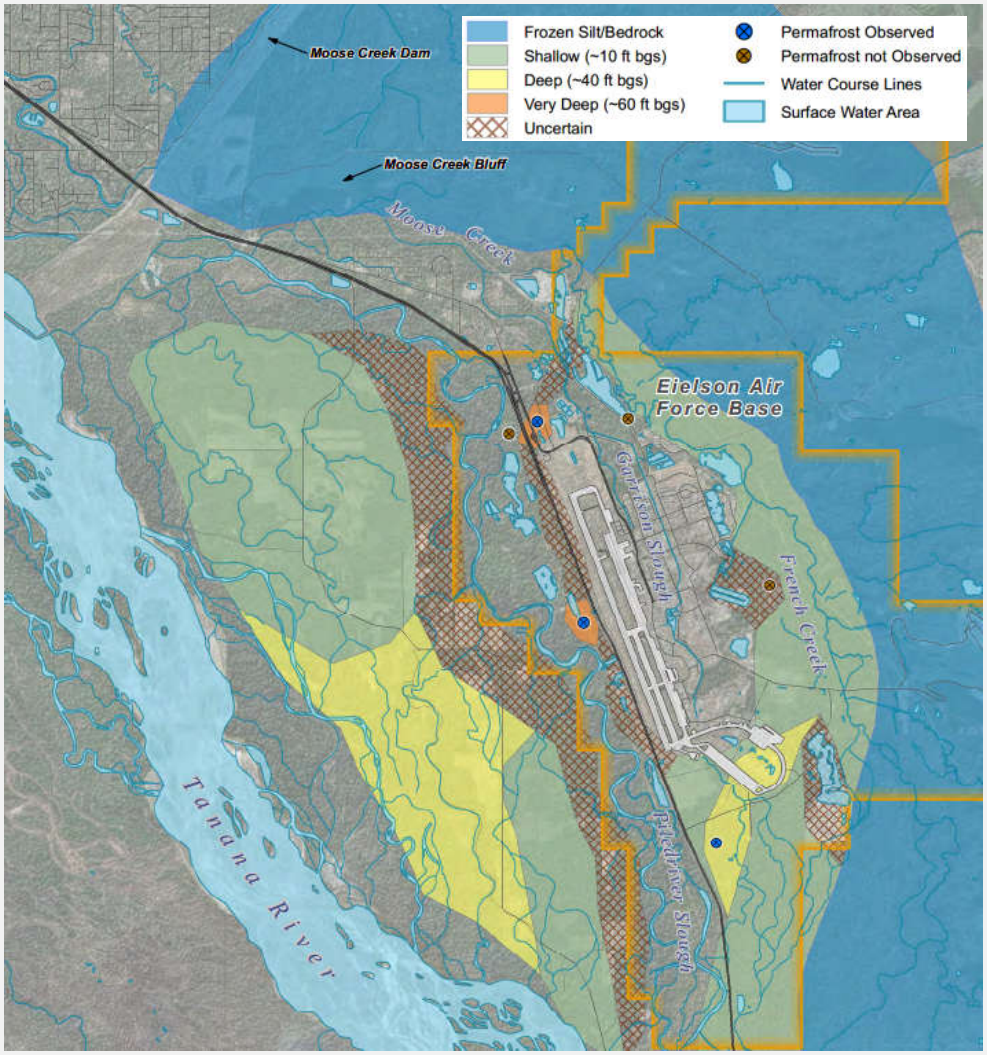
Hydrogeology and Hydrology

- Shallow groundwater present across the base, generally encountered less than 12 feet bgs.
- Groundwater & surface water flow to the north /northwest
- Several key surface water features present
  - Garrison Slough
  - Piledriver Slough
  - French Creek
  - Moose Creek
  - Multiple wetland, ponds and lakes
- Wet season (late May/ June 2021) in spring to coincide with snow melt, transitioning to the dry season (late July/ early August)



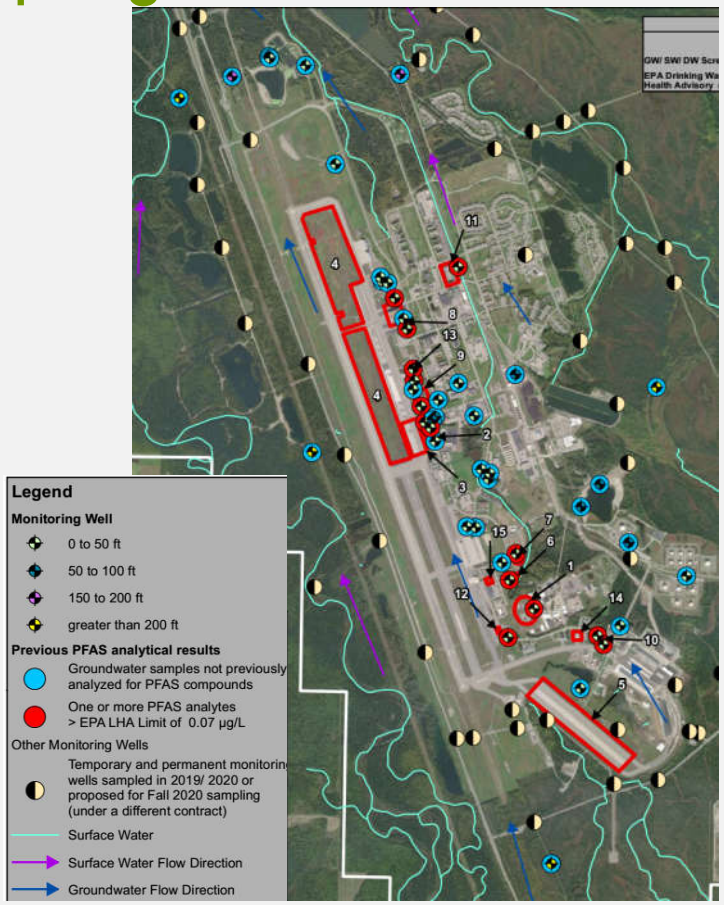
Permafrost Extent

- Permafrost across the majority of EAFB and the adjacent community of Moose Creek is regionally characterized as discontinuous.
- Where present, the presence of permafrost can act as a controlling factor in groundwater dynamics
- Permafrost has been documented between Piledriver Slough and the Tanana River
- Limited occurrences have been documented between the developed portion of EAFB and Piledriver Slough.
- Where present the occurrences have been deep and in thin layers.



Fall 2020 Groundwater Sampling Results

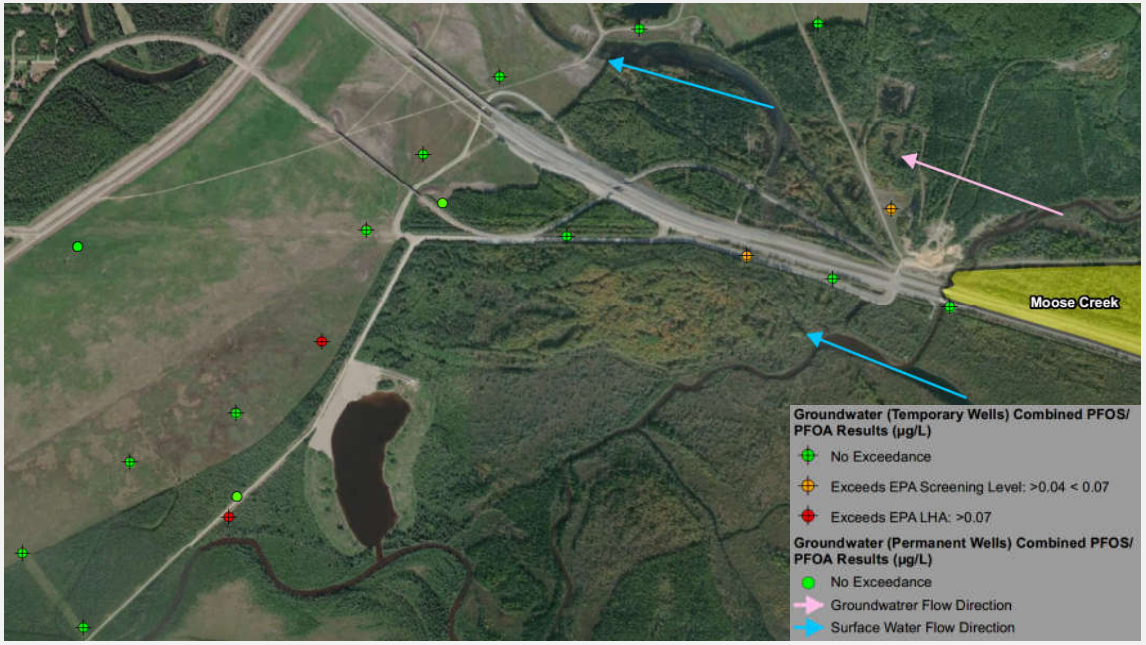
- Scope of work included 49 wells sampled across the site. Wells ranged in depth from 9 to 204 feet bgs.
- Wells selected to provide:
  - Updated PFAS data in areas sampled in 2016
  - Wells not previously sampled for PFAS
  - Multiple depths within the aquifer
- Results from wells previously sampled
  - Most results were consistent, in the same magnitude
  - Several concentrations increased but still within limits of proposed RI Scope
- Wells not previously sampled:
  - Results for shallow wells provided additional data that allowed for shallow GW scope adjustment
  - Deep wells (193 to 204 ft) confirmed vertical extent of characterization along the periphery of the investigation area
  - Limited intermediate/deep data onsite near validated source areas. Where available, confirms impacts extend to 50-100 ft bgs on base.



Fall Sampling Results used to adjust scope, but did not result in major modifications to RI Approach

Updated Off-base PFAS Extent

- Additional data collected in 2020 used to further evaluate lateral and vertical extent and to adjust proposed RI Scope
- Data included:
  - 2019 RI biota sampling
  - 2019 USACE biannual Groundwater Monitoring
  - 2019/2020 Expanded SI temporary and permanent monitoring wells
  - 2020 Groundwater Sampling Results
- Shallow groundwater impacts are present downgradient of Moose Creek, with exceedances detected in the SW near known/prior surface water pathways



- Limited intermediate data (2 well clusters to 50 & 100 ft) east of the Dam indicate no exceedance of screening levels at two areas. No deeper data exists.
- PFAS results are below screening levels for shallow locations to the North of Moose Creek Bluff, and shallow and limited intermediate (1 well to 65 ft) and deep (2 wells from 120 to 183 ft) locations in North Pole.

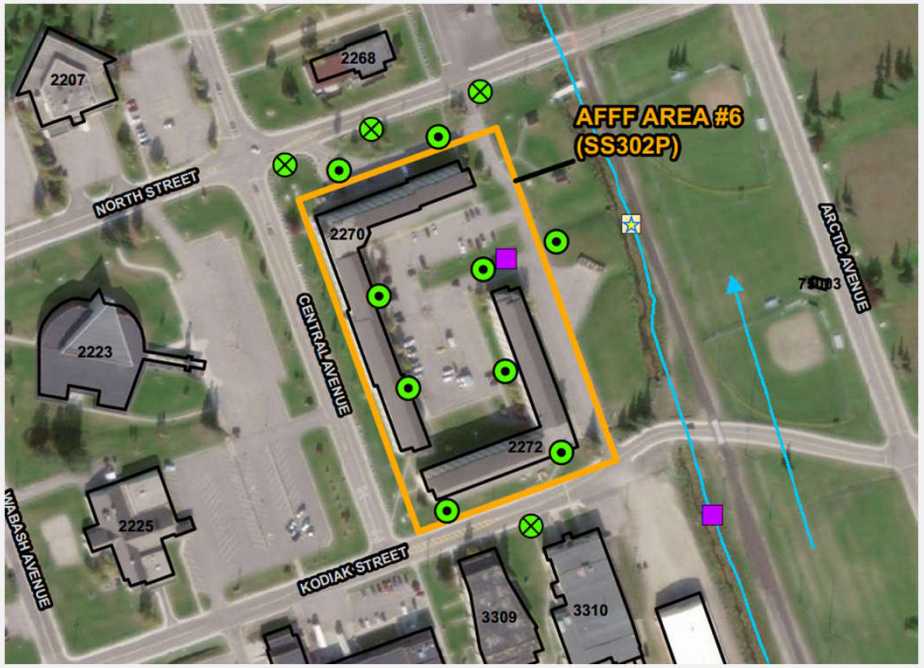
Project Team Communication and Decision-Making Consensus

Project Team communication will be managed to ensure frequent updates, maintain schedule and information sharing by workflow consisting of:

- Technical meetings & training presentations – in person and virtual
- Clear identification of project expectations and member roles
- A comprehensive project plan (QAPP) detailing sampling methods, decision-making logic and schedule
- Establishment of routinely scheduled progress meetings along with weekly or bi-weekly field progress meetings
- **Innovative data management and decision-making tools (project dashboard, 3-D digital CSM)**
- Identification/discussion of evolving scientific findings and emerging regulatory guidance that could influence the work associated with this RI.
- Use of Field Change Forms and scoping meeting minutes to document decisions.

The project's success is dependent upon client and regulatory buy-in to maintaining diligence for meeting schedules/timelines.

Validated Source Areas / Scope Review

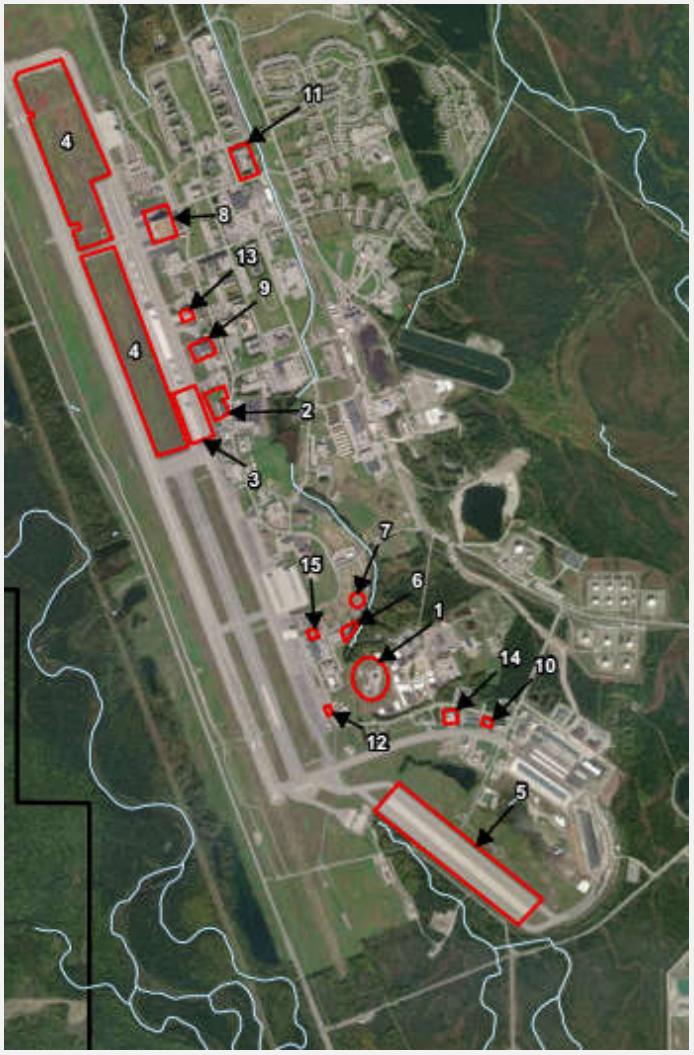


Proposed 2021 Sample Locations

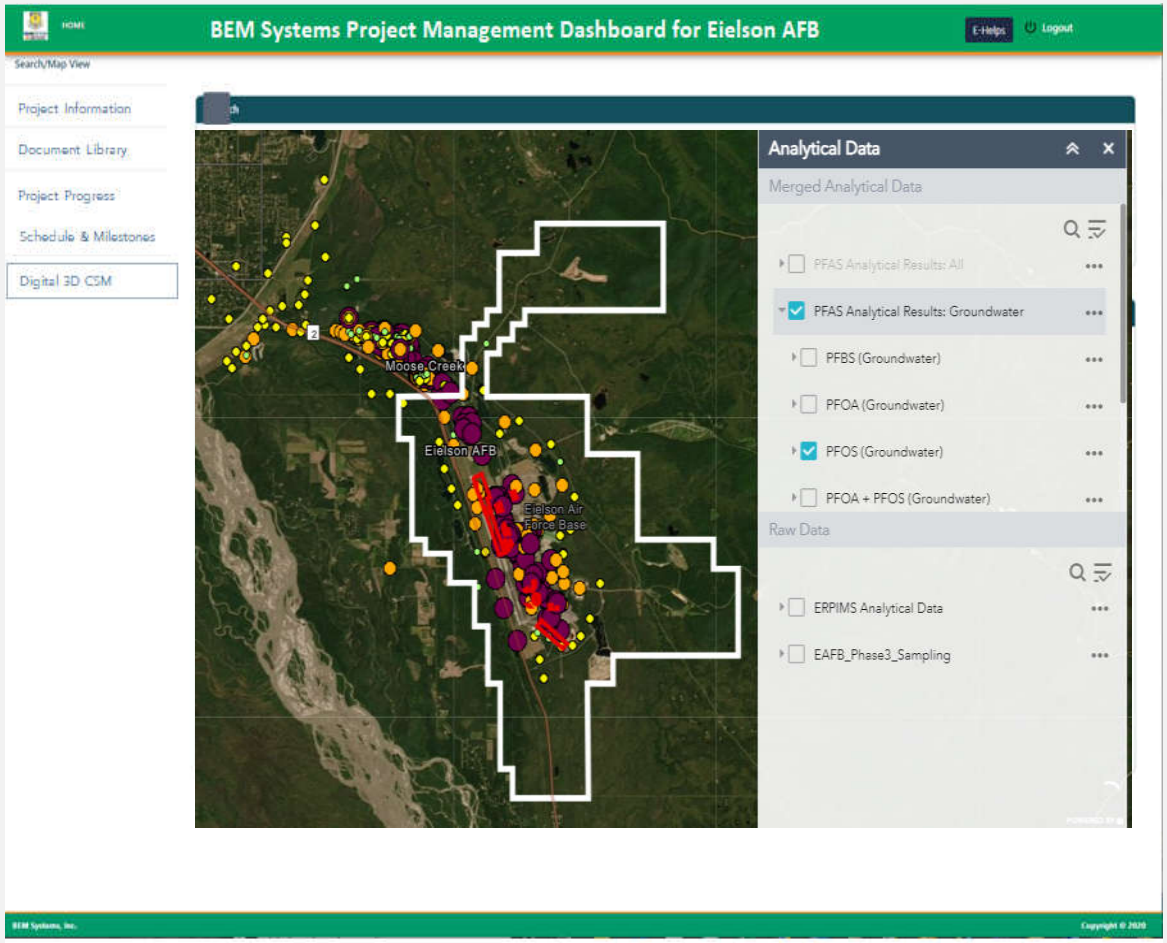
- Soil Boring: 25-ft
- VAP Borings and HPT Borings: 50-ft
- Surface Water / Sediment
- Surface Water / Sediment / Pore Water

EAFB Validated Source Areas

Map Key	Site Number	Area Name
1	FT009	AFFF Area 4 – Current FTA (FT009)
2	SS306P	Site 3 – Former Ball Field Spray Test Area
3	SS311P	Site 2 – KC-135 Fire
4	SS312P	Site 4 – Foamed Runway
5	SS310P	Site 1 – South Ramp Spray Test Area
6	FT092	AFFF Area 9 – Former FTA near the Current Entomology Building (Building 4335)
7	FT092	AFFF Area 8 – Former FTA near the Antenna Farm (FT092)
8	SS309P	AFFF Area 14 – Thunderdome (Building 1140)
9	SS303P	AFFF Area 2 – ANG KC-135 Hangar (Building 1176)
10	SS305P	AFFF Area 12 – Hangar (Building 1344)
11	SS302P	AFFF Area 6 – Former Adak Building Fire
12	SS307P	AFFF Area 10 – Fuel Pump House (Building 1246)
13	SS314P	AFFF Area 1 – ANG Hangar (Building 1171)
14	SS304P	AFFF Area 3 – Corrosion Control (Building 1348)
15	FT092	AFFF Area 7 – Former Fire Station 1



Interactive Project Dashboard Demo



Scope Review on GIS Web Application

****This section will break from the PowerPoint Presentation and introduce the GIS Web Application****

- The GIS Web Application will be used to:
  - Introduce each validated source zone and discuss known information of the potential releases or history of the area
  - Further detail the specific data for each of the validated source areas, including the Fall 2020 sampling results
  - Discuss prescriptive locations based on current data (Soil, GW, SW, SED, porewater, and fish tissue)
  - Discuss rationale for stratigraphic flux transect placement and depth
  - Adaptive Source Area Characterization Decision Logic (Sites SS306P)
  - Stratigraphic Flux Decision Logic (Transect 1)

Adaptive Source Characterization Decision Logic - QAPP Worksheet #17

Triggering Event	Triad Adaptive Contingency Action(s)
Source Delineation – Soil: 1. Soil sample(s) less than screening levels (SLs) 2. Soil sample(s) between 1 to 10 times (X) the SL 3. Soil sample(s) greater than 10X the SL	1. Delineation Complete 2. Step out 1 to 1.5X the boring spacing at representative locations 3. Step out at each location 1.5 to 2X the boring spacing
PFAS results indicate refinement is needed: 1. Extent not defined with sufficient precision (e.g., a sample greater than 20X the SL adjacent to non-detect [ND] value) 2. Data suggests a non-continuous source or isolated source areas within a larger investigation area (e.g., ND values present within what was assumed to be a larger source area)	1. Step in between the ND and the exceedance locations to better evaluate distribution (approximately mid-point or as determined by the technical lead). 2. Step in at location(s) with highest concentrations using two to three borings to evaluate extent of the more confined source area.

Adaptive Source Characterization Decision Logic – Proposed Soil Borings



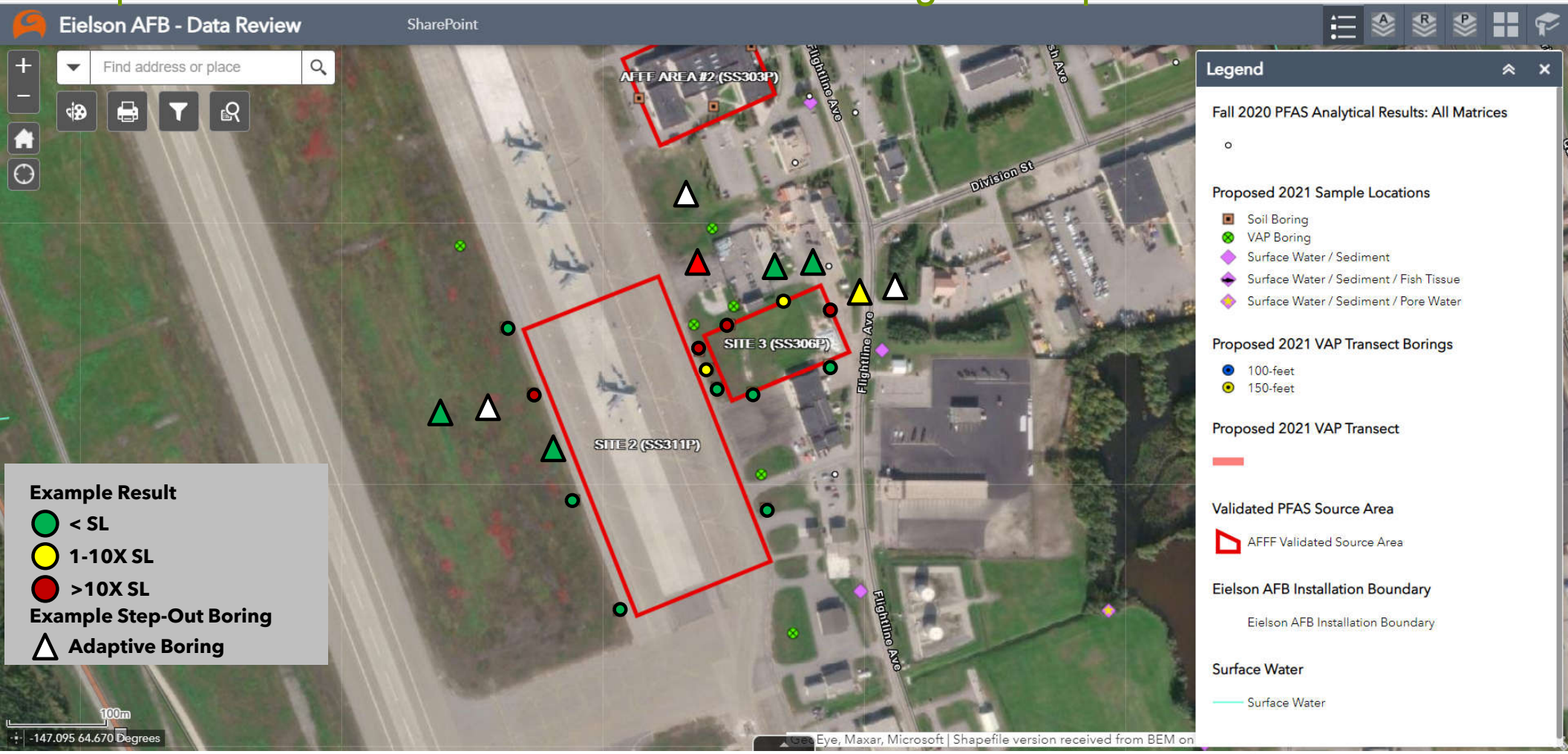
Adaptive Source Characterization Decision Logic – Proposed Soil Boring Results



Adaptive Source Characterization Decision Logic – Step-Out 1



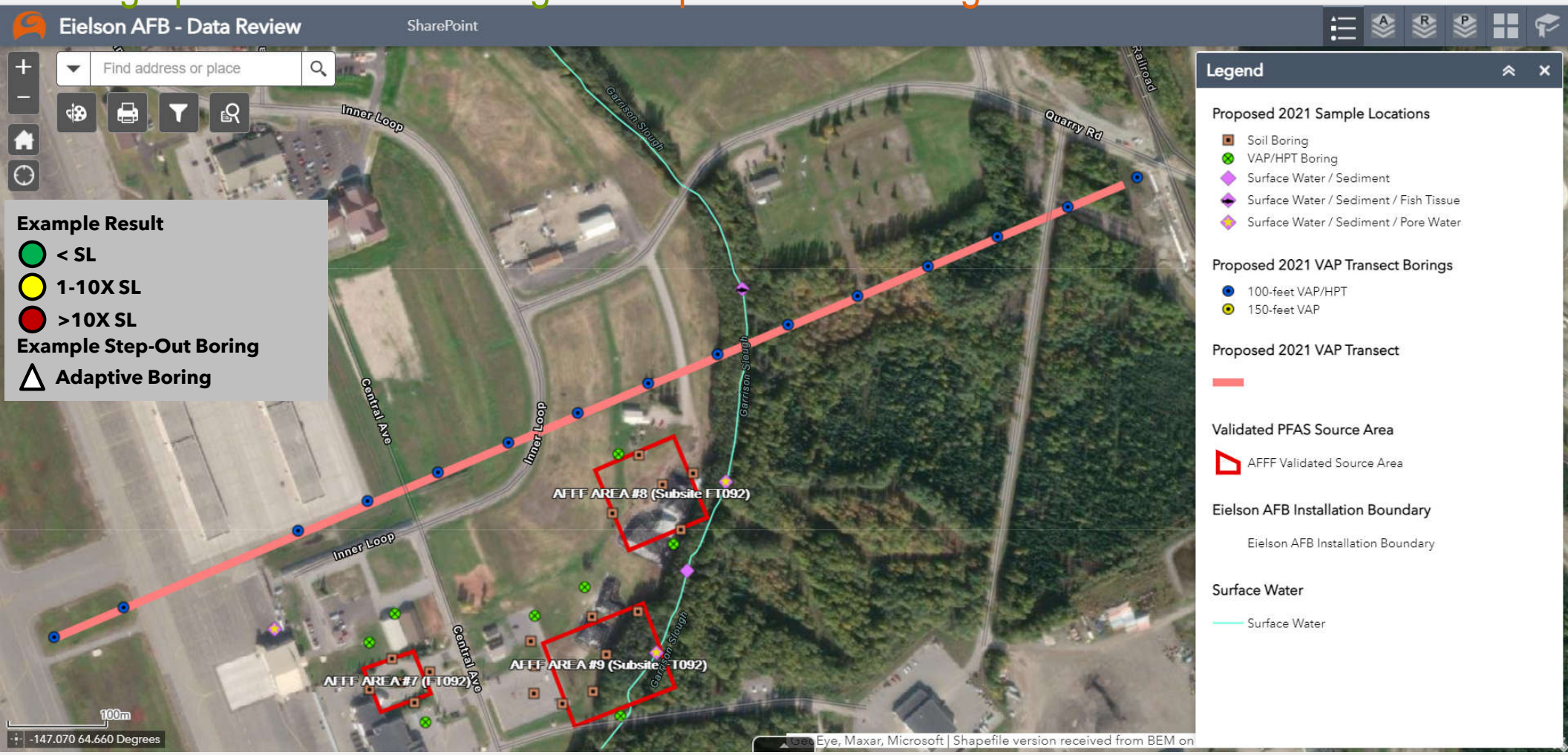
Adaptive Source Characterization Decision Logic – Step-Out 2



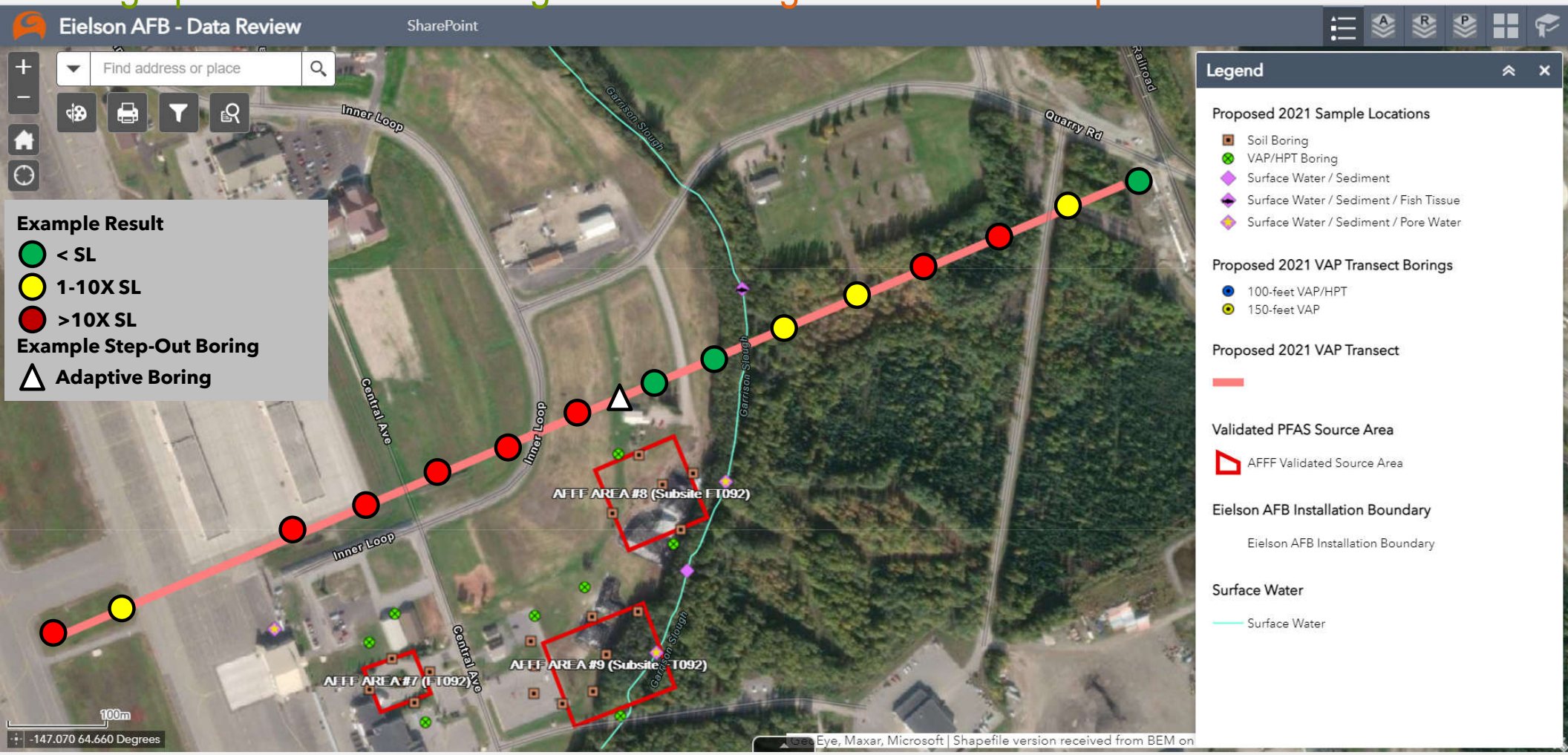
Stratigraphic Flux Decision Logic - QAPP Worksheet #17

Location	Triggering Event	Triad Contingency Action(s)
Lateral Delineation at the end of a stratigraphic flux profile	Groundwater analytical results are below target screening levels	Boring will represent the end of the transect. Delineation would be complete in that direction.
	Groundwater analytical results are within the same order of magnitude as the target screening levels	Complete an additional VAP boring as a step-out location. The point spacing should be the same as the area-specific transect spacing of the prescriptive borings.
	Groundwater analytical results are more than an order of magnitude above the target screening levels	Complete an additional VAP boring as a step-out location. The adaptive point should be located at 2X the point spacing to provide a broader delineation. Additional adaptive borings will be located based on the results of the original adaptive boring. Adaptive borings will be completed perpendicular to the groundwater flow direction along the transect. Step-outs along the groundwater flow direction (north/south) will not be added to the stratigraphic flux transects.
Additional delineation along a stratigraphic flux profile	Permeability and or concentration data requires additional resolution to characterize the hydrostratigraphy or concentration distribution along the stratigraphic flux profile.	Complete an additional adaptive boring that is located between two completed prescriptive borings. The point spacing should be half the original spacing along the flux transect.
Vertical delineation along the stratigraphic flux profile	Groundwater analytical results are within the same order of magnitude as the target screening levels	Collect 1 additional VAP sample below the target depth and re-evaluate the concentrations

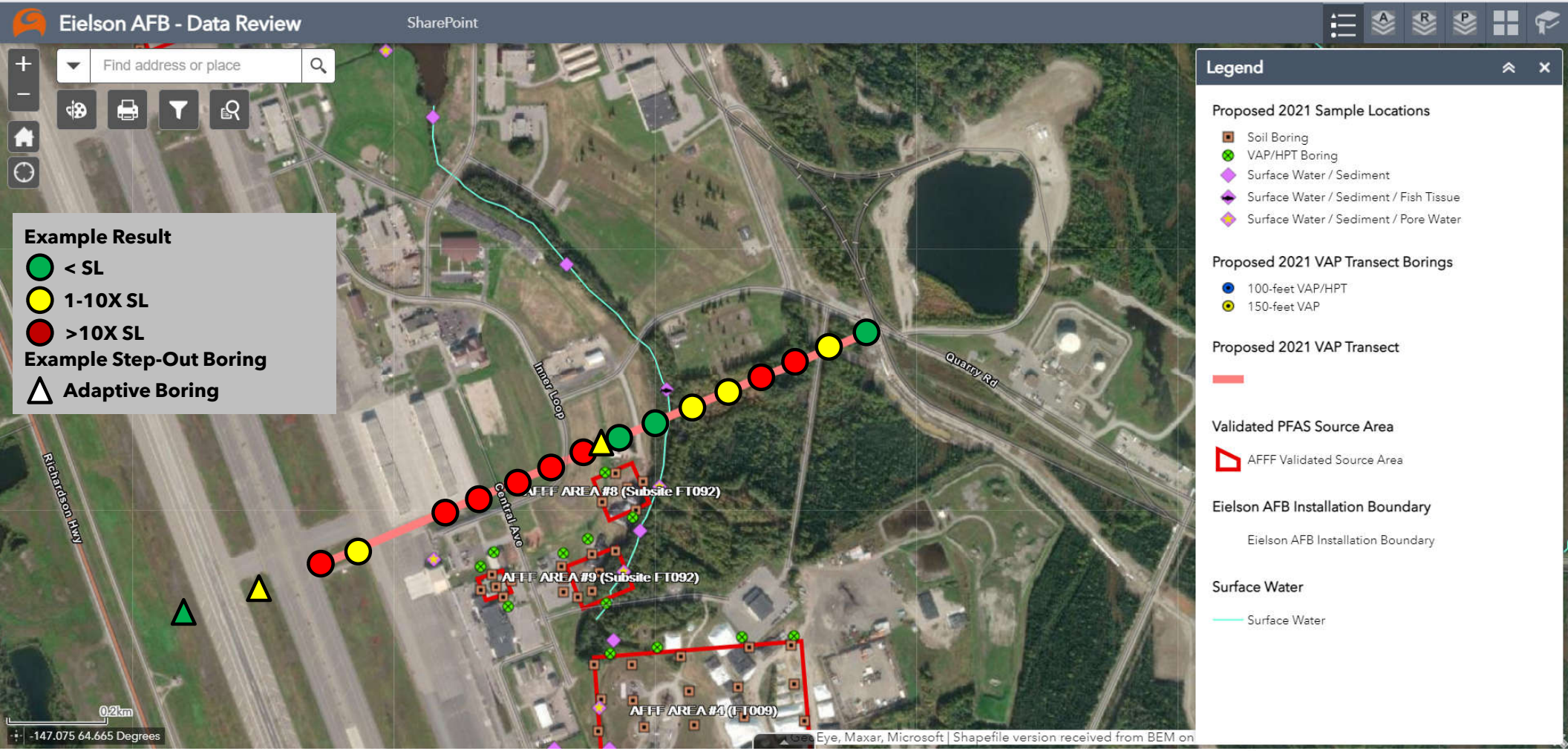
Stratigraphic Flux Decision Logic – Proposed VAP Borings



Stratigraphic Flux Decision Logic –VAP Borings Results and Step-Outs



Stratigraphic Flux Decision Logic –VAP Borings Results and Step-Out Results



Eielson AFB PFAS RI Dashboard

**** This section will break from the PowerPoint Presentation and introduce the Eielson AFB RI Dashboard ****

- The Project Management component of the Dashboard will include:
  - A map of the base showing validated source areas and offsite areas of investigation.
  - Project Team Points of Contact
  - Project management submittals/Project Field Change Forms/Meeting Minutes
  - Historical documents
  - Schedule
  - Project progress
- The Technical component of the dashboard will include:
  - 3D CSM
  - Sample/Boring locations
  - Analytical results
  - Field forms (well logs, soil boring logs, development logs, sample collection logs, site photos, and field notes).

Closing and Next Steps



Closing and Next Steps

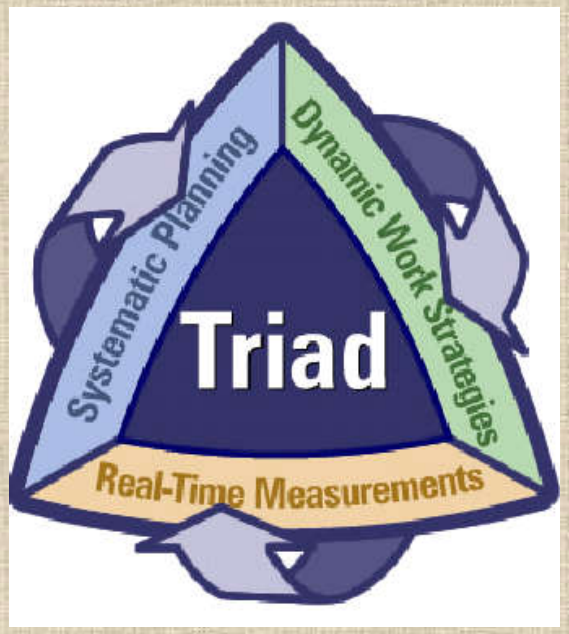


- Recap on rationale for Triad approach
- Current status of QAPP and discussion
- Follow-up call to discuss RI approach (after QAPP review)?
- Status of new/ pending sites
- Dashboard user training meeting
- Questions/ Comments
- Schedule
  - AFCEC Review of RTC and Draft QAPP (redline): 14 January to 25 January 2021
  - AFCEC/ Regulator Review of Draft QAPP: 29 January to 01 March 2021
  - Project Dashboard Training and Project Work Plan Discussion: Mid March to Early April 2021
  - AFCEC/ Regulator Review of RTC and Draft-Final QAPP (redline): 09 March to 08 April 2021
  - Submit Final QAPP: 15 April 2021
  - RI Field Work: 17 May to 09 September 2021

Project Schedule Summary

FY2021 Q1	FY2021 Q2/ Q3	FY2021 Q4	FY2022
• Triad/ Scoping Meeting Timeframe • Submit Draft QAPP and AFCEC Review	• Regulatory Review of Draft QAPP • AFCEC & Regulatory Approval of Final QAPP – April • Exercise Optional CLINS • **Mobilization – May** • Triad Implementation	• Complete Base Scope and Optional CLINs • Prepare ERPIMS Submission • Complete CSM • End of Season Wrap-up Prior to Demobilization	• Approval of ERPIMS data uploads • Approval of Final CSM • Approval of Draft/Final RI Report • Finalize Project Documents

Discussion


Systematic Planning
Dynamic Work Strategies
Triad
Real-Time Measurements

Appendix D

Office of the Secretary of Defense. 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.

ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

OCT 15 2019

SUSTAINMENT

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 SUPPORT)

SUBJECT: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program

The Department of Defense (DoD) conducts cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Defense Environmental Restoration Program (DERP). Our goal is protection of human health and the environment in a risk-based, fiscally-sound manner. This memorandum provides clarifying technical guidance on the investigation of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS). This guidance is applicable to investigating PFOS, PFOA, and PFBS at Environmental Restoration Account-funded, Base Realignment and Closure Account-funded, and Operation and Maintenance accounts for the National Guard-funded sites.

PFOS, PFOA, and PFBS are part of a larger class of chemicals known as per- and polyfluoroalkyl substances (PFAS). PFAS shall be addressed in the same manner as other contaminants of concern within the DERP.

Under CERCLA, site-specific regional screening levels[1] (RSLs) for PFOS and PFOA are calculated using the Environmental Protection Agency (EPA) online calculator using the oral reference dose (RfD) of 2E-05 mg/kg-day. The RSL for PFBS is calculated using the EPA Provisional Peer Reviewed Toxicity Value (PPRTV) RfD of 2E-02 mg/kg-day, or it may be read off the tables available on the EPA RSL website. The values are provided in the attachment. These RSLs should be used for screening to determine if further investigation in the remedial investigation (RI) phase is warranted or if the site can proceed to site closeout. When multiple PFAS are encountered at a site, a 0.1 factor is applied to the screening level. For example, in cases where there are multiple PFAS, the screening level for PFOS and PFOA individually in tap water is 40 parts per trillion (ppt) (0.1 x 400 ppt = 40 ppt) and for PFBS it is 40 parts per billion (40,000 ppt).

[1] For sites on the National Priorities List, the DoD Components will use the EPA site specific screening levels, if provided.

During the RI phase, the RfDs for PFOS, PFOA, and PFBS and the oral cancer slope factor (CSF) for PFOA of 0.07 $(mg/kg\text{-}day)^{-1}$ will be used to conduct site specific risk assessments in accordance with Risk Assessment Guidance for Superfund Volume I, Part A (EPA/540/1-89/002, December 1989). Site-specific risk assessment results will be used to determine if any necessary remedial actions are required in accordance with CERCLA, DERP, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

My point of contact for this matter is Ms. Deborah Morefield at 703-571-9067 or deborah.a.morefield.civ@mail.mil.

Robert H. McMahon

Attachment:
As stated

Attachment: Risk Screening Levels Calculated for PFOS, PFOA, PFBS in Groundwater or Soil Using EPA's RSL Calculator

Chemical	Carcinogenic Slope Factor - Oral (SF) $(mg/kg\text{-}day)^{-1}$	Non-Carcinogenic Reference Dose (RfD) (mg/kg-day)	Residential Scenario Screening Levels Calculated Using EPA RSL Calculator								Industrial/Commercial Composite Worker Screening Levels Calculated Using EPA RSL Calculator			
			Tap Water (µg/L or ppb)				Soil (mg/kg or ppm)				Soil (mg/kg or ppm)			
			HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04	HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04	HQ = 0.1	HQ = 1.0	ILCR = 1E-06	ILCR = 1E-04
PFOS	NA	2.00E-05	0.040	0.40	NA	NA	0.13	1.3	NA	NA	1.6	16	NA	NA
PFOA	7.00E-02	2.00E-05	0.040	0.40	1.1	111	0.13	1.3	7.8	775	1.6	16	33	3,280
PFBS	NA	2.00E-02	40	400	NA	NA	130	1300	NA	NA	1600	16000	NA	NA

HQ=Hazard Quotient
ILCR=Incremental Lifetime Cancer Risk
NA=Not available/applicable

NOTES:

- The table represents screening levels based on residential and industrial/commercial worker receptor scenarios for either direct ingestion of groundwater (residential scenario only) or incidental ingestion of contaminated soil (both residential and composite worker scenarios).
- All values were calculated using slope factors or reference doses for PFOS and PFOA published by EPA Office of Water in support of the LHA, and default exposure assumptions for each potential receptor scenario, contained in EPA's RSL Calculator on April 6, 2018.
- Peer reviewed toxicity values considered valid for risk assessment exist for PFBS, and the screening levels may be found in EPA's RSL table or EPA's RSL calculator used to develop them.
- Other potential receptor scenarios (e.g., recreational user, site trespasser, construction worker) are not included in the above table, but could be relevant receptors at a site potentially contaminated with PFOS, PFOA and/or PFBS. These receptors, and their associated exposure scenarios, should be further considered in the scoping phase and completion of the Baseline Human Health Risk Assessment typically completed during an RI.
- The shaded values represent conservative screening levels for PFOS and PFOA in groundwater or soil that when exceeded should be considered a contaminant of potential concern in the risk assessment process and calculations of site-specific risk posed.

Appendix E

Waste Management Plan

QAPP Appendix E
Final Waste Management Plan

Remedial Investigation for PFAS at Various Sites
Eielson Air Force Base, Alaska

June 2021

Contract Number: FA8903-16-D-0041

Delivery Order FA8903-20-F-1108

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LIST OF ATTACHMENTS

Attachment 1: Eielson Air Force Base, Alaska IDW Tracker Form

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1.0 INTRODUCTION

BEM Systems Inc., (BEM) prepared this Waste Management Plan (WMP) for the removal and/or onsite treatment of contaminated investigation-derived waste (IDW) for the Remedial Investigation (RI) for per- and polyfluoroalkyl substances (PFAS) at various sites on Eielson Air Force Base (EAFB), Alaska. IDW will consist of soil and/or rock cuttings, groundwater development and purge water, decontamination water (from decontaminating drill tooling, equipment used for monitoring well development and sampling), and personal protective equipment (PPE). A site map showing the location of the Site is presented in Figure 1 of the Quality Assurance Project Plan (QAPP).

This WMP is to be used in conjunction with the *EAFB QAPP for RI for PFAS at Various Sites* and is included as Appendix D of the QAPP. The WMP is intended to guide the proper handling and disposal of wastes generated during the RI, including the off-site disposal of contaminated soil and onsite treatment of contaminated water. The determination of final IDW disposal methods will be in general accordance with regulations listed in Section 1.1. BEM will coordinate off-base disposal with the EAFB Hazardous Waste Office.

1.1 Regulatory Requirements

The handling of wastes will be performed in accordance with the following regulations:

- Title 18 Alaska Administrative Code (AAC):
    - Chapter 60 – Solid Waste Management
    - Chapter 62 –Hazardous Waste
    - Chapter 70 – Water Quality Standards
    - Chapter 75 – Oil and Other Hazardous Substances Pollution Control
    - Chapter 78 –Underground Storage Tanks
- Title 29 Code of Federal Regulations (CFR):
    - Part 1910 – Occupational Safety and Health Standards (29 CFR 1910)
    - Part 1926 – Safety and Health Regulations for Construction (29 CFR 1926)
- 33 CFR 138 – Financial Responsibility for Water Pollution
- 40 CFR (U.S. Environmental Protection Agency [USEPA]):

  - Part 60 – Standards of Performance for New Stationary Sources
  - Part 61 – National Emission Standards for Hazardous Air Pollutants
  - Parts 260–270 – Hazardous Waste Management System: General; Identification and Listing of Hazardous Waste; Standards Applicable to Generators of Hazardous Waste; Standards Applicable to Transporters of Hazardous Waste; Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities; Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities; Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities; Standards for Owners and Operators of Hazardous Waste Facilities Operating under a Standardized Permit; Land Disposal Restrictions; EPA Administered Permit Programs: the Hazardous Waste Permit Program
  - Part 279 – Standards for the Management of Used Oil
  - Part 300–303 – National Oil and Hazardous Substances Pollution Contingency Plan; Designation, Reportable Quantities, and Notification; Citizen Awards For Information on Criminal Violations under Superfund

- 46 CFR 150, 151, and 153 – Compatibility of Cargoes; Barges Carrying Bulk Liquid Hazardous Material Cargoes; Ships Carrying Bulk Liquid, Liquefied Gas, or Compressed Gas Hazardous Materials
- 49 CFR 171–178 – Hazardous Materials Regulations

1.2 Waste Minimization

BEM will take all precautions to avoid mixing clean and contaminated material and will not mix waste streams to the extent practicable. PFAS analytical data collected from the associated boring and/or area will be utilized to generate the waste profiles and manifests and determine the proper disposal facility for the soil cuttings. To minimize the quantity of solid IDW for disposal, soils anticipated to be PFAS-free, defined as PFAS present at concentrations less than the limit of detection, will be segregated in separate containers from soils anticipated to be impacted by PFAS. PFAS-free soils are anticipated within the vadose zone at borings downgradient from any source areas and off-base. PFAS concentrations will be confirmed by waste characterization

sampling (Section 2.2). The drums and supersacks will be marked with information pertaining to the areas the waste was generated/accumulated from per Section 2.4.

1.3 Anticipated Waste Streams

Estimates of waste types and respective quantities and associated container types to be used during the RI are listed in Table 1. Contaminated PPE generated during waste-handling activities will be added to the appropriate waste stream for disposal. Waste management and disposal associated with the onsite mobile laboratory will be the responsibility of Pace Analytical (Pace).

Table 1: Estimated Waste Types, Quantities and Containers

Waste Stream Item No.	Waste Types	Estimated Waste Quantities	Container Types
1	Solid IDW (PFAS detections) will include: soil cuttings generated from soil borings and spent GAC potentially containing PFAS, metals, VOCs, and SVOCs. Assumed to be non-Hazardous	300 tons	55-gallon drums and/or supersacks
2	Solid IDW (PFAS free) will include: soil cuttings generated from soil borings and spend GAC potentially containing metals, VOCs, and SVOCs. Assumed to be non-Hazardous		
3	Equipment decontamination water potentially containing PFAS, metals, VOCs, and SVOCs. Assumed to be non-hazardous	27,000 gallons	55-gallon drums and/or IBC container
4	Development and purge water from monitoring well development and sampling potentially containing PFAS, metals, VOCs, and SVOCs	3,000 gallons	55-gallon drums and/or IBC container
5	Treated Aqueous IDW containing PFAS, metals, VOCs, and/or SVOCs	Not Available	Not Available
6	Potentially contaminated sampling debris (including PPE, tubing, and other debris associated with sampling)	3 tons	55-gallon drums, supersacks (included in containers used for appropriate waste stream)
7	Project generated solid wastes (trash construction debris)	2 tons	Garbage bags, supersacks, and/or a roll-off dumpster

Notes:*quantities are estimated
IBC = industrial bulk container
PFAS = polyfluoroalkyl substances
GAC = granulated activated carbon
PPE = personal protective equipment
SVOCs = semi-volatile organic compounds
VOCs = volatile organic compounds

2.0 Waste Management

2.1 Accumulation

All soil cuttings will be containerized at each drilling site in 55-gallon steel drums and/or supersacks, properly labeled, and moved for staging at the EAFB IDW yard. Soils will be sampled for waste characterization parameters specified in Section 2.2. Soil cuttings will be segregated as described in Section 1.2. The drums and supersacks will be marked with information pertaining to the areas the waste was generated and will be placed on pallets in the EAFB IDW yard.

Aqueous IDW (decontamination water, development water, and purge water) will be containerized at each site, marked with information pertaining to the areas the waste was generated, and transported to the EAFB IDW area. The aqueous IDW will then be transferred to an IBC tank to allow for sediments to settle. At the end of the project, the water will be treated with a portable onsite treatment system. The portable treatment system will consist of a series of GAC vessels with GAC media, 5-micron cartridge filters, and a resin vessel with SORBIX media. The treated water will be discharged to a secondary IBC tank and the effluent will be sampled as described in Section 2.2. The water will be staged temporarily until sample results are received and discharge is approved or it is deemed necessary for retreatment.

Spent GAC will be stored in either 55-gallon drums and/or supersacks at the EAFB IDW yard. Solid waste will be placed in garbage bags and/ or supersacks and placed in a roll-off dumpster located either at the IDW yard or adjacent to the job trailer. The location of the job trailer is to be determined.

For each container stored at the EAFB IDW Yard, a record will be maintained on the EAFB IDW Tracker Form. The form will be updated daily and submitted to EAFB Point of Contact (POC) weekly. The IDW form includes a running list of generated waste, date the waste was generated, source location, current location, media, container type, container ID, and volume. The EAFB IDW Tracker from is provided in **Attachment 1**.

2.2 Waste Sampling and Characterization

To ensure proper disposal, wastes will be classified in accordance with 40 CFR 261; 40 CFR 761; and 40 CFR 61, Subpart M. Each waste will be evaluated to identify all applicable treatment standards in 40 CFR 268, Land Disposal Restrictions. Air Force Civil Engineer Center (AFCEC) will provide the USEPA Generator identification number. The Contractor will notify the AFCEC

POC immediately if Resource Conservation and Recovery Act (RCRA) hazardous waste are identified. RCRA and hazardous waste are not anticipated for this project.

Soil cuttings and spent GAC will be sampled for waste characterization before shipment offsite. The soil boring PFAS analytical data will be utilized to generate the waste profiles and manifests and determine the proper disposal facility for the soil cuttings. Composite samples of the soil cuttings will be collected and analyzed for toxicity characteristic leaching procedure (TCLP) VOCs, TCLP metals, pH, reactivity, and flashpoint. Composite samples of the spent GAC will be sampled for PFAS compounds, TCLP VOCs, TCLP metals, pH, reactivity, and flashpoint. Soils and spent GAC containing PFAS in concentrations above the laboratory reporting limit will be transported off-base for disposal in a Subtitle C Landfill. Soils and spent GAC with no PFAS detections will also be disposed of via Subtitle C landfill. Table 2 provides the analytical methods, sample containers, preservation requirements, and hold times for the waste characterization samples.

Liquid IDW will be treated and then after treatment, effluent samples will be collected for PFAS, VOCs, SVOCs, and metals. In addition, the effluent water will be observed for any sheen or any odors. PFAS concentrations must be reduced to less than or equal to the USEPA Lifetime Health Advisory (LHA) of 70 nanograms per liter (ng/L). Total aromatic hydrocarbons (TAH) will be calculated from benzene, toluene, ethylbenzene, and xylenes (BTEX) analytical results and must be less than 10 micrograms per liter (µg/L). Total aqueous hydrocarbons (TAqH) will be calculated utilizing select SVOCs and BTEX results and must be less than 15 µg/L. If contaminants are present at concentrations greater than the USEPA LHA, TAH, TAqH, and/or any additional applicable state or local promulgated standards, the water will be treated and sampled again.

Analytical samples will not be collected from project generated solid wastes (non-hazardous, non-regulated; e.g. PPE and well construction materials). For PPE, analytical results from associated soil and groundwater samples will be used to develop a waste profile.

Table 2: Analytical Methods, Sample Containers, and Hold Times

Analyte/ Analyte Group	Method	Container(s) (number, size, & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Solid/Soil DW						
PFAS	PFAS per DoD QSM 5.3, Table B-15	HDPE with HDPE screw cap 2 x 4 ounce (oz)	Cool to < 6°C	28 days	28 days after extraction	21 calendar days
TCLP VOCs	SW846-8260D	60ml wide mouth glass (no headspace)	Cool to < 6°C	14 days	14 days after extraction	21 calendar days
TCLP Metals	SW846-6101D	500 ml wide mouth glass	Cool to < 6°C	180 days, 28 days for Hg	180 days, 28 days for Hg	21 calendar days
pH	SW846-9045D	250 ml wide mouth glass	Cool to < 6°C	NA	NA	21 calendar days
Flashpoint	SW846-1010A					
Reactivity	7.3.3 & 7.3.4	125 ml wide mouth glass (no headspace)	NA	NA	NA	21 calendar days
Decontamination, Development, and Purge Water IDW						
PFAS	PFAS per DoD QSM 5.3, Table B-15	High-density polyethylene (HDPE) with HDPE screw cap 2 x 250 milliliter (mL)	Cool to less than (<) 6°C	7 Days	30 days after extraction	21 calendar days
VOCs	SW8260C	3 x 40ml Vials	HCL to pH <2, Cool to <6°C	14 days	14 days	21 calendar days
SVOCs	SW8270D	2x1 L Amber glass TLC	Cool to <6°C	7 days	40 days	21 calendar days
Metals	SW6020	1 x 4 oz glass	Cool to <6°C	14 days	180 days	21 calendar days

2.3 Containerization

Hazardous waste liquids will be stored in liquid-tight containers, and incompatibles will be separated. Containers will be compatible with each respective waste (49 CFR 100-177), will be in good condition, and will be marked in accordance with 40 CFR 262.

2.4 Marking and Labeling

Waste containers will be marked and labeled as Pending Analysis. All IDW containers will be marked Unique Container Identification Number

- Generator Information: USAF AFCEC/ CZOP
- Contents
- Associated Site ID where the waste was generated from
- Accumulation Start Date
- Contract FA8903-16-D-0041, TO FA8903-20-F-1108
- EAFB POC
- BEM POC

Once determined, based on waste characterization analytical results, the waste will be labeled as Non-Hazardous or Hazardous.

3.0 Waste Disposal Documentation

Prior to transport of IDW offsite, BEM will complete an Alaska Department of Environmental Conservation (ADEC) Contaminated Media Transport and Treatment or Disposal Form to AFCEC for approval and signature.

A manifest package will accompany all waste leaving the site, and will include:

- Applicable waste manifests (Canadian and U.S.);
- Regulated material shipping papers and descriptions of types of packaging, markings, labeling, and placarding;
- Waste profiles (as applicable); and,
- Land disposal restriction notifications and certification forms (as applicable).

3.1 Non-Hazardous Waste Manifest

Waste Management (BEM's subcontractor) will prepare waste manifests for all wastes that are transported for off-site treatment, storage, or disposal. BEM will coordinate with the EAFB point of contact (POC) to sign all waste manifests. For each waste type, the following information will be provided:

- Proper shipping names, as determined by 49 CFR 172, Section 101 and description,
- Number of containers,
- type of container,
- total quantity of containers,
- and total volume and/or weight.

Also included on each manifest will be the following:

- The Generator's EPA ID number
- Transporter names and associated transporter EPA ID numbers
- A 24-hour emergency response number
- Generator and transporter signatures
- Shipper's certification

A land disposal restriction (LDR) notification will be prepared as required by 40 CFR 268. An AFCEC representative will sign the LDR notification.

3.2 Canadian Documentation

The Basel Convention, which Canada ratified in August 1992, prohibits the shipment of hazardous wastes across international borders without prior notification and approval. International shipments of hazardous waste that pass into, though, or out of Canada are subject to the requirements of the Export and Import of Hazardous Wastes regulations.

A Canadian Transit Notice will be completed and sent to the appropriate Canadian authority before shipment of hazardous waste through Canadian waters. The Canadian Confirmation Letter will be provided to the AFCEC upon its receipt. In addition, Canadian manifest forms will be completed for all hazardous waste streams, in the event that these wastes may land on Canadian soil. Hazardous waste is not anticipated.

3.3 Manifest Document Review

A complete manifest packet for the off-site shipment at the end of the field season will be generated prior to shipment. The packet will include all of the following:

- Waste Manifests
- Canadian documentation
- Waste profiles
- Waste Shipment Records and LDRs
- Analytical results, where applicable
- Safety Data Sheets, when available
- Generator's Certification Statement regarding packaging, marking, labeling, and placarding
- A certification signed by the AFCEC RPM that the packet is correct

Disapproved documents will be returned for revision. Approved documents will be provided to the Environmental Manager prior to shipment.

3.4 Manifest Copy Distribution

Final copies of the manifests and transportation documents will be included as an appendix in the Final RI Report.

4.0 Transportation and Disposal

All waste will be transported from EAFB, Alaska to a permitted Waste Management Facility located in the continental United States. Once the facility is determined, AFCEC approval will be obtained, and then the waste transported. Prior to transport off base, BEM will coordinate with the EAFB Hazardous Waste Office.

4.1 Treatment and Disposal

Wastes removed from the site and generated during RI activities will be treated or disposed of as listed in Table 3.

Table 3: Waste Types and Disposal

Waste Stream Code	Waste Type	Final Treatment/Disposal	Treatment Facility/Location
1	Solid IDW (PFAS detections) will include: soil cuttings generated from soil borings and spent GAC potentially containing PFAS, metals, VOCs, and SVOCs. Assumed to be non-Hazardous	Disposal in Subtitle C Landfill	Chemical Waste Management – Arlington, OR
2	Solid IDW (PFAS free) will include: soil cuttings generated from soil borings potentially containing metals, VOCs, and SVOCs. Assumed to be non-Hazardous	Disposal in Subtitle C Landfill	Chemical Waste Management – Arlington, OR
3	Equipment decontamination water potentially containing PFAS, metals, VOCs, and SVOCs. Assumed to be non-Hazardous	On-Site treatment and discharge	Temporary on-site treatment area
4	Development and purge water from monitoring well development and sampling potentially containing PFAS, metals, VOCs, and SVOCs	On-Site treatment and discharge	Temporary on-site treatment area
5	Treated Aqueous IDW containing PFAS, metals, VOCs, and/ or SVOCs	Solidification and Disposal in Subtitle C Landfill	Chemical Waste Management – Arlington, OR
6	Potentially Contaminated sampling debris (including PPE, tubing, and other debris associated with sampling)	Disposal in Subtitle C Landfill	Chemical Waste Management – Arlington, OR
7	Project generated solid wastes (trash construction debris)	Disposal in a municipal landfill	Fairbanks Solid Waste Facility

Attachment 1:

Eielson Air Force Base, Alaska IDW Tracker Form

Attachment 1 EAFB IDW Tracker

Date of Generation	Site Number	Source Location	Current Location	Source Action	CoCs	Media	Volume or Weight	Unit	Container Type	Waste Drum Numbers	Point of Contact	Contact #	Date Removed	Destination

Appendix F

Accident Prevention Plan

QAPP APPENDIX F
ACCIDENT PREVENTION PLAN

Remedial Investigation for PFAS at Various Sites
Eielson Air Force Base, Alaska

June 2021

Contract Number: FA8903-16-D-0041 and Delivery Order FA8903-20-F-1108

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LIST OF ATTACHMENTS

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Attachment 2: Coronavirus Disease 2019 (COVID-19) Best Practice Procedures (Prior to 2021 fieldwork the most recent copy of BEM's COVID-19 Best Practice Procedures will

be included with the APP)

Attachment 3: Activity Hazard Analyses

Attachment 4: Contractor Corporate Health and Safety Plan

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Attachment 7: Safety Data Sheets

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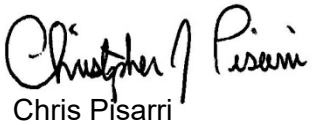
ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
%	percent
ACGIH	American Conference of Governmental Industrial Hygienists
ADEC	Alaska Department of Environmental Conservation
AED	Automatic External Defibrillator
AFCEC	Air Force Civil Engineer Center
AFFF	aqueous film-forming foam
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
Arcadis	Arcadis U.S., Inc.
ATV	all-terrain vehicle
BEM	BEM Systems, Inc.
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Cis 1,2-DCE	cis-1,2-Dichloroethylene
COR	Contracting Officer's Representative
COVID-19	Coronavirus Disease 2019
CPR	cardiopulmonary resuscitation
CSHP	Corporate Safety and Health Program
CSIR	Contractor Significant Incident Report
dBA	decibel
DFOW	definable feature of work
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
EAFB	Eielson Air Force Base
EC	Emergency Coordinator
EHS	Environmental Health and Safety
EM	Engineering Manual
EMR	Experience Modification Rate
ER	Engineer Regulation
EZ	exclusion zone
FFA	Federal Facility Agreement
FMP	Fatigue Management Plan
FTA	Fire Training Area
FTL	Field Team Lead
GFCI	ground fault circuit interrupter
HAZWOPER	Hazardous Waste Operations and Emergency Response
HI	Heat Index
HIV	Human Immunodeficiency Virus
HPT	hydraulic profiling tool
IC	institutional controls
IDLH	Immediately Dangerous to Life and Health
IDW	investigation derived waste
IRP	Installation Restoration Program
km/h	kilometers per hour

mph	miles per hour
NEC	National Electrical Code
NOAA	National Oceanic and Atmospheric Administration
NRTL	nationally recognized testing laboratory
OSHA	Occupational Safety and Health Administration
PADS	Physical Agent Data Sheets
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PEL	permissible exposure limit
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	perfluorooctane sulfonate acid
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
QAPP	Quality Assurance Project Plan
RAC	Risk Assessment Code
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
SDS	safety data sheet
SHM	Safety and Health Manager
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
STEL	Short Term Exposure Limit
SZ	support zone
TCE	trichloroethylene
TLV	Threshold Limit Values
TWA	time-weighted average
UL	Underwriter’s Laboratory
USACE	U.S. Army Corp of Engineers
USAF	U.S. Air Force
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
UTV	utility task vehicle
VAP	vertical aquifer profiling
WBGT	Wet Bulb Globe Temperature Index
WMP	waste management plan

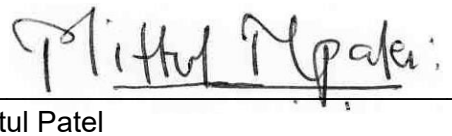
1.0 SIGNATURE SHEET

Prepared by:



Chris Pisarri
BEM Project Manager
Phone: (407) 402-4440

Approved by:



Mittul Patel
BEM Health and Safety Manager
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2.0 BACKGROUND INFORMATION

BEM Systems, Inc. (BEM), along with its teaming partner Arcadis, U.S, Inc. (Arcadis) (collectively referred to herein as the "BEM Team") prepared this Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) (Attachment 9) under U.S. Air Force (USAF) Contract FA8903-D-0041, Delivery Order FA8903-20-F-1108. Under this contract, a remedial investigation (RI) will be conducted for per- and polyfluoroalkyl substances (PFAS) at Various Sites at Eielson Air Force Base (EAFB) in Fairbanks North Star Borough, Alaska. The purpose of the RI is to characterize the nature and extent of 24 PFAS compounds, specifically perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) in surface soil, subsurface soil, groundwater, surface water, pore water, and sediment.

This APP was prepared to address the specific risks of chemical, physical, and environmental hazards associated with the proposed 2021 RI activities planned at EAFB. This APP is to be used in conjunction with the EAFB *Quality Assurance Project Plan (QAPP) for RI for PFAS at Various Sites* and is included as Appendix F of the QAPP, submitted under separate cover.

2.1 Contractor

BEM is the Prime contractor responsible for the planning, field, and reporting activities for this project. For this project installation APP, BEM is referred to as the Contractor, responsible for upholding health and safety protocols for all persons and subcontractors performing work covered under this APP.

2.2 Contract Number

The USAF contract number is FA8903-16-D-0041 and Delivery Order FA8903-20-F-1108.

2.3 Project Name

The USAF project name is RI for PFAS at Various Sites at EAFB, AK.

2.4 Description and Site History

EAFB is located within Fairbanks North Star Borough, approximately 25 miles southeast of Fairbanks and just southeast of Moose Creek, Alaska. Moose Creek is located approximately one (1) mile north of the EAFB boundary. EAFB encompasses an area of approximately 19,700 acres and current operations include industrial areas, aircraft maintenance and operations, an active runway and associated facilities, and administrative offices, as well as residential and recreation facilities. The community of Moose Creek abuts the northern boundary of EAFB and the Salcha area community lies a few miles south of the Base. EAFB is in a relatively undeveloped area. The Base is bordered on the north, east, and west by undeveloped military reservation lands. A mixture of commercial, light industrial, and residential areas, as well as recreational areas, have been developed in a narrow corridor along the Richardson Highway between the Base and Fairbanks (AECOM, 2013).

2.5 Investigation History

In November 1989, EAFB was listed on the National Priorities List of Federal Superfund sites by the United States Environmental Protection Agency (USEPA). The USAF, the USEPA, and Alaska Department of Environmental Conservation (ADEC) entered into a Federal Facility Agreement (FFA) for EAFB, which went into effect May 1991 (USEPA et al., 1990). EAFB contains 66 source areas identified in the FFA, or prior to the FFA, that are regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and managed under EAFB's Installation Restoration Program (IRP). Of these 66 source areas, 21 have enforceable institutional controls (ICs) specified along with the selected remedy, as outlined in the Record of Decision (ROD) documents.

PFAS specific environmental investigations have been ongoing at EAFB since 2014. Specifically, PFOA, PFOS, and PFBS have been investigated. Previous PFAS investigations have evaluated a number of potential source areas which include fire training areas (FTAs), hangars, fire stations, emergency responses potentially involving the use of aqueous film-forming foam (AFFF), AFFF spray test areas, AFFF spills, and drinking water wells. Descriptions of previous investigations, geology, hydrogeology, and other background information are provided in the QAPP.

2.6 Major Phases of Work

The overall scope of work for this project is to complete an RI at various sites and basewide at EAFB, which includes delineation of 13 validated PFAS source areas (and 2 subsites) where detection of PFAS compounds have been confirmed, along with assessment of surface water and groundwater migration pathways.

Work performed under this task order will include two separate field mobilizations that include: (1) an initial investigation to collect groundwater samples only from existing monitoring wells to supplement the development of the technical approach (previously completed in Fall 2020 under the QAPP Addendum) (BEM Team, 2020) and (2) RI field activities planned in the late Spring/Summer of 2021.

The work effort for the Spring/Summer 2021 activities will include the following activities:

- Mobilization of staff to EAFB.
- Advance up to 130 soil borings to depths of approximately 25 feet below ground surface (bgs) at source areas and collect discrete soil and grab groundwater samples for laboratory analysis of PFAS compounds. Geotechnical samples will also be collected.
- Advance up to 46 hydraulic profiling tool (HPT) borings to a maximum depth of 50 feet bgs and 30 HPT borings to a maximum depth of 100 feet bgs.
- Advance up to 46 vertical aquifer profiling (VAP) borings to 50 feet bgs, 30 to 100 feet bgs, and 25 to 150 feet bgs. Grab groundwater samples for analysis of PFAS compounds will be collected to assess for impacts within the aquifer.
- Install up to 25 monitoring wells to approximate depths of 20 feet bgs, develop the monitoring wells, and collect groundwater samples for laboratory analysis.

- Install up to 20 sets of nested wells with installations completed to depths of approximately 50 feet, 100 feet, and 150 feet within each well cluster. All wells will be developed and sampled.
- Collect collocated surface water and sediment samples from up to 80 locations. At fifteen (15) of the locations, porewater samples will also be collected. The surface water and sediment samples will be collected twice, once during the wet season (spring) and once during the fall season (fall).
- Collect fish tissue samples from 20 locations with up to four (4) samples collected from each location (80 total samples). Collection methods may include electrofishing, seining, gillnetting, trap netting (fyke/hoop nets), or angling.
- Treat water utilized for decontamination and drilling with an onsite treatment system to ensure liquids are PFAS free to reduce the potential for cross-contamination (refer to Waste Management Plan [WMP], Appendix E to the QAPP).
- Treat investigation derived waste (IDW) liquids (decontamination water, purge water, and drilling water) utilizing an onsite treatment system, sample effluent, and discharge to area specified by AFCEC and ADEC. Refer to WMP provided as Appendix E of the QAPP.
- Proper storage, transport, and disposal of solid IDW that includes soil cuttings, drilling muds, inert solid waste, and spent personal protective equipment (PPE). Refer to the WMP provided as Appendix E of the QAPP.

Personnel engaged in these activities will adhere to the provisions of this APP and the SSHP **(Attachment 9**), and applicable Occupational Safety and Health (OSHA) rules and regulations. Personnel and subcontractors will also adhere to BEM's revised September 03, 2020 *Coronavirus Disease 2019 (COVID-19) Best Practice Procedures – Version No. 3*, guidelines included as **Attachment 2**. This set of procedures details COVID-19 safety precautions, requirements per the Center for Disease Control (CDC), availability of PPE, and applicability scenarios for staff involved in all stages of the project (BEM, 2020). If necessary, the COVID-19 practices and procedures document will be updated as new information is obtained or as the CDC issues updated precautions or guidance prior to mobilization of the field team. Mandates and procedures are constantly changing due to the many unknowns associated with COVID-19, so prior to Summer 2021 RI field activities, all field personnel will review the most recent Alaska travel and EAFB COVID-19 procedures.

The currently anticipated definable features of work (DFOW) or major activity based on currently known or defined information are as follows, each requiring an activity hazard analysis (AHA):

- Mobilization and demobilization;
- Borehole and monitoring well installation;
- Groundwater, soil, surface water, sediment, pore water, and fish tissue sampling
- Boating or work near-surface water; and
- IDW management.

Work for any task, activity, or DFOW the work will not commence until the AHA has been accepted by the Air Force Civil Engineer Center (AFCEC) Remedial Project Manager (RPM), and is discussed with all personnel engaged in the activity including the Contractor, subcontractor(s), and the government on-site representatives at the preparatory and initial control phase meetings. **Attachment 3** includes preliminary AHAs for the major phases of work listed above. The Contractor and subcontractors may refine these preliminary AHAs and/or develop new AHAs that will be submitted to the USAF RPM for review/comment prior to beginning each DFOW.

3.0 STATEMENT OF SAFETY AND HEALTH POLICY

The Contractor believes strongly that our people are the company's most important and valuable asset. The actions of the personnel, working together as a team ultimately determine the success of the endeavors of the individual companies and our subcontractors.

The Contractor is committed to providing a safe and healthful work environment for all of our employees, with an accident-free work environment being the ultimate goal. Injuries and illnesses can cause needless pain and suffering of employees and their families, as well as increase costs and decrease productivity and morale among employees. The Contractor plans to perform the work in a manner that integrates safety and health considerations to eliminate the risk of workers' injuries or illnesses, environmental releases/impacts, and property damage. In addition to the line and staff management functions described in this APP, everyone performing work under this contract is responsible for their own personal health and safety and for assisting in ensuring the health and safety of coworkers.

All site operational and other personnel who have potential exposure to site hazards are subject to the requirements of this APP. Work may not be performed in a manner that conflicts with the intent of, or the inherent safety, health, or environmental precautions expressed in this APP. After initial correction, the Contractor will dismiss personnel who continue to violate safety procedures.

This APP was developed in accordance with the requirements of 29 Code of Federal Regulations (CFR) 1910.120 (OSHA, 2019); 29 CFR 1926 (OSHA, 2019); Engineer Regulation (ER) 385-1-92 (USACE, 2018); Engineering Manual (EM) 385-1-1 (USACE, 2014); any other applicable federal, state, and local safety and occupational health laws and regulations; and the Contractor Corporate Safety and Health Plan (CSHP) (**Attachment 4**).

Based on the Form 300A, the Contractor Experience Modification Rate (EMR) indicates that its losses due to worker's compensation claims are less than the industry average of 1.0. Following is a summary of the Contractor EMR for the past six years:

Table 3-1. EMR Summary

Fiscal Year	Experience Modification Rate
2015	.82
2016	.84
2017	.84
2018	.78
2019	.91
2020	.91

The Contractor CSHP has been established in compliance with the following regulations:

- OSHA Occupational Safety and Health Standards for General Industry (29 CFR 1910)
- OSHA Safety and Health Regulations for Construction (29 CFR 1926)
- EM 385-1-1

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4.0 RESPONSIBILITIES AND LINES OF AUTHORITY

The roles and responsibilities of specific individuals for work performed in accordance with this APP are described in the following sections.

4.1 Statement of Responsibility

The contractor is ultimately responsible for the implementation of its Environmental Health and Safety (EHS) Program for contractor employees, subcontractors, and all others on the worksite. No person will be required or instructed to work in surroundings or under conditions that are unsafe or dangerous to his or her health. Each employee is responsible for complying with applicable safety and occupational health requirements, wearing prescribed safety and health equipment, reporting unsafe conditions/activities, preventing avoidable accidents, and working in a safe manner.

4.2 Identification and Accountability

This section identifies the roles and responsibilities of the Contractor's corporate-level and project-level personnel and subcontractors who are conducting field activities during the remedial action operations and other activities at the locations throughout Alaska. Resumes for the corporate Safety and Health Manager (SHM) and the Site Safety and Health Officer (SSHO), as well as other key field staff are provided as **Attachment 5.**

4.2.1 Project Management

It is the responsibility of project managers (PMs), supervisors, and Field Team Leads (FTLs) to ensure that project activities are executed in accordance with the contractor's EHS programs, procedures, and applicable regulations. PMs have primary EHS responsibility and rely on EHS personnel to support them in fulfilling this responsibility. PMs have the responsibility to integrate loss-control principles into operations and to ensure the following.

- Contractor safety culture is preserved by demonstrating commitment and program involvement; safety remains a major project goal and is not subordinate to other demands.
- Project-specific continuous improvement goals and objectives are developed based on EHS events and issues and are communicated to the Contractor's employees and subcontractors.
- Projects are implemented in compliance with federal and state environmental, safety, and health laws and regulations, U.S. Department of Defense (DoD) guidance, and contractor EHS program requirements.
- EHS plans are developed, approved, and implemented in accordance with the Contractor's requirements.
- Personnel understands the requirements of the project's EHS plan(s) and each individual understands their responsibility for plan implementation.
- Personnel have the required training and capabilities to perform the assigned tasks.

- Corporate professionals or external resources, such as private consultants, are available for project support as needed.
- Project staff members are aware of and have access to technical information that the contractor maintains.
- Additional EHS reference books and technical information are made available to project staff upon request.
- Facilities and equipment meet contractor and government regulations.
- Work rules are enforced.
- Inspections and incident investigations are conducted per EHS program requirements.
- Effective corrective actions are implemented in a timely manner following inspections, audits, incident investigations.
- Employees, including subcontractors, are not only encouraged but also required to notify their supervisor(s) of any actual or potential health and safety hazards in the workplace and to develop safe work methods and controls to be implemented in project AHAs. The contractor has given STOP WORK authority to all workers, including subcontractors. When there is an immediate hazard or threat to the safety of any worker or person on a project, the work will be stopped and the PM, SSHO, and the SHM will be notified.
- Employees and subcontractors are assured they will be rewarded (not reprimanded) for reporting health and safety concerns.
- Clients are notified of the Contractor's incident reporting procedures.
- Appropriate disciplinary action is implemented by site supervision when necessary.
- Management responsibilities necessary to maintain a safe, healthful, and environmentally compliant workplace are identified in each procedure of the contractor's EHS program.

4.2.2 Project Manager

With respect to the EHS program, it is the responsibility of the PMs, Chris Pisarri (Sr. Project Manager) and Lesa Zimnawoda (Deputy Technical Lead), to:

- ensure implementation of this APP through coordination with the FTL/SSHO, and SHM;
- conduct quarterly inspections jointly with the SHM, when required;
- participate in the incident investigations;
- ensure the APP has the required approvals before any site work is conducted;
- ensure the SHM and FTL/SSHO are informed of project scope changes that require modifications to the APP;
- assume overall project responsibility for health and safety; and
- ensure adequate field staff resources are provided to carry out the responsibilities outlined in the APP and SSHP.

4.2.3 Corporate Safety and Health Manager

The SHM, Mittul Patel, will review and approve this APP and any amendments prior to their adoption. The SHM will assist with the implementation of the APP and provide project support on health and safety issues. The SHM will verify field personnel training, medical surveillance, and respirator fit test requirements, as required. The SHM will advise the SSHO regarding industrial hygiene concerns, interpretation and evaluation of analytical exposure data, and other safety-related issues, as needed. Subcontractor EHS plans will be reviewed by the SHM. It is also the SHM's responsibility to:

- provide for the development and approval of the APP and SSHP;
- serve as the primary contact to review any health and safety matters that arise;
- approve revised or new safety protocols for field operations;
- approve individuals who are assigned SSHO responsibilities;
- approve the SSHO to fulfill other project roles;
- approve any revisions to this APP and its AHAs;
- approve upgrading or downgrading of PPE;
- assist in the investigation of incidents; and
- visit the project as needed to audit the effectiveness of the APP and SSHP.

4.2.4 Field Team Lead

The FTL, Ben Siwiec, will be on-site during all site activities and will have direct oversight of the investigation. For this project, the FTL will be the same individual as the SSHO and the position will be designated FTL/SSHO throughout the remainder of this document. It is the FTL/SSHO's responsibility to:

- ensure site personnel and subcontractors comply with the APP and SSHP;
- coordinate with the PM, and SHM on matters regarding site safety and health;
- monitor team members' performance;
- implement and enforce all work plans;
- identify potential problem areas and make corrective action recommendations to the PM;
- ensure completion of the project on schedule and within budget, in accordance with the permits and project plans;
- ensure that appropriate change management procedures are in place;
- ensure compliance with all environmental, health, and safety requirements, including corporate policies, programs, and procedures; OSHA general and construction management regulations (OSHA 2019); and any client/Base-specific requirements included in this APP;
- ensure adequate site security appropriate for the activities being performed;

- implement material control requirements in accordance with government property control procedures;
- ensure that an adequate labor force is assigned to the project with the proper training, education, experience, skills, tools, equipment, and materials to complete the tasks and minimize potential impacts to the environment;
- halt or modify any work conditions or remove personnel from the task site if conditions are unsafe;
- ensure all task site personnel understand and comply with all safety requirements;
- be responsible for the day-to-day work at the site;
- conduct incident investigations;
- initiate corrective actions for observed safety violations;
- oversee the implementation of specified levels of PPE;
- implement all corrective actions, and maintain a daily log of work activities including noting any extraordinary occurrences;
- conduct weekly safety inspections;
- conduct daily safety meetings (Tailgate safety form provided in Attachment 6);
- ensure AHAs are updated when changes to work tasks occur; and
- act as primary Emergency Coordinator (EC).

4.2.5 Site Safety and Health Officer

For this project, the SSHO will be the same individual as the FTL and will fulfill the duties and responsibilities as defined in corporate procedures. For this project, Ben Siwiec will serve as the FTL/SSHO. The FTL/SSHO will have completed the 30-hour OSHA construction safety class or equivalent. The FTL/SSHO has five (5) years of construction experience (a minimum of one [1] year experience implementing EHS procedures at cleanup operations) and has had eight (8) hours of formal health and safety training every year. The FTL/SSHO reports to the SHM and assists with the on-site implementation of relevant contractor EHS programs and procedures (presented in **Attachment 4**). The FTL/SSHO helps to ensure that operations are performed in compliance with applicable client- and site-specific requirements and government regulations.

The FTL/SSHO's authority and responsibilities include, but are not limited to, the following:

- implement the safety program and the APP and SSHP in compliance with all DoD, federal, state, and local statutes;
- analyze operational risks, hazards, and safety requirements;
- enforce personnel limits and safety zones;
- ensure that contractor employees and subcontractors understand the requirements of the contractor EHS program and procedures through training and communications;
- conduct daily EHS briefings in accordance with corporate procedures;

- conduct daily informal inspections of the project site and recording observations in the logbook;
- update the Safety and Health Deficiency Log on a daily basis and post the log as required by EM 385-1-1, Section 01.A.13.d;
- conduct weekly health and safety inspections and ensure corrective actions identified are being addressed and corrected;
- exercise stop work authority when warranted by conditions, in accordance with the project plans;
- ensure that contractor site personnel have received required EHS regulatory and program training, in accordance with corporate procedure training;
- support the PM in accident and incident investigations;
- function as a technical resource for all environmental, safety, loss control, and industrial hygiene issues;
- ensure that the specific responsibilities for EHS personnel identified in the contractor EHS programs and the EHS plan(s) are fulfilled;
- perform on-site exposure monitoring to determine/adjust appropriate levels and use of PPE;
- ensure that safety data sheets (SDSs) (**Attachment 7**) for new chemicals or materials are available on-site and that site personnel have access to SDSs at all times;
- perform site surveillances, hazard identification, and health risk analysis;
- implement procedures and programs to eliminate risk to site personnel, including initiating changes to the plan;
- act as EC;
- implement site control measures;
- maintain the field health and safety logbook; and
- provide summaries of field operations and progress to the SHM.

4.2.6 Field Crew Personnel

Field crew personnel include the other persons entering the work site for the purpose of assisting in the completion of the project. This includes, but is not limited to, engineers, surveyors, facility representatives, contractor management personnel, subcontractors, regulatory personnel, and site workers.

It is the responsibility of field crew personnel to:

- report any unsafe or potentially hazardous conditions to the FTL/SSHO;
- maintain knowledge of the information, instructions, and emergency actions contained in this APP;

- comply with rules, regulations, and procedures set forth in this APP and any instituted revisions;
- initiate the incident reporting chain by notifying supervisor when involved in an incident/accident (if able to do so);
- prevent admittance to work sites by unauthorized personnel (if the unauthorized persons refuse to leave, the field crew personnel will cease operations and notify the FTL/SSHO, who will notify the PM for guidance);
- perform daily inspections of tools and equipment, including PPE, prior to use;
- conduct a daily operations check of electronic equipment and annotate the findings in the team's logbook; and
- assist the FTL/SSHO with implementation and compliance with the APP/SSHP.

4.2.7 Subcontractors and Suppliers/Vendors

The Contractor directs the subcontractor's supervisor regarding the work and the manner in which the tasks are to be performed. Subcontractors are responsible for assigning specific tasks to their employees; ensuring their employees are properly trained and are in compliance with applicable regulations; and allocating sufficient time, materials, and equipment to safely complete activities in accordance with this APP and their individual EHS plans. Subcontractors will attend the Contractor's daily health and safety meeting prior to starting fieldwork. The Tailgate Safety Form is provided in **Attachment 6**.

4.2.8 Risk Management Process

This plan requires the preparation of an AHA for each task, activity, or DFOW. This plan also requires that these task analyses are reviewed with all workers and that workers acknowledge their review of the safety and health requirements for each task. Where subcontractors are used to perform certain work activities, the FTL/SSHO will ask the subcontractor to provide an initial AHA for review or the FTL/SSHO will work with the subcontractor workers in the preparation of the AHA.

Preliminary AHAs for these activities are provided in **Attachment 3**. Prior to the start of work activities, these preliminary AHAs will be further refined by the persons who will perform the work and the remaining AHAs from the subcontractor will be developed by the subcontractor and reviewed by the contractor. All AHAs will be prepared and internally reviewed and approved by the SHM, then will be submitted to the PM at or prior to preparatory meetings, or prior to work being performed. As new activities or tasks are identified or the work environment of the task changes, new or revised AHAs are prepared by the Contractor. New AHAs will be submitted to the SHM and PM for review prior to the start of the operation and any revisions to existing AHAs will be submitted to the SHM and the PM for review only if the Risk Assessment Code (RAC) increases from that of the original AHA (e.g., a medium becomes a high or a low becomes a medium).

Each worker performing tasks described in an AHA must receive training in the AHA and be allowed to make comments and suggestions regarding the AHA to ensure that all hazards are

properly identified and that control measures are in place to mitigate these hazards. Retraining will occur if/when AHAs are modified.

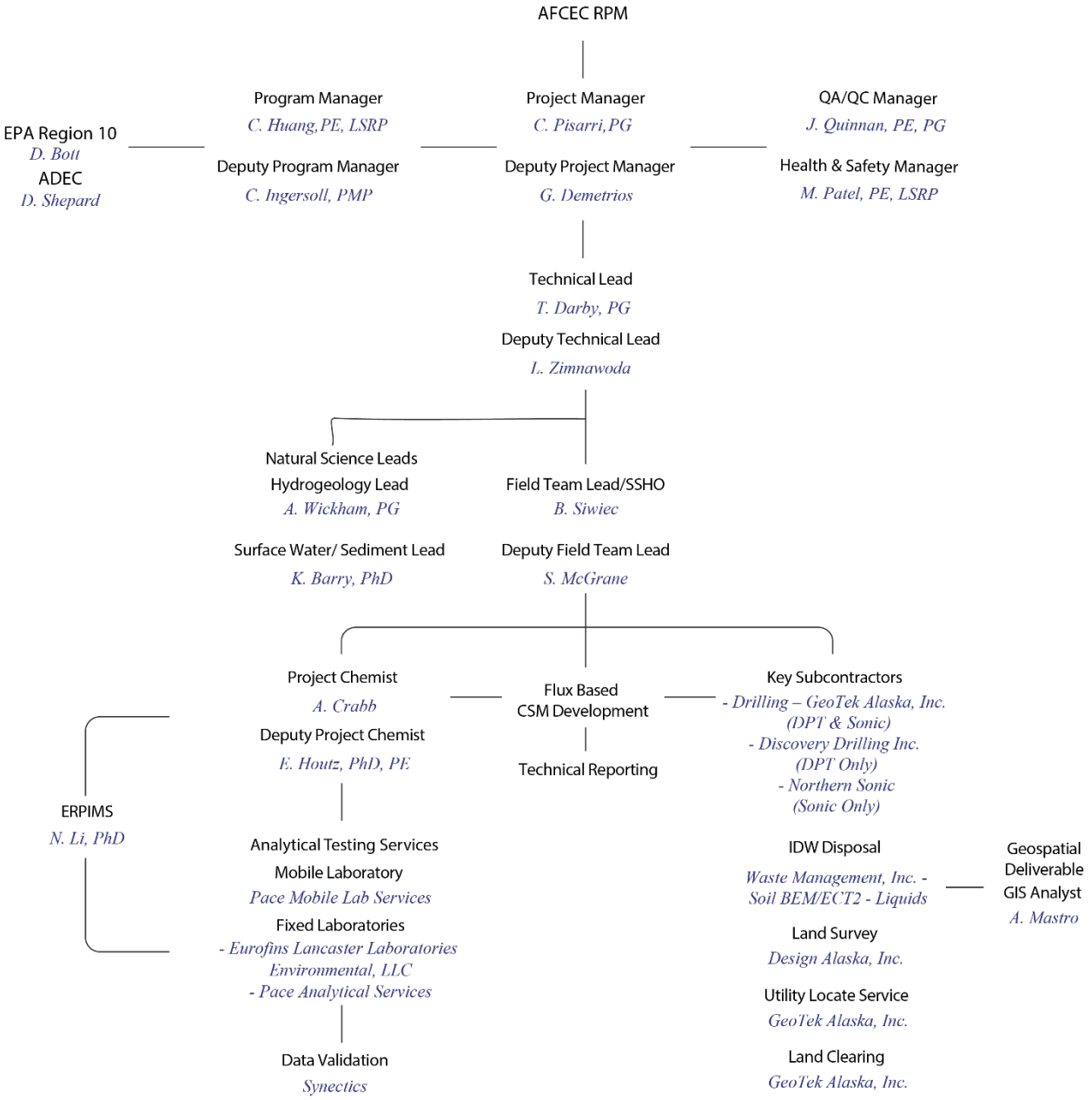
4.3 Lines of Authority

An organization chart depicting the lines of authority is included as Figure 1. The contractor will require that the personnel and subcontractors follow the requirements in this APP and verify that this requirement is being met.

4.3.1 Policies Regarding Noncompliance

The Contractor has a progressive disciplinary program. However, if at any time there is a significant compromise of safety procedures, immediate termination of an employee is allowed by the procedure. The FTL/SSHO will immediately report to the PM and SHM observations of noncompliance in the performance of the subcontractor or workers.

Figure 1. Organizational Chart and Lines of Communication and Authority



5.0 SUBCONTRACTORS AND SUPPLIERS/VENDORS

The roles and responsibilities of subcontractors and suppliers/vendors for work performed in accordance with this APP are described in the following sections.

5.1 Identification of Subcontractors and Suppliers/Vendors

The prime contractor, BEM, subcontracted services to multiple firms to execute different aspects of work included under this APP. Arcadis is the primary subcontractor that will support this effort and at times will lead field activities during the implementation of the sampling effort.

During the implementation of the RI field effort in Spring/Summer of 2021, subcontractors will include: Arcadis, the mobile analytical laboratory (Pace Analytical), land surveyor (Design Alaska, Inc.), utility locator (GeoTek Alaska, Inc.), IDW disposal contractors (Waste Management, ECT2) and the drilling subcontractors (GeoTek Alaska, Inc., Discovery Drilling, and Northern Sonic) will be onsite performing a variety of activities.

5.2 Means for Controlling and Coordinating Subcontractors

The Contractor directs the subcontractor's supervisor on the tasks to be performed and the manner in which tasks are performed. Subcontractor supervisors are responsible for assigning specific tasks to their employees; ensuring that their employees are properly trained and maintain compliance with applicable regulations; and allocating sufficient time, materials, PPE, and equipment to safely complete activities in accordance with this APP and their SHM-reviewed individual EHS plans. Subcontractors' EHS plans are reviewed by the SHM and, if used, must be as stringent or more stringent that the Contractor's EHS Plans.

5.3 Safety Responsibilities of Subcontractors and Suppliers/Vendors

Individuals employed by subcontractors and suppliers/vendors will receive a site-specific briefing regarding the site-specific physical, chemical, or biological hazards present on the worksite; required safety activities; and their individual roles and responsibilities for safety practices. While on-site, all subcontractor supervisors will ensure their crews perform tasks that they are contracted to perform and that they follow, at a minimum, this APP and the task/activity AHAs. The FTL/SSHO will observe their performance and have the subcontractor's supervisors ensure compliance.

Subcontractors are responsible for complying with this APP and all applicable federal, state, and local regulations. Subcontractor personnel must receive a briefing from the FTL/SSHO prior to accessing the project work site. They must fulfill the requirements described in this APP and must acknowledge receipt of the plan and the hazard communication briefing. Onsite subcontractors are responsible for providing their personnel with appropriate PPE as specified by the plan, however, it is the ultimate responsibility of the FTL/SSHO to ensure the APP is followed. Prior to the commencement or continuation of work, the subcontractor and third-party personnel have the authority to request a work area hazard assessment by the FTL/SSHO. Any member of the work party observing an imminent safety hazard or potentially dangerous situation will immediately suspend field activities.

Most subcontractors have their own EHS plans and/or corporate policies that are specific to their specialty services. The contractor management is responsible for ensuring that subcontractor employees follow the policies and procedures of the contractor and this APP. If subcontractors' EHS plans are more restrictive, the subcontractor supervisors must ensure that their EHS plans are also followed. A copy of the subcontractor's plan will be maintained onsite either in hard copy or electronic format.

Hazards not listed in this APP but known by the subcontractor or known to be associated with a subcontractor's specialty must be identified and addressed prior to beginning work, both in the subcontractor's EHS plan and during the daily health and safety briefing. The Contractor will inform the FTL/SSHO of these hazards and assist in the development and/or revision of AHAs.

6.0 TRAINING

The following training is required on this project.

6.1 Construction Safety Training

In order to maintain competency, the FTL/SSHO will have completed the 30-hour OSHA construction safety class or equivalent and has completed eight (8) hours of refresher training annually. All project personnel will receive site orientation training at the start of work. This training will be repeated as necessary whenever work activities and site conditions change. Workers with specific training and qualifications will receive recurrent training as required by regulation or certification credential requirements.

6.2 Hazardous Waste Operations Training and Refresher

All site workers who work within an exclusion zone (EZ) and may either be exposed to chemical-related hazards are required by 29 CFR 1910.120/1926.65 (OSHA, 2019) to have completed 40-hours of Hazardous Waste Operations and Emergency Response (HAZWOPER) training. An 8-hour refresher course is also required on an annual basis. This includes workers who interact directly with or conduct sampling where contact with contaminants in soil or contaminants in water could occur. Supervisors such as the FTL/SSHO must have also completed 8 hours of HAZWOPER Supervisor Training and hold current first aid/cardiopulmonary resuscitation (CPR)/bloodborne pathogen training.

6.3 Hazard Communication Training

The FTL/SSHO will provide hazard communication training for all hazardous materials brought on site. The FTL/SSHO will prepare and maintain a list or table of hazardous materials used on-site for project activities, including Material/Chemical Name, Volume/Quantity, Storage/Staging Location, and Intended Use. The purpose of a hazard communication or employee right-to-understand program is to ensure that the hazards of chemicals located at the site are communicated to site personnel and visitors in accordance with 29 CFR 1926.59 (OSHA, 2019).

Site hazard communication includes the following:

Container Labeling: Personnel will ensure that drums and containers are labeled according to contents. These drums and containers will include those from manufacturers and those produced on-site by operations. Incoming and outgoing labels will be checked for identity, hazard warning, and the name and address of the responsible party.

Safety Data Sheets: an SDS will be on-site for each hazardous chemical used or known to be onsite. SDS's are provided in **Attachment 7**.

At a minimum, site personnel will be instructed on the following:

- Chemicals and their hazards in the work area,
- How to prevent exposure to these hazardous chemicals,
- Controls in place to prevent worker exposure to these chemicals,
- Procedures to follow if workers are exposed to these chemicals,
- How to read and interpret labels and SDSs for hazardous substances found on site,

- Emergency spill procedures,
- Proper storage and labeling, and
- Location of SDSs.

When a new hazardous material is introduced or discovered on-site, site personnel will be given information about this material at the daily safety meeting. The FTL/SSHO is responsible for ensuring that the SDS for the new chemical or material is available on site. The FTL/SSHO will ensure that site personnel have access to SDSs at all times. SDS's are provided in **Attachment 7**.

6.4 Site-Specific Training

Prior to the commencement of field activities, the FTL/SSHO or their designee will provide site-specific orientation training on each element of this APP to all personnel assigned to the site. Site-specific training will address the activities, procedures, monitoring, and equipment for the work operations. Training will include site layout, hazards, evacuation route(s), and the emergency services at the site and will highlight all provisions contained within the APP. This training will also allow fieldworkers to clarify anything they do not understand and to reinforce everyone's responsibilities regarding health and safety for his or her particular activity. If additional training is required for the completion of field tasks during the site work, then the SHM or FTL/SSHO will either conduct the training or manage site personnel to ensure that tasks are conducted by appropriately trained personnel.

Personnel will also be trained in the site-specific emergency response plan, including the employee alarm system; evacuation procedures, routes, meeting places, and accountability; control of fuel sources; fire extinguisher education; minor spill control and cleanup procedures; reporting requirements; and rescue operations, as applicable.

6.5 First Aid and Cardiopulmonary Resuscitation

The FTL/SSHO will identify those individuals who have current first aid and CPR training. At a minimum, the FTL/SSHO will have current CPR/first aid certification. The names of all CPR/first aid-qualified workers will be posted on the APP contact list. An automatic external defibrillator (AED) is anticipated to be available at multiple installation buildings when working within the EAFB boundary/active facility.

6.6 Bloodborne Pathogens Training

Individuals on site who have first aid and CPR certification and who may provide first aid and/or CPR will have completed training in accordance with the Contractor's Bloodborne Pathogens Program and the annual OSHA Bloodborne Pathogen Standard found in 29 CFR 1910.1030 and OSHA equivalent.

6.7 Use of Portable Fire Extinguishers

Project personnel will receive OSHA-compliant fire extinguisher education (29 CFR 1910.157[g]), and OSHA equivalent for the use of portable fire extinguishers to respond to incipient stage fires. Typically, this is given during site orientation.

6.8 Hearing Protection

Users of personal hearing protection will receive OSHA hearing conservation program and hearing protector use training (29 CFR 1910.95[i],[k]) and OSHA equivalent. Typically, this is given during site orientation.

6.9 Hazardous Materials Transportation Training

U.S. Department of Transportation (DOT) Hazardous Material Regulation training is required for all persons who prepare DOT shipping papers (including waste manifests or bills of lading for hazardous materials, including samples), label, package, and/or mark containers for purposes of transportation.

6.10 On-Site Health and Safety Briefings and AHA Review

Project personnel and visitors will participate in daily on-site health and safety briefings conducted by the FTL/SSHO, or designee to assist site personnel in safely conducting their work activities. The briefings will include information on new operations, changes in work practices, or changes in the site's environmental conditions, including AHAs if modified. The briefings will also provide a forum to facilitate conformance with safety requirements, identify performance deficiencies related to safety during daily activities or as a result of safety inspections, and review any events (near misses, injuries, and material releases). Work will be stopped, and a safety briefing will be conducted following any event that could compromise the safety of personnel or the environment.

6.11 Training Certificates

Copies of the required training certificates and licenses (as applicable) will be made available for government inspection upon request either in hard copy or electronic format. Subcontractors will provide the Contractor with copies of their staff's training certifications upon request.

6.12 APP/SSHP Acceptance Form

The APP/SSHP Acceptance Form (see below) is to be signed by all workers entering the project site to document site-specific training. Each AHA will also have a signature page.

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APP/SSHP ACCEPTANCE FORM

I have read and understand the policies and procedures listed in the Accident Prevention Plan and Site Safety and Health Plan for EAFB, AK. I will comply with the provisions therein.

Print Name	Signature	Date

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7.0 SAFETY AND HEALTH INSPECTIONS

Vehicle inspections will be performed daily by the operator in accordance with the Corporate Safety and Health Plan (**Attachment 4**). Weekly site inspections will be completed by the FTL/SSHO on a weekly basis in accordance with the Contractor safety program. Subcontractor personnel and/or craft personnel may be asked to participate in inspections. Daily inspections on the day(s) of scheduled field activities will be performed by the FTL/SSHO and will be noted in the site activity logbook. If any deficiencies are identified during the inspections, they will be noted and corrected. Deficiencies to safety devices or equipment will be corrected before use or the safety devices/equipment will be removed from service until they are fixed. The inspections will be tracked for follow-up action on each of the respective forms. The SHM, or their designee, may conduct an unannounced inspection of the project.

7.1 Responsibility for Minimum Daily Job Site Safety and Health Inspection

Daily EHS inspections will be conducted by the FTL/SSHO during this field effort to ensure safe work areas and compliance with the APP, and OSHA regulations. Observations will be documented in a site logbook.

7.1.1 Documentation Procedures

The FTL/SSHO will record any deficiencies in the onsite field logbook or in a daily safety report that is submitted along with the Contractor Production and Contractor Quality Control daily reports (**Attachment 6**) to the PM, with a copy submitted to the SHM.

7.1.2 Deficiency Tracking System

Deficiencies will be logged within the project logbook and on the daily safety reports. The items noted during field audits will be communicated to the Contractor's Corporate SHM who maintains a corrective/preventive action database. Responsibility for resolving each item noted during these audits is assigned and tracked through resolution. Results from field audits are also regularly communicated through training and electronic means as a method of ensuring continuous program improvement.

7.1.3 External Inspections

AFCEC may periodically conduct inspections/ audits. The Contractor does not anticipate any external inspections from outside agencies.

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8.0 MISHAP REPORTING AND INVESTIGATION

A mishap is any unplanned, undesired event that occurs during the course of work being performed. The term “mishap” includes accidents, incidents, and near misses.

When a mishap occurs, the employee must notify their supervisor immediately. The supervisor will notify the FTL/SSHO. The FTL/SSHO will notify the PM and the SHM. If the mishap is an emergency, the contractor will notify emergency services and respond as discussed in the Emergency Plans (Section 9.2) and will then follow up with internal reporting and investigation.

Recordable mishaps will be reported by the PM as soon as possible (generally within one hour) but not more than 24 hours afterward to the Contracting Officer and Contracting Officer’s Representative (COR).

8.1 Immediate Notification of Major Accidents

Immediate reporting of incidents is required within the contracting company. In addition, if any accident has, or appears to have, any of the consequences listed below, Contractor management will immediately report the accident to the PM who will follow up with official accident reports.

List of accidents to be immediately reported:

- Fatal injury/illness
- Permanent totally disabling injury/illness
- Permanent partial disabling injury/illness
- One or more persons hospitalized as inpatients as a result of a single occurrence
- $500,000 or greater accidental property damage or damage in an amount specified in current accident reporting regulations
- Three (3) or more individuals become ill or have a medical condition which is suspected to be related to a site condition or a hazardous or toxic agent on the site

In addition to the above, any mishap occurring in any of the following high hazard areas will be immediately reported to the PM. These mishaps will be investigated in-depth to identify all causes and to recommend hazard control measures. The PM will subsequently follow-up with official reports as prescribed by regulation. The PM must also be notified immediately (within 24 hours) and be provided follow-up investigative findings within 10 days of the following types of occurrences:

- electrical – including arc flash, electrical shock, etc.;
- uncontrolled release of hazardous energy (electrical and non-electrical); and
- fall from height (any level other than the same surface).

8.2 Additional Reporting Requirements

In addition to the reporting requirements listed above, the employer is required to report:

- property damage exceeding $5,000;

- Days Away injuries;
- Days Away illnesses; and
- Restricted/Transferred injuries.

If a fatal injury, in-patient hospitalization of one or more persons as the result of a single occurrence, amputation, or loss of an eye occurs, the following additional steps will be followed:

- The SHM will initiate contact with OSHA within eight hours for work-related fatalities, and within 24 hours for in-patient hospitalizations (as noted above).
- The work activities on the project must be stopped for 24 hours for a fatality.

8.3 Accident Investigations, Reports, and Logs

Except for rescue and emergency measures, the mishap scene will not be disturbed until it has been released by the investigating official.

After the oral reporting has been done, the FTL/SSHO must complete an initial written-event report form within 24 hours. This form can be prepared manually using the form found in the corporate procedure or electronically using the corporate database. A completed investigation report must be submitted within 72 hours. The investigation report is part of the initial written report form. These forms can be completed by persons involved in the incident, but the investigation must be completed by a supervisor and/or the FTL/SSHO. All reports will be reviewed by the PM and the SHM upon submission. Corrective actions and persons responsible for those corrective actions are identified within the reporting system. The system requires follow-up to ensure the completion of corrective actions. All recordable injuries, near-miss incidents, high loss potential incidents, property damage incidents costing more than $5,000, first aid cases, and environmental spills (greater than reportable quantity) will be entered on the Contractor program incident safety database. This database summarizes the accident/incident history of the program from the start of the contract and on a year-to-date basis.

In addition to the above Contractor procedures and after immediate notifications are performed, the PM or the FTL/SSHO will complete a Contractor Significant Incident Report (CSIR) within 48 hours (**Attachment 8**), as required for any injury beyond first aid or for any government property damages of $5,000 or greater. The FTL/SSHO will ensure that a report is prepared, and the forms are completed as requested by the PM and SHM. This report will include corrective actions that have been implemented.

9.0 PLANS (PROGRAMS, PROCEDURES) REQUIRED BY EM 385-1-1, THE SAFETY MANUAL (AS APPLICABLE)

The Contractor has established written requirements for complying with regulations and implementing contractor policy to prevent accidents and injuries. This section describes how some of these programs are implemented specifically for this project.

9.1 Fatigue Management Plan

A Fatigue Management Plan (FMP) must be completed as part of the APP whenever work hours:

- exceed 10 hours per day for more than four (4) consecutive days;
- exceed 72 hours in a seven-day workweek;
- exceed 12 hours per day for more than three (3) consecutive days; or
- exceed 58 hours per week for sedentary (including office) work.

During this phase of the project, work hours may exceed 10 hours per day for more than four (4) consecutive days. The table is a summarized version of the Fatigue Management Plan that will be enforced for this PFAS RI at EAFB, AK.

Contractor Fatigue Risk Policy Statement: BEM will ensure that our staff and those support subcontractors receive sufficient durations of rests or breaks to mitigate fatigue during the implementation of the fieldwork efforts. Our goal is to ensure a minimum of 10 hours of rest/breaks within each 24-hour period of work. Should work above the proposed duration limit rest to 10 hours per day or less, the FTL/SSHO shall monitor staff for signs of fatigue and contact the PM if additional resources are necessary to work multiple “shifts” or evaluate if time-off from the job is required to eliminate or reduce the risk of fatigue.

Fatigue Risk	Mitigation Measure	Management Action
Working Long Hours on Consecutive Days	• Where possible, keep field workdays to 12 hours or less to ensure a minimum of 10 hours of rest per crew. • Conduct work breaks to allow for mid-day rest	• Ensure proper staff are available based upon the level of effort for project requirements. • Verify through the onsite FTL/SSHO that the field team is receiving proper break/rest time. • Authorize time off if workers are showing signs of fatigue.

Fatigue Risk	Mitigation Measure	Management Action
Drowsiness Conditions while Operating Motor Vehicles	• Ensure staff that are operating vehicles receive proper rest. • Require the FTL/SSHO to conduct visible checks of field staff for signs of fatigue prior to travel to the site, during the daily tailgate meeting, and throughout the duration of the workday prior to operation of a motor vehicle.	• Provide the FTL/SSHO with the authority to assign work breaks when needed. • Enforce proper rest periods per FMP. • Ensure seat belts are worn by all staff while operating or riding in company vehicles
Slips, trips, and falls due to overworked staff	• Eliminate physical hazardous that could result in tripping hazards or slips to staff. • Ensure proper durations of rest by field team	• Ensure safety of APP including completion of activity hazardous analysis sheets. • Review daily tailgate briefing to ensure topics are being discussed and safety measures implemented.
Mistakes while conducting field work or completing daily field forms	• FTL/SSHO will observe for evidence of fatigue by staff during daily meetings and briefings • The FTL/SSHO will inspect/audit field forms to ensure completeness and accuracy • If necessary, the FTL/SSHO may switch out staff that are showing evidence of fatigue	• Ensure proper depth of resources are available to support the proposed field activity for the anticipated duration of work. • Have the PM conduct inspections/audit of field generated forms and logs to evaluate for evidence of fatigue. • Conduct daily conversations with field staff to identify fatigue-like mannerism.

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9.2 Emergency Plans

Emergencies involving physical hazards, including fires, are generally readily apparent visually. Injuries and medical emergencies, including potential exposure to hazardous materials, may not always be apparent. Tasks to be performed at the site, potential hazards associated with those tasks, and the recommended control methods are discussed in this APP and associated AHAs. Early recognition of hazards will be supported by daily site surveys to eliminate any situation predisposed to an emergency. The FTL/SSHO will be responsible for performing surveys of work areas prior to initiating site operations, and regularly while operations are being conducted. Survey findings are documented by the FTL/SSHO in the site health and safety logbook. Site personnel are responsible for reporting situations they perceive as hazardous and correcting those hazards that are immediately correctable (e.g., removing tools or materials that may present a trip hazard).

The above actions will provide early recognition for potential emergency situations and allow the contractor to instigate necessary control measures. However, if the FTL/SSHO determine that control measures are not sufficient to eliminate the hazard, the Contractor will withdraw from the site until the hazard can be effectively managed or eliminated and notify the appropriate response agencies whenever a hazard presents an emergency situation. Emergency plans have been prepared to address employee safety in case of fire/unplanned explosion, injury or medical emergency, inclement weather, and spills of hazardous materials. These emergency plans will be reviewed with employees and will be tested to ensure their effectiveness. The emergency plans also include information on communication, emergency equipment, first aid/CPR qualifications, and means of rescue.

In the event of an emergency during on-site work, the primary response action by on-site personnel will be to safely assemble and evacuate to an area unaffected by the emergency, notify the FTL/SSHO, and render the appropriate level of response and support as specified in these plans.

Local emergency service providers capable of providing immediate response to site emergencies are available in the site vicinity. In the event a fire or explosion, injury, or medical emergency occurs; these agencies will be notified in the event of an emergency by calling **911** and communicating the nature of the emergency so that dispatch of appropriate responders can be determined and deployed. The PM and the FTL/SSHO will be notified if these response agencies are contacted. Contractor personnel will perform incipient emergency prevention activities, such as:

- initial (e.g., non-structural) firefighting support and prevention (e.g., use of fire extinguishers);
- initial spill control and containment measures and prevention;
- evacuation of personnel from emergency situations beyond the initial response level; and
- initial medical support for injury/illness requiring only first aid-level support.

Contractor personnel will not provide emergency response support beyond their on-site capabilities and their training.

9.2.1 Pre-Emergency Planning

Based on the nature of the planned activities, emergencies resulting from physical or chemical hazards such as personnel exposures, fires or explosions, injuries, or medical emergencies could occur. To minimize or eliminate the potential for these emergency situations occurring, pre-emergency planning activities will include the following (which are the responsibility of the FTL/SSHO with participation by subcontractor and craft personnel):

- coordinating with the local emergency response personnel and local hospitals prior to the commencement of work to ensure that contractor emergency action activities, including rescue and escape capabilities, are compatible with existing emergency response procedures;
- establishing and maintaining information and equipment at the project staging areas (support zones [SZs]) for easy access in the event of an emergency;
- training of all workers regarding the requirements of these emergency plans and the location of emergency equipment, evacuation routes, and locations; and
- creating and maintaining documents on-site that will be important in the event of an emergency situation, including:
  - a logbook identifying personnel on-site each day;
  - emergency equipment on-site (**Table 9-1**);
  - Figure showing site location and evacuation route (**Figure 2**); and
  - Emergency notification names and phone numbers (**Table 9-2**).

9.2.2 Personnel and Lines of Authority for Emergency Situations

The FTL/SSHO will serve as the EC until emergency response personnel arrive on-site and take command. If the FTL/SSHO is not present, the area or task supervisor will be the immediate EC and will take all necessary precautions and measures to initiate the emergency response, including notification of emergency personnel and the FTL/SSHO. In the event of an emergency, personnel will safely halt operations and evacuate to a safe area and the EC will be in charge until emergency responders arrive and take command. The EC will conduct a headcount to confirm that all employees have been safely evacuated and are accounted for.

9.2.3 Emergency Signal, Assembly, and Evacuation Procedures

In the event of an emergency situation where the Contractor is making the determination to evacuate the site, the EC will activate an air horn (or vehicle/equipment horn if available) to signal an evacuation. The emergency signal will be steady long beeps indicating the initiation of evacuation procedures.

An evacuation will be initiated whenever recommended hazard controls are insufficient to protect the health, safety, or welfare of site workers. Specific examples of conditions that may initiate an evacuation include, but are not limited to the following: severe and sudden extreme weather conditions, fire or explosion, evidence of acute personnel overexposure to a chemical, the discovery of unanticipated waste materials that are unknown, and emergencies that could also occur due to activities or conditions not directly related to site work.

In an emergency, personnel in affected work zones will immediately and safely stop work and assemble near the field vehicle or other safe area (upwind whenever possible), as identified by the FTL/SSHO (or immediate supervisor of that operation) where accountability of personnel will be performed. Personnel will then proceed to the designated evacuation area. Evacuation routes and areas will be established based on individual work zones, as directed by EAFB personnel.

The location of assembly and evacuation areas and routes will be upwind of the site, as determined by the wind direction, whenever possible. The FTL/SSHO will ensure that that diagrams showing these safe egress routes and locations of assembly areas and evacuation areas are kept current. All site personnel will be briefed regarding the assembly and evacuation locations and routes (including alternative locations for each work location) and the diagrams will be updated whenever this information changes. **Figure 2** shows the location of the nearest hospital that will be used if emergency medical services are required.

For efficient and safe site evacuation and assessment of the emergency situation, the EC will have the authority to initiate proper action if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the project area once the emergency signal has been given and the order to evacuate is issued. Once the alarm has been sounded, the EC must establish that access for emergency equipment is provided and that equipment that may cause combustion has been shut down. Emergency agency notification will commence as soon as possible and while the safety of the personnel is being confirmed. The FTL/SSHO will brief site personnel each day and when the location of either the assembly or evacuation area is revised.

If an emergency warranting evacuation occurs, the following procedures are to be initiated by the EC:

- declare the evacuation via cellular telephones, hand signals, voice commands, line-of-site communication, or vehicle/air horns, as necessary;
- use the following signal when communication via vehicle horn or air horn is necessary;
    - steady long beeps will be used to indicate emergency situations
- report to the designated evacuation area for accountability;
- ensure that nobody is allowed back into the work area until the FTL/SSHO, or PM has given the “all clear” for employees to return to the site; and
- describe the incident precipitating the evacuation to the FTL/SSHO using all pertinent incident details.

9.2.4 Emergency Equipment

The emergency equipment listed in **Table 9-1** will be strategically placed and maintained on-site inaccessible locations where active work is taking place. A description of the equipment and the circumstances under which it will be used are provided below.

- An industrial first aid kit meeting the requirements of OSHA and a bloodborne pathogens kit will be readily available and visible at the worksite. The location of each first aid kit will be clearly marked and kits will be protected from the weather and properly maintained. The

first aid kit must include at least one pocket mouthpiece or CPR barrier and latex gloves. The first aid kit will be inspected weekly and items will be replaced as they are used.

- Emergency eyewash bottles will be available at the worksite and will be inspected weekly by the FTL/SSHO to ensure that they are functional, in sanitary condition, and that the sterile water solution is still sealed in and the bottle is not compromised.
- An air horn will be available on-site unless vehicle/equipment horns are immediately available for use.
- A means of communication for notifying 911 emergency response will be provided within immediate reach (e.g., cellular telephone/satellite phone or landline or, for remote locations, a radio that can reach a dedicated person with access to a landline).
- An emergency contact list with telephone numbers will be provided on-site and will be updated as necessary.
- An emergency evacuation area location and route map will be available on-site and will be updated as necessary.

Table 9-1. Types and Locations of Emergency Equipment

Equipment	Location
First Aid Kit	Work vehicle
Portable eyewash	Work vehicle
Air horn (if not equipped with vehicle horn)	Work vehicle
Fire Extinguisher	Work Vehicle
Cellular telephones	FTL/SSHO

9.2.5 Posting of Emergency Telephone Numbers

The list of emergency telephone numbers provided in **Table 9-2** will be maintained at the telephone communications points in the site vehicles (since there is no field office), and at any SZ near active work locations.

Table 9-2. Emergency Contact List

Service/Contact	Agency	Telephone Number
Immediate Emergency		**911** (from landline or cell)
Alaska State Troopers	Alaska State Troopers	**911** / (907) 451-5100
Fairbanks Memorial Hospital (26 miles by vehicle)	Emergency Room	(907) 458-5555
Urgent Care Clinic	Steese Immediate Care 1275 Sadler Way, Fairbanks, AK 99701	(907) 374-7911
Police	354th Security Police Squadron	**911** / (907) 377-5130
Police	North Pole Police Department 125 Snowman Ln, North Pole, AK	**911 /** (907) 488-6902
Ambulance	Salcha Fire and Rescue 7153 Richardson Hwy, Salcha, AK	911 / (907) 488-5274
Fire	Salcha Fire and Rescue 7153 Richardson Hwy, Salcha, AK	911 / (907) 488-5274
Mittul Patel	BEM Corporate SHM	(908) 598-2600 x 115
Chris Pisarri	BEM PM	(407) 402-4440
Lesa Zimnawoda	BEM Deputy Technical Lead	(907 947-7018
Kris Smith	USAF RPM	(907) 987-9024
Tracy Kissler	USAF COR	(907) 384-2520
Rita Leal	USAF Contract Officer	(210) 395-8671
CHEMTREC	Chemical Transportation Emergency Center	(800) 424-9300
National Capital Poison Center		(800) 222-1222
Centers for Disease Control http://www.cdc.gov/		(800) 232-4636
National Response Center		(800) 424-8802

9.2.6 Spill Emergency Plan

It is not anticipated that any of the proposed field activities associated with the initial groundwater sampling event would result in the generation of a hazardous material spill requiring emergency response.

During the implementation of the proposed RI field activities spill countermeasures will be documented and detailed. The general spill response procedure is to stop the source of the spill, contain any spilled fuel, and clean up the spill in a timely manner to prevent accidental injury or

other damage. Small spills will be contained by site workers providing they are able to do so without risking injury. In the event of a large spill, a properly trained government employee will assess the area for immediate dangers to health or safety. If dangers are present, the area will be cleared and USAF points of contact will be contacted immediately. Protective gear (clothing, gloves, goggles, etc.) will be used. The spill kit will be retrieved, storm drains protected, and spill kit material deployed. The spill source will be contained if possible. Once the spill has been contained and any storm drains protected, CHEMTREC will be contacted for cleanup procedures. If a hazardous substance spill exceeds 25 gallons or if any amount has been released to soil, surface water or storm drains, the National Response Center (800-424-8802) and the appropriate State-regulated Northern Area Spill Prevention and Response Department (907) 451-2121 during business hours, (800) 478-9300 after hours) shall be contacted.

In the State of Alaska, the following requirements also apply for releases of oil/petroleum products:

- **To Water:** Any release of oil to water must be reported as soon as the person has knowledge of the discharge.
- **To Land:** Any release of oil in excess of 55-gallons must be reported as soon as the person has knowledge of the discharge. Any release of oil in excess of 10-gallons but less than 55-gallons must be reported within 48 hours after the person has knowledge of the discharge. A person in charge of a facility or operation shall maintain, and provide to the Department on a monthly basis, a written record of discharge of oil from 1 to 10 gallons.

In addition, the State of Alaska spill notification form will be completed, which is included in **Attachment 9** along with the notification instructions.

9.2.7 Fire Emergency Plan

Workers will not fight any fires other than small fires that have recently occurred and can be reasonably extinguished immediately (incipient stage fires). If a fire breaks out on-site, call (or designate someone) to call 911 before attempting to put out the fire (incipient stage only) and only if fighting the fire does not put anyone at further risk. Ensure a means of egress is available in the event that the fire cannot be extinguished. It is not anticipated that the proposed sampling activities would require a fire emergency response. However, the use of vehicles to travel to the sample site could become a source of ignition if parked in dry tall grass.

To use the fire extinguisher, remember the word P.A.S.S. – pull the pin, aim the nozzle at the base of the fire, squeeze the lever, and sweep side to side at the base of the fire.

Fire extinguishers (if utilized) will be inspected by the FTL/SSHO at the start of the project and then on a monthly basis (at a minimum). Additionally, all fire extinguishers will be inspected and serviced annually by a qualified professional. Any defective or partially used fire extinguisher will be red-tagged and taken out of service until such time that it can be serviced. Fire extinguishers will be secured or supported when transported and in storage. During project demobilization, all fire extinguishers and other hazardous material will be properly dispositioned for further use at other contractor projects.

In the event of a fire or explosion, contact the appropriate emergency authorities by calling **911** as specified in **Table 9-2**. Any fire must also be reported to the appropriate client point of contact

and the FTL/SSHO. The person reporting the fire is required to provide the following information to responding emergency personnel:

- their name;
- location of the fire;
- number of injured persons and nature of injuries, if known;
- substance(s), chemical(s), or materials involved in the fire;
- size of the fire and available fuel (estimate);
- extent of fire;
- rate that the fire is expanding (estimate);
- time the fire started and the time the fire was extinguished; and
- any other pertinent information.

9.2.8 Medical Emergencies

In the event of a medical emergency, first aid and CPR assistance will be provided by CPR-/first aid-trained individuals. The injured party will be moved as minimally as possible if the scene remains safe for the injured or ill person and first aid responders or responding emergency personnel. If it is safe to move the person without further injury or the location is compromised, the person will be moved to the nearest appropriate location for continued care. No person will enter an unsafe location, to rescue an injured worker if the scene poses a hazard that could injure or trap the would-be rescuer.

In the case of medical emergencies, emergency responders, as determined by emergency dispatch personnel typically will be relied on to stabilize patients and to provide transportation to the hospital. In the event of a medical emergency in which an actual or suspected serious injury occurs, the following procedures will be followed.

- Survey the scene and evaluate whether the area is safe for entry.
- Render first aid and CPR as necessary.
- Obtain emergency medical services for ambulance transport to a local hospital by calling **911** from a cell phone or landline. This procedure will be followed even if there is no visible injury. Provide the following information to the emergency dispatch personnel:
  - Identify the location by address, nearest cross street, or global positioning system coordinates, request medical assistance, and provide a name and telephone number.
  - Stay on the line with dispatch.
- Other personnel in the work area will be evacuated to a safe distance until the EC determines that it is safe for work to resume. If there is any doubt regarding the condition of the area, work will not commence again until the hazard control issues are resolved.
- Notify the PM and FTL/SSHO.

The location of and directions to the hospital from the site are also included in **Figure 2**, and contact numbers for the hospital are provided in **Table 9-2**.

9.2.8.1 Decontamination During Medical Emergencies

Based on the nature of the planned activities, the need for specific personal decontamination activities in an emergency medical situation is unlikely. However, if workers are saturated with fuel products during refueling, decontamination may be required. If decontamination becomes necessary, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of the involved personnel. Decontamination will be postponed if the incident warrants immediate evacuation.

As soon as possible and prior to transportation to a medical center,

- the contaminated site worker will be washed, and rinsed with water, as necessary;
- contaminated clothing will be removed and disposed of;
- first aid treatment will be rendered; and
- if decontamination is not feasible, as much information as is known will be provided to emergency responders regarding the potential contaminants.

9.2.8.2 First Aid

The contractor will ensure that at least one person on site have current certifications in CPR, first aid, and bloodborne pathogens. Other than rendering basic CPR and first aid, these employees are not expected to perform emergency medical duties; however, they are authorized to perform emergency rescue or other duties up to the level of their training.

For first aid injuries that are not deemed an emergency situation, appropriate care following first aid may include stabilization and transportation to a nearby urgent care facility or occupational medicine clinic for evaluation. The FTL/SSHO will evaluate the location of the nearest occupational medicine provider by contacting the clinic and determining if the clinic accepts contractor worker's compensation insurance during mobilization for these non-emergency injuries or illnesses. Subcontractors will be instructed to do the same as per their company's corporate procedures.

9.2.9 Inclement Weather

The FTL/SSHO will monitor the weather when a storm is forecast for the area. If severe weather conditions are predicted, the FTL/SSHO will monitor radio broadcasts or National Weather Service reports a minimum of two (2) times per day, and management will evaluate the situation and take appropriate action to maintain worker safety, including travel to and from work sites, and to evaluate whether shutting down of the site or specific tasks will be required before inclement weather arrives.

Nearby thunderstorms, if present, could have lightning associated with them. When a thunderstorm arises, the FTL/SSHO will determine if lightning is within 10 miles of the site. Once lightning is seen, count the number of seconds until thunder is heard and divide the number of seconds by five to calculate the distance the lightning is from the site. If lightning is 10 miles away or less, work should stop until 30 minutes after the last audible thunder or visible flash of lightning.

If lightning is observed, all load-handling equipment work and other hazardous work will stop until no lightning activity is observed for a minimum of 30 minutes, and all outdoor workers will seek shelter in a fully enclosed vehicle cab or other fully enclosed structure, such as the field office.

The FTL/SSHO will assess what work procedures can be safely performed when wind conditions exceed 20 miles per hour (mph) for any activities that can be affected by wind; lesser wind speeds may require consideration of work suspension depending on conditions. The FTL/SSHO will also give consideration to the safety of equipment in high winds, and protection of workers from flying debris.

In preparation for an approaching storm, equipment stored outside will be secured, and all doors and windows associated with the equipment and worksite will be closed. Tools and supplies will be stored in a designated secure location. Work tasks will be safely idled and secured as necessary.

9.2.10 Earthquake

If an earthquake occurs, workers in vehicles will stay in their vehicles. Workers will avoid standing next to structures. Workers on the ground may choose to lie on the ground until the quake subsides. After the earthquake, the FTL/SSHO will monitor radio broadcasts or other emergency instructions and account for all crewmembers while awaiting further assessment of site safety before work continuation. Be aware that aftershocks are possible.

9.3 Site Sanitation/Housekeeping Plan

This project site is an active USAF installation; sanitation facilities are available and are maintained by USAF contractors operating the site.

Additional sampling activities are expected to be performed off-site. Private sanitation facilities are not anticipated to be available. Use of public sanitation facilities is recommended, in addition to use of personal sanitation equipment (i.e. anti-bacterial hand wipes, hand sanitizer).

9.4 Medical Support Agreement

The project DFOWs, activities, and tasks are all anticipated to have a “low” to “medium” RAC, therefore, the medical support agreement is not required to be in writing.

Contractor and subcontractor crews will have working cellular telephones capable of communicating between teams and dialing 911 if required. **Table 9-2** includes the telephone numbers of the nearest hospital and urgent care clinic for emergency medical support, along with project personnel emergency contact names and numbers.

Personnel at medical facilities who are expected to treat injured employees will be informed of the nature of the work to be performed and the injuries/illnesses prevalent on such job sites by the FTL/ SSHO during or prior to mobilization, as required.

Figure 2 contains a map delineating the best route to the nearest emergency medical facilities listed in **Table 9-2**.

The project site will have a first aid kit (one for every 25 or fewer employees) that complies with the criteria contained in American National Standards Institute Z308.1.

A minimum of one (1) first aid-/CPR-qualified persons will be on site for each work shift and will be listed on the AHAs.

9.5 Bloodborne Pathogen Program

Bloodborne pathogens enter the human body and blood circulation system through punctures, cuts, or abrasions of the skin or mucous membranes. They are not transmitted through ingestion (swallowing), through the lungs (breathing), or by contact with whole, healthy skin. However, under the principle of universal precautions, all blood should be considered infectious and all skin and mucous membranes should be considered to have possible points of entry for pathogens. Two significant primary bloodborne pathogens are Hepatitis B and the human immunodeficiency virus (HIV).

Potential bloodborne pathogen exposures include the following.

- Contact with contaminated medical equipment or medical waste or sharps waste.
- Contact through medical emergency response operations such as administering first aid or CPR.

To reduce the risk of contracting a bloodborne pathogen, take the following precautions:

- avoid contact with blood and other bodily fluids;
- use protective equipment when giving first aid/CPR, such as disposable gloves and breathing barriers (which are provided in the first aid kits); and
- thoroughly wash your hands with soap and water immediately after giving care.

When cleaning up blood or other bodily fluids:

- clean up the spill immediately or soon as possible after the spill occurs;
- use disposable gloves and other PPE when cleaning spills;
- wipe up the spill with paper towels or other absorbent materials;
- after the area has been wiped up, flood the area with a solution of one-quarter cup of liquid chlorine bleach to one gallon of fresh water and allow it to stand for at least 20 minutes; and
- dispose of the contaminated material used to clean up the spill in a labeled biohazard container.

The FTL/SSHO should be notified of any potential contact with blood or bodily fluids resulting from first aid or CPR administered on the job. The FTL/SSHO will notify the SHM. Site personnel will be given bloodborne pathogens training.

9.6 Exposure Control Plan

Should an exposure occur, the SHM will direct post-exposure-related activities. The protocol shall include a plan to ensure immediate medical evaluation of exposed individual(s) per the current recommendations of the Centers for Disease Control and Prevention for HIV, Hepatitis B virus, and Hepatitis C virus.

Prior to the start of work outside the employee's normal geographical area, the contractor will inform employees of parasitic, bacterial, viral, and environmental diseases endemic to the geographical work location. This information and preventative measures and actions to take upon exposure from potential carriers of these diseases relevant to this project location (e.g., mouse or bird droppings, bites from mosquitos, etc.) are contained in Section 9.12.4.

9.7 Automatic External Defibrillator Program

On-site project activities will be performed within an active USAF installation, and as such, an AED has been confirmed to be present and maintained, available at the installation.

An AED is not anticipated to be available for off-site project activities (i.e. boring installations, sampling of wells, or surface water/sediment sites outside of EAFB boundary).

9.8 Site Layout Plan

Not applicable.

9.9 Access/Haul Road Plan

Not applicable.

9.10 Hearing Conservation Program

Working around drill rigs can be very loud and hearing protection should be worn for personnel near the drill rig while in operations. In addition, the work will be conducted at an active military installation that conducts routine training of aircraft that generate noise levels that can be damaging to hearing if extended exposure occurs. The FTL/SSHO will evaluate the workplace for noise hazards initially and then regularly during the course of work. The FTL/SSHO will re-evaluate the workplace whenever there is difficulty in communicating or when new equipment is placed into service or into new areas.

The assessment of noise hazards, if necessary, will comply with the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value continuous noise exposure standards outlined in Table 5-4 of EM 385-1-1, and the assessment/evaluation will be documented.

- For impact (impulse) noise, personnel exposures may not exceed 140 decibels (dBA) (unweighted) without the use of effective hearing protection devices.
- For continuous (steady-state) noise, personnel exposures may not equal or exceed 85 dBA without the use of effective hearing protection devices.

As an administrative control, the FTL/SSHO will post noise-hazardous areas (areas where the noise values exceed the above thresholds) and the requirement for hearing protection in these areas. Equipment that is identified as noise hazardous will be labeled as a noise hazard requiring the use of hearing protection, and if the noise hazards of the equipment may affect adjacent workers, the workers will be notified of the noise values and offered hearing protection. If noise exposure to employees cannot be reduced to below the required standard, operating time limits may be imposed.

Hearing protection devices will be provided to affected employees for the attenuation of noise to acceptable levels (less than 85 dBA for continuous (steady-state) noise. Ear insert devices, including disposable, pre-formed, or custom-molded earplugs, will be fitted to the exposed individual by an individual trained in such fitting and able to recognize the difference between a good and poor fit. Workers who work in noise-hazardous environments more than 30 days per year on the job will undergo pre-employment and end-of-employment hearing testing.

9.11 Respiratory Protection Plan

Periodic air monitoring for volatile organic compounds (VOCs) in the breathing zone will be conducted utilizing a photoionization detector. The results of the air monitoring shall be recorded in the field logbook on a daily basis. Details regarding exposure monitoring and action levels are detailed in Section 8 of the SSHP (**Attachment 1**). If real-time air monitoring instrument in any work area exceeds an action level, as presented in **Table 1 of the SSHP (Attachment 1)**, the level of protection will be upgraded, potentially requiring a respirator.

BEM's respiratory protection plan is described in Section 11.5 of BEM's Corporate Safety and Health Plan (**Attachment 4**).

if the action levels are exceeded. Additional details regarding the lower explosive limit, upper explosive limit, physical/ chemical data, and toxic effects are provided in the applicable SDS (**Attachment 7**).

9.12 Health Hazard Control Plan

Biological hazards, including bloodborne pathogens, may be present on site. In addition, the potential exists for bites or stings by wildlife that can result in an allergic reaction or the transmission of potential bloodborne diseases.

Section 9.12.1 addresses chemical hazards and mitigation measures to reduce those hazards, including the monitoring strategy for this project. Section 9.12.4 addresses biological hazards (e.g., animals, poisonous plants, insects, and insect-transmitted bloodborne pathogens). Section 9.61 identifies and describes other physical and classic safety hazards, and mitigation measures to reduce those hazards that have not been discussed elsewhere in this APP.

The contractor will create systems and procedures to prevent and control physical, chemical, and biological hazards that are identified through the risk/hazard analysis. The hierarchy of controls is engineering, administrative, work practice, and PPE. Use of such controls in conjunction with PPE will help reduce the hazard or exposure to the lowest practical level.

The basic formula for controlling workplace hazards, in order of preference, is:

1. Eliminating the hazard from the method, material, or the facility.
2. Abating the hazard by limiting exposure or controlling it at its source.
3. Training personnel to be aware of the hazard and to follow safe work procedures to avoid it.
4. Prescribing PPE for protecting employees against the hazard and ensuring they not only use the PPE but know how to use it correctly.

9.12.1 Chemical Hazards, Controls, and Monitoring Strategy

Potential COCs for the site are based on known previous investigations and remedial activities of the site. The Permissible Exposure Limits (PELs) and threshold limit values (TLVs) of expected hazardous site contaminants are summarized in **Table 9-3**. Periodic air monitoring for VOCs in the breathing zone will be conducted utilizing a PID. The results of the air monitoring shall be recorded in the field logbook on a daily basis. Additional details regarding exposure monitoring and action levels are detailed in Section 8 of the SSHP (**Attachment 1**). Additional details regarding the lower explosive limit, upper explosive limit, physical/ chemical data, and toxic effects are provided in the applicable SDS (**Attachment 7**).

Table 9-3. Project Chemical Exposure Limits

Chemical	OSHA Exposure Limit PEL	ACGIH Exposure Limit TLV
PFOS, PFOA	-	-
Tetrachloroethylene (PCE)	100 ppm Time Weighted Average (TWA), 200 parts per million (ppm) ceiling, 300 ppm peak	25 ppm TWA; 100 ppm Short Term Exposure Limit (STEL)
Trichloroethylene (TCE)	100 ppm TWA, 200 ppm ceiling, 300 ppm peak	10 ppm TWA; 25 ppm STEL
cis-1,2-Dichloroethylene (cis-1,2-DCE)	-	200 ppm
Vinyl Chloride	1.0 ppm TWA, 5 ppm STEL	1 ppm TWA
Benzene	1 ppm TWA; 5 ppm STEL	0.5 ppm TWA; 2.5 STEL
Toluene	200 ppm TWA, 300 ppm peak	TWA 100 ppm*, STEL 150 ppm*
Ethylbenzene	100 ppm TWA	20 ppm TWA
Polychlorinated biphenyl (PCB)	1 mg/m^3 TWA	0.5 mg/m^3 TWA
Xylenes	100 ppm TWA; 150 ppm STEL	100 ppm TWA; 150 ppm STEL
Carbon monoxide	50 ppm TWA; 1,200 ppm Immediately Dangerous to Life and Health (IDLH)	25 ppm
Diesel fuel	None	100 mg/m3 TWA (skin)
Gasoline	None	300 ppm TWA; 500 ppm STEL

Notes:

ACGIH = American Conference Governmental Industrial Hygienists
IDLH = Immediately Dangerous to Life and Health
mg/m3 = milligrams per cubic meter
OSHA = Occupational Safety & Health Administration
PEL = Permissible Exposure Limit
* = NIOSH REL
ppm = parts per million
STEL = short-term exposure limit
TLV = threshold limit value
TWA = time-weighted average (8-hour)
- = no data available

9.12.2 Site Control Measures

Not applicable.

9.12.3 Personal Hygiene and Decontamination

This section provides decontamination procedures and guidelines for developing site- and activity-specific decontamination procedures.

9.12.3.1 Responsibilities

The FTL/SSHO is responsible for establishing and maintaining appropriate equipment and personnel decontamination areas and ensuring that subcontractors follow this plan.

9.12.3.2 Contamination Avoidance

Avoiding contamination is the first and best method for preventing the transfer of contamination. Each person involved in site operations must regularly practice the methods listed below for contamination reduction.

- Know the limitations of the protective equipment being used.
- Do not sit or lean against anything in a contaminated area and try to limit the need for excessive contact with contaminated media.
- Use the proper tools to safely conduct the job.
- Inspect tools and equipment used for subsurface activities for soil and remove these materials before tracking out of the exclusion zone work area.

9.12.3.3 Decontamination

Decontamination for this project involves physically removing contaminants from equipment and/or PPE. Decontamination, proper PPE donning and doffing procedures, and management of work zones minimize the chance of cross-contamination from protective clothing to wearer, equipment to personnel, and one area to another.

In general, decontamination will consist of:

- Removing residual materials from tools and equipment or personnel, regardless of their source, before taking breaks or engaging in hand-to-mouth activities.
- Employing a soap and water wash and rinse for hands and, if required, face. Hygiene wipes may also be used but are not a substitute for handwashing with soap and water.
- Keeping break areas clean. No potentially contaminated PPE or equipment will be permitted in these locations or offices.
- Proper doffing of used and contaminated PPE and proper storage of reusable PPE after decontamination and between uses.

9.12.3.4 Personnel Decontamination Guidance

It is anticipated that disposable PPE, such as gloves, boot covers, and coveralls, will be disposed of after use. Personnel decontamination will consist of a soap/water wash and rinse. This function will take place in an area adjacent to the site activities. A handwashing station will be available for workers to wash their hands before leaving the work area or taking breaks. Workers will be instructed to wash their hands before going on breaks.

9.12.3.5 Equipment Decontamination Guidance

It is anticipated that equipment, such as pumps, tubing, buckets, etc., will be cleaned of adhering soil or loose debris prior to being moved. Mobile equipment tracks or tires are not anticipated to come into contact with contaminated media and wet decontamination methods are not anticipated to be required for motorized vehicles at this time.

The FTL/SSHO will be responsible for evaluating equipment both arriving on-site and leaving the site. Evaluation will consist of a visual inspection to ensure that visible contamination has been effectively removed.

9.12.4 Biological Hazards

Overall, wildlife should not be harassed, fed, or interacted with by site personnel. Identification of potentially dangerous wildlife will be communicated to the FTL/SSHO and other personnel onsite. Other potential biological hazards are listed in the following subsections.

9.12.4.1 Insects

The following is a list of preventative measures that can be taken in order to avoid insect bites while onsite.

- Wear proper protective clothing (work boots, socks, and long pants).
- Tuck pant legs into socks and wear long-sleeved shirts.
- Avoid placing bare hands in dark corners or under stored material.
- Apply insect repellent

Mild insect stings or bites should be treated by applying a baking soda paste or ice wrapped in a wet cloth. Bee stingers should be gently scraped off the skin, working from the side of the stinger. If insect bites become red or inflamed, or symptoms such as nausea, dizziness, shortness of breath, etc. appear, medical care will be sought immediately. Immediate medical care is essential for persons who are allergic to insect bites/stings. If an allergic person receives a spider bite or insect bite/sting, seek immediate medical attention, keep the victim calm, and check vital signs frequently. Rescue breathing should be given, if necessary, to supply oxygen to the victim. All suspected spider bites should be managed by washing the area with soap and water to prevent infection. Medical care will be sought immediately if any of the above symptoms develop.

9.13 Hazard Communication Program

Refer to Section 6.3 of this APP.

9.14 Process Safety Management Program

Not applicable.

9.15 Lead Compliance Plan

Not applicable.

9.16 Asbestos Abatement Plan

Not applicable.

9.17 Radiation Safety Program

Not applicable.

9.18 Abrasive Blasting Procedures

Not applicable.

9.19 Heat and Cold Stress Monitoring Plans

Heat and cold stress can be a hazard encountered during fieldwork. Heat stress is exacerbated when PPE is used. Physiological monitoring will be conducted as described whenever temperatures are greater than 75 degrees Fahrenheit (°F). Cold stress monitoring will be conducted when air temperature or wind chill drops below 40 °F. Average project site (Fairbanks, Alaska) air temperatures are included in **Table 9-4**. Wind-chill factors and ambient temperatures must be considered. Temperatures may be moderated by providing temporary shelters (enclosures) and portable heaters. A summary of heat and cold stress prevention guidelines is available in the form of Physical Agent Data Sheets (PADS) (**Attachment 10**).

The FTL/SSHO will review conditions with site personnel that would modify an individual's susceptibility to heat/cold-induced stress. They will ensure that such individuals have the opportunity to modify or refrain from activities that would put themselves at risk. Based on weather data for this project, there is a chance that heat/cold stress will be a potential concern during field activities. Cold stress will especially be a concern in fall and winter timeframes.

Table 9-4. Fairbanks, Alaska Temperature Summary

Month	Average	
	High	Low
July	73 °F	52 °F
August	66 °F	46 °F
September	55 °F	35 °F
October	32 °F	17 °F
November	11 °F	-6 °F

(National Oceanic and Atmospheric Administration [NOAA], 2020)

Prior to initiating site activities each day and periodically throughout the day, the FTL/SSHO will inspect the site personnel for evidence of heat/cold-related illnesses. Evidence of extreme dehydration, illness, or drug or alcohol use may require the FTL/SSHO to restrict the worker's activities until the worker is fit for duty. Personnel identified as being at high risk for cold and heat stresses who are allowed to participate in site operations will be monitored frequently by the FTL/SSHO. The Windchill Chart (**Table 9-5**) and Heat Index Chart (**Table 9-6**) will be consulted daily to evaluate work conditions.

Table 9-5: Windchill Chart

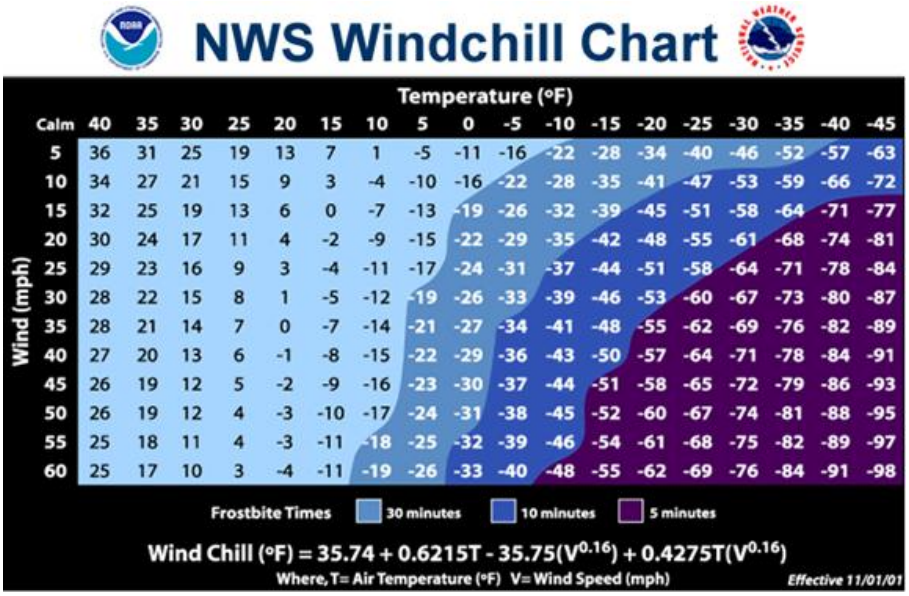
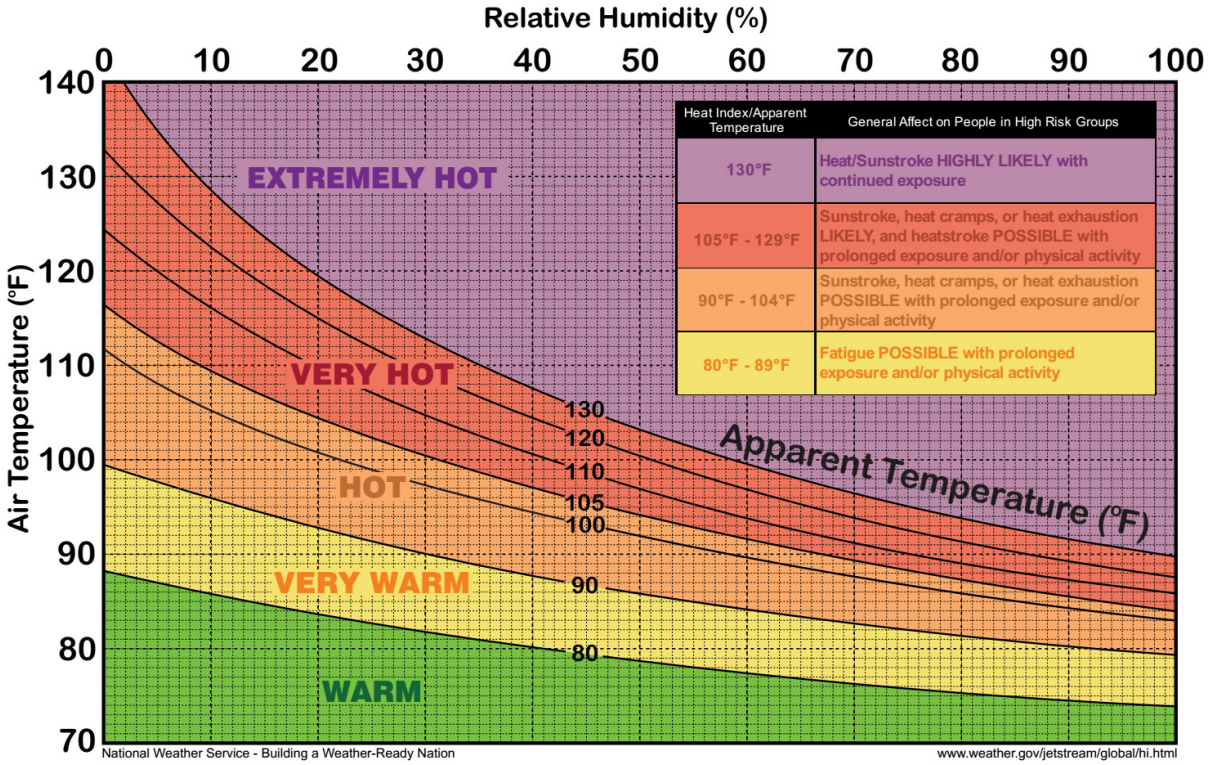


Table 9-6: Heat Index Chart



National Weather Service, 2020

GREEN ZONE: No work limits
YELLOW ZONE: Adjust work time for 45 minutes work/15 minutes break per hour
ORANGE ZONE: Adjust work time to 30 minutes work/30 minutes break time per hour
RED ZONE: ALL WORK STOPS

Since measurement of deep body temperature is impractical for monitoring the workers' heat load, the measurement of environmental factors is required which most nearly correlate with deep body temperature and other physiological responses to heat. The Wet Bulb Globe Temperature Index (WBGT) Index is the simplest and most suitable technique to measure the environmental factors (**Table 9-7**). WBGT values are calculated by the following equations:

Outdoors with solar load: WBGT = 0.7 NWB + 0.2 GT + 0.1 DB

Indoors or Outdoors with no solar load: WBGT = 0.7 NWB + 0.3 GT

Where: NWB = Natural Wet Bulb Temperature
DB = Dry Bulb Temperature
GT = Globe Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry bulb thermometer. When WBGT instruments are not available, approximations can be made using the below chart.

Table 9-7. Approximate Wet-Bulb Globe Temperature (WBGT) Chart

Degrees F

Relative Humidity (%)	68	70	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102	104	106	108
0	59	61	61	63	64	64	66	66	68	68	70	72	72	73	73	75	75	77	77	79	81	81	82
5	61	61	63	64	63	66	66	68	70	70	72	72	73	75	75	77	79	79	81	81	82	84	84
10	61	63	63	64	66	66	68	70	70	72	73	73	75	77	77	79	81	81	82	84	86	86	88
15	63	63	64	66	66	68	70	70	72	73	73	75	77	79	79	81	82	84	84	86	88	90	91
20	63	64	64	66	68	70	70	72	73	75	75	77	79	81	81	82	84	86	88	90	90	91	95
25	64	64	66	68	68	70	72	73	75	75	77	79	81	82	82	84	86	88	90	91	93	95	97
30	64	66	68	68	70	72	73	73	75	77	79	81	82	84	84	86	88	90	91	93	95	97	99
35	64	66	68	70	72	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102
40	66	68	70	70	72	73	75	77	79	81	82	84	86	88	90	91	93	95	97	99	100	102	
45	66	68	70	72	73	75	77	79	81	81	82	84	86	90	91	93	95	97	99	100			
50	68	70	72	73	73	75	77	79	81	82	84	86	88	91	93	95	97	99	102				
55	68	70	72	73	75	77	79	81	82	84	86	88	90	93	95	97	99	100					
60	70	72	73	75	77	79	81	82	84	86	88	90	91	95	97	99	100						
65	70	72	73	75	77	79	81	82	84	88	90	91	93	97	99	100							
70	72	73	75	77	79	81	82	84	86	88	91	93	95	97	100	102							
75	72	73	75	77	79	81	84	86	88	90	91	95	97	99	102								
80	73	75	77	79	81	82	84	86	90	91	93	97	99	100									
85	73	75	77	79	82	84	86	88	90	93	95	99	100	102									
90	75	77	79	81	82	84	88	90	91	95	97	99	102										
95	75	77	79	81	84	86	88	91	93	95	99	100											
100	75	79	81	82	84	88	90	91	95	100	100	102											

Chart assumes full sunshine and light wind. Using this chart on a cloudy or windy day will result in an overestimation of heat stress

Higher heat exposures that are shown below are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant at work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38.0 degrees Celsius (°C), or 100.4 °F. **Table 9-8** identifies the Permissible WBGT Heat Exposure TLV and recommended work/rest cycles.

Table 9-8. Permissible WBGT Heat Exposure Threshold Limit Values

Work/Rest Regimen	Workload		
	Light	Moderate	Heavy
75 Percent Work / 25 Percent Rest	87.8 °F (31°C)	82.4 °F (28 °C)	--
50 Percent Work / 50 Percent Rest	87.8 °F (31°C)	84.2 °F (29 °C)	81.5 °F (27.5 °C)
25 Percent Work / 75 Percent Rest	89.6 °F (32.5 °C)	86 °F (30 °C)	84.2 °F (29 °C)

Assumes eight-hour workdays in a five-day workweek with conventional breaks.
TLVs assume that workers exposed to these conditions are adequately hydrated, are not taking medication, are wearing lightweight clothing, and are in generally good health.
Examples of workloads:
Rest – sitting (quietly or with moderate arm movements)
Light work – sitting or standing to control machines; performing light hand or arm work (e.g. using a table saw); occasional walking; driving
Moderate work – walking about with moderate lifting and pushing or pulling; walking at moderate pace; scrubbing in a standing position
Heavy work – pick and shovel work, digging, carrying, pushing/pulling heavy loads, walking at a fast pace, carpenter sawing by hand
Adapted from 2016 TLVs and BEIs – Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati: ACGIH. 2016, p. 218.

9.19.1 Physiological Monitoring Protocols

Temperature extremes can affect on-site personnel and the use of PPE. **Table 9-9** identifies the heat and cold stress disorders, symptoms, and treatment.

Heat stress is one of the most common (and potentially serious) illnesses that affect site workers. When site personnel are engaged in operations involving hot environments, a number of physiological responses can occur which may seriously affect the health and safety of the workers. The amount and type of PPE worn directly influence reduced work tolerance as well as the increased risk of excessive heat stress. PPE adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. Therefore, when selecting PPE, the benefit of each item should be carefully evaluated in relation to its potential for increasing the risk of heat stress.

The effects experienced by site personnel when working in cold environments depend upon many environmental and personal factors, such as ambient air temperature, wind speed, duration of exposure, type of protective clothing and equipment worn, type of work conducted, level of physical effort, and health status of the worker. In cold environments, overexposure can cause significant stress on the body, which can lead to very serious and permanent injury. Cold may affect just the exposed body surfaces and extremities or may affect the deeper body tissues and the body core. Air temperature and wind speed shall be taken at least every four hours if the temperature drops below 20 degrees °F (-6 °C) and wind speed exceeds 5 miles per hour (mph) (8 kilometers per hour [km/h]) or broadcasted wind chill factors may be used if the reading is within 10 miles of the location.

Table 9-9. Heat and Cold Stress Disorders, Symptoms and Treatment

Disorder	Symptoms	Treatment
Heat Rash. Caused by continuous exposure to heat and humid air and is aggravated by wet, chafing clothing. This condition can decrease a worker's ability to tolerate hot environments.	Mild red rash, especially in areas of the body that sweat heavily.	Decrease amounts of time in protective gear and provide powder, such as cornstarch or baby powder, to help absorb moisture and decrease chafing. Maintain good personal hygiene standards and change into dry clothes if needed.
Heat Cramps. Caused by a profuse rate of perspiration that is not balanced by adequate fluid and electrolyte intake. The occurrence of heat-related cramps is often an indication that excessive water and electrolyte loss has occurred, which can further develop into heat exhaustion or heat stroke.	Acute, painful spasms of voluntary muscles such as the back, abdomen, and extremities.	Move victim to a cool area and loosen clothing. Lightly stretch and gently massage affected muscles to increase blood flow to the area. Have patient drink one to two cups of liquids immediately and every 20 minutes thereafter. Consult with physician if condition does not improve. If available, an electrolyte replacement solution should be taken along with liquids.
Heat Exhaustion. Heat exhaustion is a state of weakness or exhaustion caused by stress on various organs to meet increased demands to cool the body. This condition leads to inadequate blood supply and cardiac insufficiency. Heat exhaustion is less dangerous than heat stroke, but nonetheless must be treated. If allowed to go untreated, heat exhaustion can quickly develop into heatstroke.	Pale or flushed, clammy, moist skin, profuse sweating, and extreme weakness. Body temperature is basically normal or slightly elevated, pulse is weak and rapid, and breathing is shallow. The individual may have a headache, be dizzy, or nauseated.	Move the individual to an air-conditioned place, loosen clothing, elevate feet, and allow the individual to rest. Consult physician, especially in severe cases. Have patient drink one to two cups of liquids immediately and every 20 minutes thereafter. Total liquid consumption should be about one to two gallons per day. If the signs and symptoms of heat exhaustion do not subside, or become more severe, immediate medical attention will be required.
Heat Stroke. An acute and dangerous reaction to heat stress caused by failure of the heat-regulating mechanisms of the body. The failure of the individual's temperature control system causes the perspiration system to stop working correctly. When this occurs, the body's core temperature rises very rapidly to a point (>105 °F) where brain damage and death will	The victim's skin is hot and may or may not be red and dry, due to the fact that the individual may still be wet from having sweated. Other symptoms include nausea, dizzy spells, confusion, extremely high body temperature, rapid breathing and pulse rate, convulsions, or coma.	Cool the victim immediately. If the body temperature is not brought down quickly, permanent brain damage or death may result. The victim should be moved to a shady area; he/she should lie down and the head be elevated. Cool the victim by either sponging or immersing the victim in very cool water to reduce the core temperature to a safe level (<102 °F). If conscious, give the victim cool liquids to drink. Observe the

Disorder	Symptoms	Treatment
result if the person is not cooled quickly.		victim and obtain immediate medical help. Do not give the victim caffeinated or alcoholic beverages. Medical help should be summoned.
Hypothermia. Hypothermia occurs when the body cannot maintain a normal core temperature of 98.6 °F to 99.6 °F. Hypothermia can take a victim by surprise since it can occur above freezing. Wind, physical exhaustion, and wet clothing all make a person more prone to hypothermia. Air temperature alone is not enough to judge the cold hazard of an environment. Most cases of hypothermia develop in an air temperature of 36 °F to 50 °F.	Numbness, stiffness, or pain (especially in the neck, arms, and legs); poor coordination, slurred speech and drowsiness; slow, irregular breathing and heartbeat/pulse; puffiness in the face; low blood pressure; listlessness, confusion and disorientation (it is not unusual to see someone who makes little or no effort to get out of the cold or to keep warm); collapse or exhaustion after rest; severe shivering; and death is a possibility.	Unconscious persons with severe hypothermia should be treated aggressively by experienced medical personnel and transported to a hospital. If no pulse is detected, CPR should be administered immediately until help arrives. Get the person out of frozen, wet, or tight clothes. Mild hypothermia in young and otherwise healthy persons can be treated by re-warming the person in a warm bed or bath with warm packs, warm dry clothes, or blankets. Have the victim drink something warm (if conscious), but do not give caffeine or alcohol. (NEVER give anything by mouth to someone who is unconscious.)
Frostnip. Frostnip occurs when the face or extremities are exposed to cold wind, which caused the skin to turn white.	Firm, cold, white areas on the face, ears, or extremities; peeling or blistering that may appear similar to sunburn; and a mild hypersensitivity to cold persists.	The frost-nipped area should be treated by rewarming the area with an unaffected hand or a warm object. Do not use hot water.
Frostbite. Frostbite occurs when there is freezing of the skin. It can occur without hypothermia when the extremities do not receive sufficient heat from central body stores because of inadequate clothing or circulation. The most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes. Damage from frostbite can be serious; scarring, tissue death, and amputation are all possible, as is permanent loss of	The area is cold, hard, white, and anesthetic; on warming, it becomes blotchy red, swollen, and painful; depending on the extent of the injury, the area may recover normally or deteriorate to gangrene.	Remove restrictive clothing or jewelry near the affected area or body part. Warm the frozen part and exercise it, but do not walk on frostbitten feet. Warm the frozen part quickly with sheets and blankets. Remove wet clothing from the affected area and gently dry the affected part. Place the affected part next to a warm part of the body. Seek medical attention immediately. Do not rub the affected areas. Do not apply a heat lamp or very hot water bottle. Do not go near a hot stove. Do not break any blisters. Do not drink

Disorder	Symptoms	Treatment
movement in the affected parts. As wind velocity increases, heat loss is greater and frostbite will occur more rapidly. If skin should come in contact with objects colder than freezing, frostbite may develop at the point of contact, even in a warm environment.		caffeine or alcohol to treat for hypothermia or frostbite. Do not re-warm the frozen tissue if refreezing is a possibility. Do not use hot water (use warm water only).
Chilblains. Chilblains are caused by prolonged, continuous exposure to cold without freezing, combined with persistent dampness or actual immersion in water. When this affects the feet it is called “trench foot”.	Swelling, tingling, itching, and severe pains; possibly blistering, tissue death and ulceration; pale, clammy cold skin that is swollen and numb; infection is likely; sensitivity to temperature may persist for years.	Treatment for chilblains is the same as for frostbite.

9.19.2 Prevention Protocols

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat exhaustion, that person may become predisposed to additional heat injuries. In order to avoid heat-related illnesses, proper preventive measures will be implemented whenever environmental conditions dictate. These preventive measures represent the minimal steps to be taken and will include the following procedures.

9.19.2.1 Heat Stress Preventative Measures

The FTL/SSHO will examine each site worker prior to the start of daily operations and throughout the day as possible to determine the individual’s susceptibility to heat-induced stress. Workers exhibiting factors that make them susceptible to heat stress will be closely monitored by the SSHO.

Site workers will be trained to recognize and treat heat-related illnesses. This training will include the signs, symptoms, and treatment of heat-stress disorders. In order to maintain their body fluids at normal levels, workers will be encouraged to drink at a minimum approximately 16 ounces of liquids prior to the start of work in the morning, after lunch, and prior to leaving the site at the conclusion of the day’s activities. Staff will have the option of providing their own bottles and in addition, pre-bottled liquids will be available. Staff will be encouraged to drink water and an electrolyte replacement solution in equal amounts. Liquids containing caffeine are to be avoided.

When ambient conditions and site workload requirements dictate, as determined by the FTL/SSHO, workers will be required to drink a minimum of 16 to 32 ounces of liquids during each rest period. The normal thirst mechanism is not sensitive enough to ensure that enough water will

be consumed to replace lost sweat. When heavy sweating occurs, workers will be encouraged to drink even though they may not be thirsty.

A shelter or shaded area will be provided where workers may be protected from direct sunlight during rest periods. Monitoring of ambient or physiological heat stress indices, such as heart rate and recovery heart rate, will be conducted to allow prevention and/or early detection of heat-induced stress. Site workers will be given time to acclimate to site work conditions, temperature, protective equipment, and workload. Acclimation is the adaptive process that results in a decrease of the physiological response produced by the application of constant environmental stress.

Upon initial exposure to a hot environment, there is an impaired ability to work, and evidence of physiological strain. If the exposure is repeated on several successive days, there is a gradual return of the ability to work and a decrease in physiological strain. Acclimation usually takes two to six days of continued work in hot environments and allows the worker's body to become adjusted to this level and type of work. This process involves a gradual increase in the workload over the required period, the length of which depends upon the nature of the work performed, the ambient temperatures, and the individual's susceptibility to heat stress. The results of acclimation include subjective discomfort practically disappearing; body temperature and heart rate lowering; there is a more stable blood pressure; and the sweat is more profuse and dilute.

Work schedules will be adjusted as follows:

- mandate work slowdowns as needed;
- rotate personnel: alternate job functions to minimize overstress or overexertion at one task;
- add additional personnel to work teams; and
- perform work during cooler hours of the day if possible.

Workers will be encouraged to achieve and maintain an optimum level of physical fitness. Increased physical fitness will allow workers to better tolerate and respond to hot environments and heavy workloads. In comparison to an unfit person, a fit person will have less physiological strain, a lower heart rate and body temperature, and a more efficient sweating mechanism.

Alcohol should not be consumed in a hot environment because the loss of body fluids increases the risk of heat stress.

9.19.2.2 Cold Stress Preventative Measures

A wind chill chart, *Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature*, will be available on-site and should be used to monitor the conditions on exposed flesh. Cold injuries are classified as either localized (such as frostnip, frostbite), or generalized as in hypothermia (a lowering of the body's core temperature).

Workers exposed to the cold should be physically fit, without any circulatory, metabolic, or neurological diseases that may place them at increased risk for hypothermia. A new employee should not be required to work in the cold full time during the first days of employment until they become adjusted to the working conditions and required protective clothing. New workers should be introduced to the work schedule slowly and be trained accordingly. **Table 9-10** describes the recommended working and warm-up times for cold weather activities.

Working in the cold can cause a significant water loss through the skin and lungs as a result of the dryness of the air. Increased fluid intake is essential to prevent dehydration, which can increase the risk of damage to the extremities since blood flow is decreased. Warm, sweet drinks (not caffeinated), or soups should be consumed.

As with heat stress, consuming extra salt is not necessary. It is very important for persons working in cold environments to follow a well-balanced diet. Workers should avoid smoking, drugs, or alcohol use since these can restrict circulation and/or cause heat loss.

Safe work practices include the following.

- Change out of wet clothing as soon as possible.
- Do not use unprotected metal chair seats or touch any cold objects with bare hands.
- People who are taking certain medications, older, overweight, have allergies, smoke, or have poor circulation (diabetics, for example) are more prone to cold injuries and should take extra precautions.
- DO NOT drink alcohol.
- Avoid soaking of clothing or gloves with any liquids (especially gasoline, alcohol, or cleaning fluids) due to the added danger of evaporative cooling.
- Always work under the buddy system if you must travel or work outdoors in dangerous conditions.
- As much as possible, avoid using vibrating tools in very cold temperatures.
- Wear ultraviolet (UV) protective eyewear if you must work outdoors in snow or ice-covered terrain.
- If you have a pre-existing injury or if you are injured on the job during cold stress periods, see your supervisor immediately. Injured tissues can be more susceptible to the cold.

Recommended clothing guidelines include the following.

- Clothing should resist rain and wind but also allow water vapor generated by perspiration to escape.
- Do not wear constrictive garments. Instead, wear several layers of loose-fitting clothes that can be added or removed as needed to aid in the evaporation of sweat.
- Suspenders may be used instead of belts, which can constrict and reduce circulation. Thin cotton fabric is very good since it helps evaporate sweat. Wear a cotton T-shirt and shorts under cotton or wool thermal underwear and wool or thermal trousers.
- Wear socks with high wool content and insulated boots. When two pairs of socks are worn, the inside pair should be smaller and made of cotton.
- Wear a hat. You can lose up to 40% of your body heat through your head if it is not covered.
- Gloves should be worn when the temperature is below 40 °F.
- Wear a facemask and/or scarf if it is windy or extremely cold and cover your mouth to protect your lungs.

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Table 9-10. Work Warm-Up Schedule for Outdoor Activities

Wind Speed	**No Noticeable Wind**		**5 MPH**		**10 MPH**		**15 MPH**		**20 MPH**	
Ambient Air Temp **(°F below 0)**	Max Work Period	Number of Warm-up Breaks	Max Work Period	Number of Warm-up Breaks	Max Work Period	Number of Warm-up Breaks	Max Work Period	Number of Warm-up Breaks	Max Work Period	Number of Warm-up Breaks
0-15	Normal	1	Normal	1	75 min	2	55 min	3	40 min	4
15-19	Normal	1	Normal	1	75 min	2	55 min	3	40 min	4
20-24	Normal	1	75 min	2	55 min	3	40 min	4	30 min	5
25-29	75 min	2	55 min	2	40 min	4	30 min	5		
30-34	55 min	3	40 min	4	30 min	5				
35-39	55 min	3	40 min	4	30 min	5				
40-44	30 min	5								
≥ 45										

This information applies to any four-hour period.
Warm-up breaks are at least 10 minutes in a warm environment.
These guidelines apply to workers wearing appropriate clothing.
Max Work Period = Max Work Period with normal breaks.
min = minute

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9.19.3 Heat and Cold Stress Documentation

The FTL/SSHO will be responsible for recording all heat/cold stress related information. This will include training sessions and monitoring data. Training sessions will be documented in the field logbook and WBGT data and other information will be recorded in the safety log.

9.20 Indoor Air Quality Management

Any designated smoking area will be at least 25 feet from any building entrance and local ordinances will be reviewed to determine if more stringent requirements apply. Use of tobacco (cigarettes and cigars or pipes) and smokeless (vapor) devices are prohibited in the Contractor's and DoD vehicles and work buildings.

9.21 Mold Remediation Plan

Not applicable.

9.22 Chromium (VI) Exposure Evaluation

Not applicable.

9.23 Crystalline Silica Evaluation

Not applicable.

9.24 Lighting Plan for Night Operations

Not applicable.

9.25 Traffic Control Plan

Not applicable.

9.26 Fire Prevention Plan

Fire prevention and protection measures require pre-planning. The FTL/SSHO will inspect fire extinguishers monthly and servicing will be performed by a qualified service provider on an annual basis.

Employees will use safe work practices, including proper storage of flammable and combustible liquids, and follow the rules described below:

- Smoking is permitted only in designated areas.
- Refueling will be performed only in a designated area that is free of dry surface vegetation. The area must have spill control materials available nearby.
- Equipment must be refueled with the equipment turned off (except under special circumstances as required by an operator's manual). Allow the equipment to cool down prior to refueling.
- No refueling will be performed unattended.

- Latching on fueling hoses is prohibited. Smoking is prohibited in any area where refueling is performed.
- Compressed gas cylinders, if present, will be secured only in an upright position. Flammable gas cylinders will be stored separately from oxygen gas cylinders. Flammable cylinder storage areas will be posted as “FLAMMABLE, NO SMOKING.”
- All sources of ignition shall be prohibited within 50 feet of operations where a potential fire hazard is present. The area shall be conspicuously and legibly posted “NO SMOKING, MATCHES, or OPEN FLAME.”
- Flammable liquids will be stored in an approved storage cabinet in Underwriter’s Laboratory (UL)-listed metal containers or National Fire Protection Association-rated fuel tank, hoses, and nozzles.
- Fuel tanks will have a means of preventing overfilling (visual or other indicators of fuel level).
- Non-sparking and explosion-proof equipment and tools will be used whenever the potential for ignition of flammable or explosive gases, vapors, or liquids exists.
- Good housekeeping will be maintained such that debris and materials do not accumulate in work areas and pose a fire hazard.
- Self-closing UL-labeled or metal containers will be used to collect waste that is saturated with flammable or combustible liquids (e.g., oily rags).
- Employees should be aware of wildfire danger as posted on base and consider avoiding driving through tall grass at times such activities could start a fire. If tall grass must be driven across at times of high fire danger, consider having grass mown prior to operating vehicles across it.

9.27 Wild Land Fire Management Plan

Not applicable.

9.28 Arc Flash Hazard Analysis

Not applicable.

9.29 Assured Equipment Grounding Control Program

Not applicable.

9.30 Hazardous Energy Control Program and Procedures

Not applicable.

9.31 Standard Pre-Lift Plan – Load-Handling Equipment

Not applicable.

9.32 Critical Lift Plan – Load-Handling Equipment

Not applicable.

9.33 Naval Architectural Analysis – Load-Handling Equipment (Floating)

Not applicable.

9.34 Floating Plant Inspection and Certification

Not applicable.

9.35 Severe Weather Plan for Marine Activities

Small, motorized boats or canoes may be used in small lakes for collecting fish or sediment samples. These activities will be delayed in the event of severe weather, or if severe weather is forecasted.

9.36 Emergency Plan for Marine Activities

See Section 9.37 for man overboard procedures while operating small boats in lakes.

9.37 Man Overboard/Abandon Ship Procedures

Small, motorized boats or canoes may be used in small lakes for collecting fish or sediment samples. In order to avoid falling out of the boat, personnel will:

- Avoid leaning over the edge of the boat when collecting samples or retrieving equipment.
- Be aware of sudden stops and starts.
- Wear PFD at all times.
- Always employ buddy system while working on board boat.
- Maintain a ring buoy on shore.
- Personnel who fall in water should not attempt to climb into boat. They should hang on to the side of the boat and have the boat transport them to the nearest safe shore location so they can climb out of the water.

9.38 Float Plan for Launches, Motorboats, and Canoes

Small, motorized boats or canoes may be used in small lakes for collecting fish or sediment samples. General boat operating procedures are as follows:

- Wear PFD at all times.
- Wear anti-slip footwear with ankle support. Plan route onto and off of boat, do not hurry through task. Secure boat to pier during egress (if available).
- Maintain good housekeeping on boat. Secure objects to prevent shifting. Secure boat to pier during equipment loading.
- Use proper techniques by keeping back straight, use buddy system for large or bulky items, avoid awkward twisting or stooping.

- Keep loads evenly distributed in the boat at all times. Operate power boats at safe speed using employees trained in powerboats operation and safety.
- See Section 9.37 for Man Overboard procedures.
- Remain seated while the boat is in motion, if movement is required use handrails, hand holds and other supporting devices to maintain stability. Wear shoes with anti-slip soles. Always maintain good housekeeping.
- Plan route to ramp or shore and use lookouts to spot objects in water that may damage boat.
- Do not hurry through task and plan route. Step, not jump, off boats. Wear shoes with anti-slip soles. Secure boat to pier before offloading personnel or equipment.

9.39 Fall Protection and Prevention Plan

Not anticipated.

9.40 Demolition/ Renovation Plan (To Include Engineering Survey)

Not applicable.

9.41 Rope Access Work Plan

Not applicable.

9.42 Excavation/ Trenching Plan

Not applicable.

9.43 Fire Prevention and Protection Plan for Underground Construction

Not applicable.

9.44 Compressed Air Work Plan for Underground Construction

Not applicable.

9.45 Erection and Removal Plan for Formwork and Shoring

Not applicable.

9.46 Precast Concrete Plan

Not applicable.

9.47 Lift-Slab Plans

Not applicable.

9.48 Masonry Bracing Plan

Not applicable.

9.49 Steel Erection Plan

Not applicable.

9.50 Explosives Safety Site Plan

Not applicable.

9.51 Blasting Plan

Not applicable.

9.52 Dive Operations Plan

Not applicable.

9.53 Safe Practices Manual for Diving Activities

Not applicable.

9.54 Emergency Management Plan for Diving

Not applicable.

9.55 Tree Felling and Maintenance Program

Not applicable.

9.56 Aircraft/Airfield Construction Safety and Phasing Plan

Not applicable.

9.57 Aircraft/Airfield Safety Plan Compliance Document

Not applicable.

9.58 Site Safety and Health Plan for Hazardous, Toxic, and Radioactive Waste

An SSHP is included as **Attachment 1**.

9.59 Confined Space Entry Procedures

Not applicable. No confined space entry is authorized by this plan.

9.60 Confined Space Program

Not applicable.

9.61 Other Hazards and Classic Safety Requirements and Precautions

Physical hazards not otherwise specifically addressed in the above sections are covered in the following sections. In addition, PADS are presented in **Attachment 10**. The PADS provide specific guidance to protect workers from hazards associated with cold/hot work environments, noise, hand/arm vibration, and ultraviolet radiation.

9.61.1 Motor Vehicles and Heavy Equipment

The project will require the use of pick-up trucks, drill rigs, and support rigs, or other small vehicles to transport or deliver equipment and supplies to and from the job site. These vehicles pose unique and immediate hazards that, if uncontrolled, can result in severe injury or fatality. Injuries can result from improper operation of vehicles, or personnel placing themselves in driver "blind spots".

The FTL/SSHO will provide initial and regular reminders to personnel that it is their responsibility to remain out of the operating areas of any moving vehicles to avoid being injured. In addition, the following precautions will be taken to help prevent injuries and accidents:

- Brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horns, and other safety devices will be checked at the beginning of each workday.
- Motor vehicle cabs will be kept free of all non-essential items and all loose items, including equipment and/or samples, will be secured.
- The parking brake, for vehicles so equipped, will be set before shutting off and dismounting a vehicle.
- Wearing of seat belts is mandatory at all times when the vehicle is in operation.
- During periods of rain, fog, or other adverse weather conditions, the use of headlights is mandatory.
- All posted traffic signs and directions from flagmen (if used) or spotters will be observed.
- Personnel will wear Class 2 high-visibility vests to increase visual recognition whenever working within 15 feet of an established traffic pattern/route or working near heavy equipment.

Safe and proper practices will be followed at all times, or vehicle operating privileges will be suspended or revoked at the discretion of the FTL/SSHO. The FTL/SSHO will be responsible for ensuring that these requirements are implemented on-site.

Contractor personnel will follow locally established traffic rules. Coordination with other contractor or client operations personnel will be conducted as required to ensure traffic safety and the delineation of controlled work zones. Personnel operating site vehicles will yield to pedestrians when present. Personnel working in areas subject to vehicular traffic or operating construction equipment will wear Class 2 high-visibility safety vests. Personnel will not direct traffic unless they have received training in compliance with OSHA regulations.

In addition to the above, a hazard anticipated for the 2021 field event will be operating vehicles within the flight line secure airfield access area. Personnel operating vehicles in this area must carefully follow instructions and rules provided by the EAFB Flight Operations Office. The primary concerns will be procedures for entering and exiting the secure area and procedures for avoidance of aircraft and avoidance of restricted areas.

9.61.2 ATV/UTV Operation and Use

The project will include the use of all-terrain vehicles (ATVs) and/or utility task vehicles (UTVs; also known as side-by-sides) to transport personnel and deliver equipment.

Inspection and maintenance considerations:

- Allow vehicle to cool down before performing maintenance or refueling. Wear protective gloves when servicing vehicle, ensure glove is of type that allows dexterity when handling small parts. Use padding to protect knees during maintenance that requires kneeling, protect hands placed on hard surfaces for prolonged periods.
- Do not hurry during refueling to reduce potential for mistakes or spills. Assume fuel lines contain fuel if disconnecting, protect eyes from potential splash hazard during a repair to the fuel system. Promptly wash exposed skin or flush eyes if fuel enters eyes.

Vehicle loading and unloading considerations:

- Use appropriate number of workers to manually place or remove vehicle from truck or trailer. Use spotter and drive slowly if driving vehicle on or off a trailer, unnecessary workers stand clear in case vehicle falls of ramp. Watch feet when working to place or remove a vehicle form truck/trailer to prevent being rolled over.
- To prevent hand injuries, wear protective gloves. Keep hands clear from binding devices and straps used to secure vehicle. Inspect for pinch hazards. Clear hands/fingers from pinch areas during tailgate or gate closing activity.
- Avoid excessive exertion or twisting of body when manually placing vehicle on truck/trailer. Use buddy system. Stretch before performing activity.
- Inspect securing devices prior to driving vehicles carrying an ATV or utility vehicle. Ensure no slack is present in the securing devices and devices are in good condition.

ATV/UTV operation:

- Always operate vehicle at a safe operating speed, factors to determine safe speed should include terrain, condition of the terrain, driver experience, weather, and vehicle type (rollover potential). Avoid sharp turns, drive at speed that allows for route planning.
- Avoid crossing creeks and water bodies where depth of water is not known. Investigate any area in water to be crossed prior to driving across.
- Vehicle to only be operated in manner specified by manufacturer, avoid conditions that promote wheelies, sliding, or harsh braking, stay clear of other workers in area.
- Avoid awkward body positions or excessive exertion in attempting to extract a stuck vehicle, call for help. Only use approved tow straps rated for load in towing vehicles out of stuck conditions, NOT tie down straps. Stand clear of any strap or cable used to extract a stuck vehicle to prevent injury form backlash if breakage occurs.

9.61.3 Drilling Hazards

Drilling of soil borings and installation of monitoring wells is planned to be one of the primary activities to be conducted in 2021 as part of this RI. The project will require the use of drill rigs to advance the soil borings and install monitoring wells. Drill rigs pose unique and immediate hazards that, if uncontrolled, can result in severe injury or fatality. Injuries can result from improper coordination with drilling contractors and personnel working in close proximity to the drill rig.

The FTL/SSHO will provide initial and regular reminders to personnel that it is their responsibility to remain out of the operating areas and a safe distance from the drill rigs. In addition, the following precautions will be taken to help prevent injuries and accidents:

- A drilling company employee (i.e., the driller or driller's helper) must give a brief safety orientation to all personnel on the drill site, which must include expectations for communication, expectations for safe distance from the drill rig, locations of all emergency cut-off switches on the drill rig, instructions on how to operate the emergency cut-off switches, and locations of fire extinguishers and other relevant safety equipment.
- Only drilling company employees (i.e., the driller and driller's helper) should be near the drill rig when the rig is in operation, or when overhead loads are being lifted, suspended, or moved. Only drilling company employees may operate the drill rig.
- If personnel other than the drilling company employees want to approach the drill rig, they must first get the attention of the driller and the driller must give a visual signal that he is aware of their position and it is safe to approach the rig.
- Level D PPE will be worn by all personnel working at the drilling site. This includes safety-toe shoes, safety glasses, appropriate hand protection, high visibility outerwear, hearing protection (when loud noises are present), and, when near overhead hazards, a hard hat.
- Emergency cut-off switches, brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horns, and other safety devices will be checked at the beginning of each workday.
- Safe lifting practices will be employed when lifting any heavy objects and team lifting will be employed when necessary.
- Motor vehicle cabs (if applicable) will be kept free of all non-essential items and all loose items, including equipment and/or samples, will be secured.
- The parking brake, for vehicles so equipped, will be set before shutting off and dismounting a vehicle.
- Wearing of seat belts (if the drilling vehicle is equipped) is always mandatory when the vehicle is in operation.
- During periods of rain, fog, or other adverse weather conditions, the use of headlights is mandatory.
- All posted traffic signs and directions from flagmen (if used) or spotters will be observed.
- Personnel will wear Class 2 high-visibility vests to increase visual recognition whenever working within 15 feet of an established traffic pattern/route or working near heavy equipment.

Safe and proper practices will be followed at all times by BEM and subcontractor personnel. The FTL/SSHO will be responsible for ensuring that these requirements are implemented on-site.

Personnel working in areas subject to vehicular traffic or operating construction equipment will wear Class 2 high-visibility safety vests. Personnel will not direct traffic unless they have received training in compliance with OSHA regulations.

9.61.4 Electrical Hazards

To prevent accidents caused by electric shock, the FTL/SSHO will inspect any electrical connections on a daily basis. The FTL/SSHO will remove any equipment that is found to have frayed or loose connections until a qualified electrician is contacted and repairs are made. Equipment will be properly grounded prior to and during work. In addition, ground fault circuit interrupters (GFCIs) will be installed for each circuit between the power source and tool for outdoor use. If generators are used to supply 110-volt power, these generators will contain GFCIs. Larger generators or equipment not connected to permanent building electrical systems will have GFCIs, or assured grounding to protect workers.

The requirements for electrical safety are described below:

- Flexible cords (extension cords) will contain the number of conductors required for service, plus a ground wire. Cords will be rated for hard usage (S, SE, SEO, SO, SOO, ST, STO, STOO). Flexible cords are not allowed to be passed through doors or windows, or to be placed on the ground where they would be subjected to being run over by vehicles.
- Flexible cords must be inspected on each day of use. No splicing or fraying is allowed.
- Flexible cords will not be secured with staples, hung from nails, or suspended by bare wire (plastic tie straps, commonly used today, are acceptable).
- Extension cords will not be plugged into other extension cords. Extension cords will not be plugged into power strips.

9.61.5 Portable Generators

Portable generators, if used, must meet the requirements for grounding as specified in National Fire Protection Association 70 of the National Electrical Code (NEC). NEC 250-6 includes certain exemptions for the grounding of portable and vehicle-mounted generators. Portable generators will be operated in open air only, where there is sufficient ventilation to prevent the accumulation of exhaust gases, including carbon monoxide.

9.61.6 Overhead Electrical Hazards

Overhead power lines (if present) may present a hazard to equipment and personnel if inadvertent contact is made. To prevent equipment contact with power lines and to prevent arcing, adequate clearance must be maintained. The contractor requires a minimum clearance of 15 feet. If adequate clearance cannot be maintained, electrical disconnects may be required to secure against a contact hazard. The voltage of overhead lines must be ascertained to determine if more than 15 feet clearance is required. The FTL/SSHO will evaluate the worksite to determine if there are any overhead power lines present in any location where activities are being conducted, including in laydown areas and travel routes, and, if present, will take actions to ensure clearance is maintained.

9.61.7 Slips, Trips, and Falls

Planned activities associated with construction operations will bring field personnel into areas with potential slip, trip, and fall hazards. These hazards may include the following:

- uneven terrain due to debris or depressions;
- workplace clutter;
- wet/icy and slippery surfaces; and
- open borings

Hazards of this nature and the potential consequences of injury from a slip, trip, or fall are more likely when personnel are maneuvering and carrying equipment on these work sites or are busy with tasks and not paying attention to surroundings.

Control measures may include the following:

- selecting the best approach routes to work areas and locations, keeping in mind that these may not be the shortest routes;
- applying traction grit such as sand over slippery surfaces;
- maintaining good housekeeping practices;
- using barricades or other appropriate warnings to demarcate hazard areas;
- selecting and using proper portable ladders (as required); and
- selecting and using proper fall protection equipment (as required).

The SSHO / FLT will evaluate all walking/working surfaces to ensure these comply with the objectives stipulated in 29 CFR 1926 Subparts C – General Safety and Health, G – Signs, Signals and Barricades, Subpart M – Fall Protection, Subpart P – Excavations, and Subpart X – Stairways and Ladders, and OSHA equivalent regulations and standards. Requisite strength, heights and widths, and fall protection will be evaluated as required for the work tasks.

9.61.8 Head Injuries

At a minimum, workers will don hard hats if a potential overhead hazard is present.

9.61.9 Falling Objects

See section 9.61.2, above. Drill rigs may be used to lift heavy objects and personnel must remain clear of the lifting area. Also, the supervisor will verify that a sufficiently wide area is clear of personnel while the equipment is in operation.

9.61.10 Heavy or Awkward Lifting

Hazards associated with heavy or awkward lifting are more frequent in the early morning hours (prior to muscles becoming limber) and later in the day (as a result of fatigue). The following provisions will be used to minimize hazards of this nature:

- Use machinery, lifting-assist devices (two-wheeled carts or dollies), or multiple personnel for heavy lifts, where possible (The contractor prohibits lifting more than 50 pounds without assistance).

- Use proper lifting techniques.
- Plan lifts: place heavy items on shelves between the waist and chest and lighter items on higher shelves. If the load must be carried to another location, plan and inspect the route to ensure that slipping/tripping hazards are absent.
- Stretch and limber muscles prior to and after extended periods/frequent lifts.
- "Test" the lift; before attempting to fully lift or move an object, give the object a "nudge" to assess its approximate weight and your ability to safely lift and move it without injury. If you are not confident that you can complete the lift without hurting yourself, either use a lifting aid (such as a dolly or mechanical hoist) and/or request assistance from others.
- Move as close to the load as possible and ensure that good hand holds are obtainable. Wear gloves where necessary to improve hand holds.
- Lift with the legs, not the back; bend the knees slightly and avoid turning and twisting at the waist when lifting, carrying, or depositing loads.
- Break lifts into steps if the vertical distance from the starting point to the placement of the lift is excessive.
- Periods of high-frequency lifts or extended-duration lifts should include sufficient breaks to guard against fatigue and injury.

Another important activity is to assess the area available to maneuver the lift. Rearrange the area, remove clutter, and minimize the necessity of twisting and turning. The activities described below should be employed when evaluating the area in which the lifting will occur, and the effort required to complete the lifting task:

- Evaluate the area of the lift.
    - Investigate conditions of the walking/working surfaces where the lift will occur, over the planned path of travel, and at the location, the load will be deposited.
    - Conditions such as poor housekeeping/clutter, slippery surfaces, and rough or uneven terrain may magnify the potential for injury during a lift.
- Take into account your overall physical condition
    - DO NOT attempt to lift items that will put you at risk.
    - Break loads into smaller, manageable loads and get assistance whenever significant lifting tasks are involved.

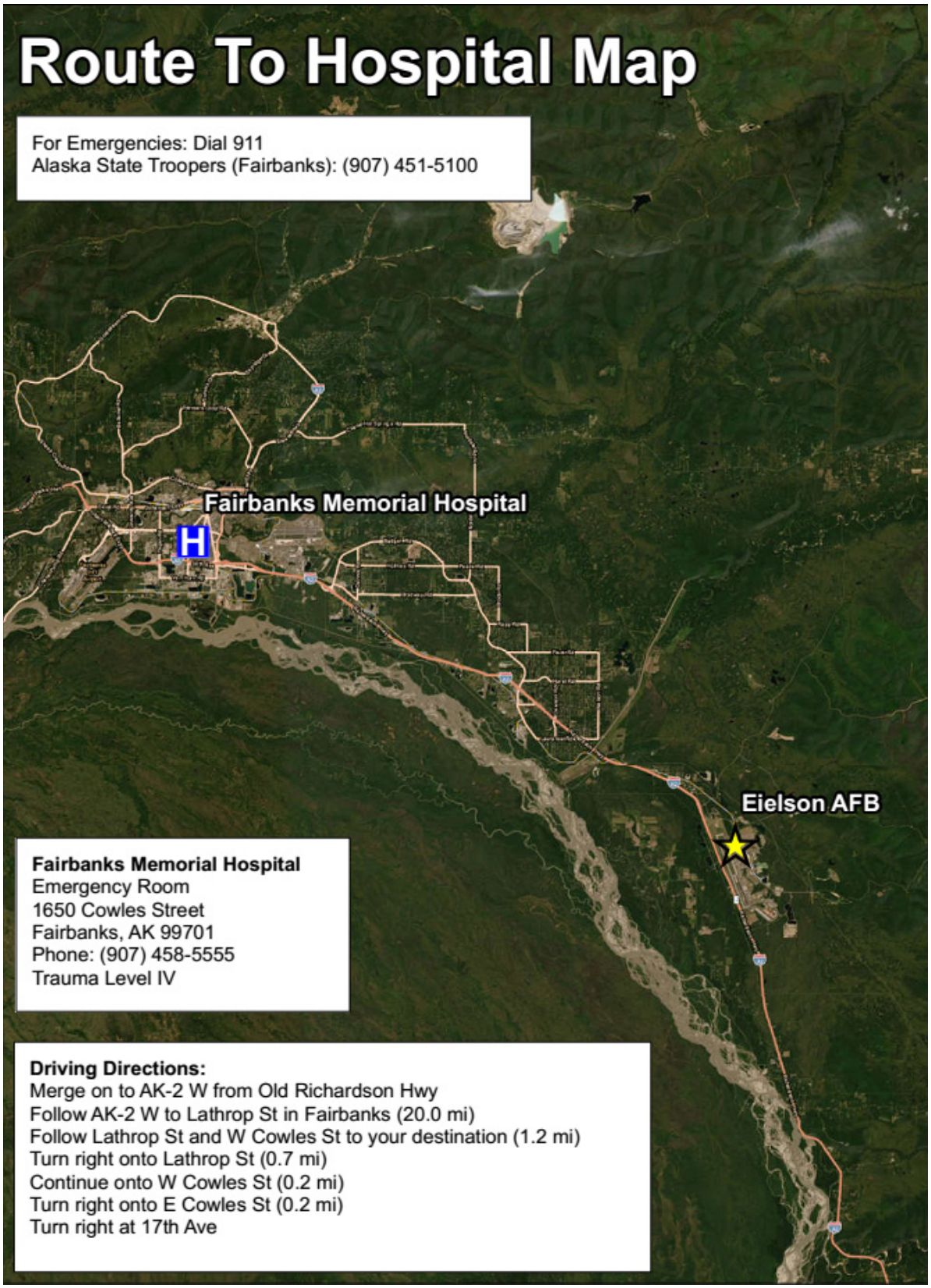
By evaluating applicable contributing factors, planning lifts, and incorporating feasible control measures, the potential for injury associated with lifting can be minimized.

9.61.11 Portable Power Hand Tools

Any portable power tools used in the work area must have appropriate guarding, interlocks, or controls to ensure safe operation. Machinery and equipment must be inspected for defects in the guarding, electrical safety, and operation before each use. The following specific precautions regarding power hand tools will be used to help prevent injuries and accidents.

- Never remove, make inoperative, or reduce the effectiveness of any equipment or machine guard.
- Never override any safety interlock or attempt to operate any piece of equipment or machinery without guards or other required safety devices in place and fully functional.
- Never operate any piece of equipment or machinery when it is functioning improperly or at any time when operation would constitute a hazard. Malfunctioning equipment must be repaired immediately or removed from the premises.
- Do not use electrically powered tools near flammable materials or within an explosive atmosphere, unless they are of the explosion-proof type meeting the NEC requirements for explosive areas. Employees operating the equipment should be aware of sparks and/or metal fragments when using this equipment.
- Never operate electrical power equipment without proper grounding. All electrical cords and cables, including extension cords, must include a third-wire ground.
- All electrical power tools will be listed by an NRTL and marked to indicate that they have double insulation if they are not internally grounded.
- Do not use electrical tools in wet or damp areas.
- Use tools only for their intended purpose (e.g., do not use a wrench to hammer an object). Defective tools (e.g., with mushroomed heads or split or defective handles) are to be taken out of service until they can be repaired or replaced.
- Do not use conductive (i.e., metal) tools around energized electrical sources; test the insulation provided.
- Select the correct size and type of wrench for each job. Do not extend wrench handles with a pipe or “cheater” bar.
- Repair mushroomed punch, drift, and chisel heads, or take the tool out of service and replace it. Metal particles may break off and fly into the face or eyes of nearby workers when mushroomed heads are struck.
- Wear eye protection at all times when using hand tools (powered or manual).
- All hand tools and power tools will be inspected prior to use. The contractor employs inspection checklists and colored stickers and/or tape, as previously described, to indicate that equipment has been inspected and is ready for use.

Figure 2: Project Location and Medical Facility Map



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10.0 RISK MANAGEMENT PROCESSES

Risk management is a process that includes the identification, assessment, and prioritization of risks, followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events to an acceptable level. The contractor utilizes the AHA as the risk management tool for this process. AHAs for each DFOW, task, or activity known at this point in time are listed in Section 2.10 and provided in Attachment 3. Additional AHAs may or may not be required during the fieldwork.

The AHA defines the work sequence, anticipated hazards, conditions, equipment, materials, personnel, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk. Before beginning each work activity/DFOW, the contractor will prepare the initial AHA, which includes a RAC for that activity. Work will not begin on the activity until the initial AHA that addresses the activity-specific hazards has been accepted by the PM and USAF PM or COR.

AHAs are living documents and are intended to be created in the field and updated (by the workers, with FTL/SSHO assistance) as needed. The AHAs will be reviewed and modified as necessary to address changing site conditions, operations, or change of CPs or QPs. If the initial RAC increases due to a change made to the AHA by the workers, the AHA shall be resubmitted to the PM and USAF PM or COR for acceptance prior to work proceeding. Changes to or updates of an AHA that do not increase the RAC are not required to be resubmitted for acceptance by the PM and AFCEC RPM or COR.

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Attachment 1:

Site Safety and Health Plan

Accident Prevention Plan Attachment 1
Site and Safety Health Plan

Remedial Investigation for PFAS at Various Sites
Eielson Air Force Base, Alaska

June 2021

Contract Number: FA8903-16-D-0041

Delivery Order FA8903-20-F-1108

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ACRONYMS AND ABBREVIATIONS

AFCEC	Air Force Civil Engineer Center
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
BEM	BEM Systems, Inc.
CFR	Code of Federal Regulations
COR	Contracting Officer's Representative
DFOW	Definable Feature of Work
EC	emergency coordinator
EAFB	Eielson Air Force Base
EM	Engineer Manual
EZ	exclusion zone
FTL	Field Team Lead
HCSMP	Heat and Cold Stress Monitoring Plan
IDW	Investigative Derived Wastes
OSHA	Occupational Safety and Health Standards
PADS	Physical Agent Data Sheets
PFAS	per- and polyfluoroalkyl substances
PM	Project Manager
PPE	personal protective equipment
RAC	risk assessment code
RI	remedial investigation
RPM	Remedial Project Manager
SHM	Safety and Health Manager
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

1.1 Purpose and Scope

This Site Safety and Health Plan (SSHP) contains safety procedures and requirements that will be implemented during the remedial investigation (RI) that will be conducted for per- and polyfluoroalkyl substances (PFAS) at Various Sites at Eielson Air Force Base (EAFB) in Fairbanks North Star Borough, Alaska.

This SSHP is Attachment 1 of the Accident Prevention Plan (APP), which is the primary safety plan document, and applies to all work conducted by BEM Systems, Inc. (BEM) and their subcontractors. Essentially equivalent or additional health and safety procedures and practices may be approved by BEM and implemented by its subcontractors where necessary. All subcontractors are required to follow BEM's health and safety programs and procedures, including the APP and this SSHP. Changes and/or additional subcontractor programs and procedures must be approved by BEM Safety and Health Manager (SHM) and Air Force Civil Engineer Center (AFCEC) Remedial Project Manager (RPM). The BEM SHM will review and provide written approval of the APP, which includes this SSHP as an attachment, and any relevant subcontractor programs and procedures prior to the initiation of fieldwork. The APP/SSHP (including any subsequent changes to the approved plan) will be submitted to the AFCEC RPM and Contracting Officer's Representative (COR).

Where applicable, this SSHP references the appropriate section of the APP where the required information (and/or supplemental information) can be found rather than including requirements that are duplicative.

1.2 Applicable Standards, Regulations, and Guidance Documents

Adherence to applicable portions of federal, local, national consensus organization, and corporate health and safety standards, regulations, and guidance manuals is required during field activities. These include, but are not necessarily limited to, the following:

- 29 Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards, General Industry and the State of Alaska equivalent regulations (Occupational Safety and Health Administration [OSHA]);
- 29 CFR, Part 1926, Occupational Safety and Health Standards, Construction Industry and the State of Alaska equivalent regulations;
- BEM Corporate Health and Safety Program Manual, provided as Attachment 4 to the APP; and
- U.S. Army Corp of Engineers (USACE) Safety and Health Requirements Manual, Engineer Manual (EM) 385-1-1.

2.0 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

Section 2.4 of the APP contains the site description and the site history is summarized in the QAPP (main document). Section 9.12.1 and Table 9-3 of the APP contains information on the contamination at the site and the potential for exposure to the contaminants to adversely affect the safety and occupational health of workers during the onsite work activities to be performed.

3.0 ACTIVITY HAZARD ANALYSIS

Section 2.6 of the APP lists the major activities, tasks, and definable features of work (DFOW) for each task/operation that will be performed during this project. The activity hazard analysis (AHA) for each DFOW, activity, or task accounts for all hazards (classic safety, physical, chemical, biological, environmental, and ionizing radiation [as applicable]) likely to be encountered while performing the work.

Preliminary AHAs for these activities are submitted with this APP submittal (Attachment 3 to the APP). AHAs will be maintained as live documents in the field and will be modified by field staff as necessary to fit changing work procedures, tasks, equipment, and hazards. Should the AHA risk assessment code (RAC) be changed to a higher risk than identified in the initial AHA, the AHA will be re-submitted for approval by the SHM, Project Manager (PM), and the AFCEC RPM or COR. In addition, the Site Safety and Health Officer (SSHO) will consult with the SHM prior to making changes to AHAs if the level of respiratory protection or personal protective equipment (PPE) will be modified, or additional tasks not already addressed in the AHA or APP are identified.

If any unforeseen hazard becomes evident during the performance of work, the SSHO will bring such hazard information to the attention of the SHM, PM, and the AFCEC RPM or COR (both verbally and in writing) for resolution as soon as possible and, in the interim, necessary action will be taken to re-establish and maintain safe working conditions.

4.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

Section 4.2 of the APP identifies the key contacts and responsibilities for the members of BEM's organization as they relate to safety on this project, including the SHM, the PM, the Field Team Lead (FTL), and the SSHO, as well as general site workers, subcontractors, competent persons, and suppliers/vendors. A project organization chart showing the relationship among the above team members and the client representatives is provided in the APP as Figure 1.

5.0 TRAINING

General and project-specific training requirements for workers on this project are included in Section 6.0 of the APP.

6.0 PERSONAL PROTECTIVE EQUIPMENT

PPE for site workers is selected and used based on existing and potential hazards, in accordance with 29 CFR Section 1910.120 requirements and the hazard assessment. The following will be provided, used, and maintained in a sanitary and reliable condition: all PPE for eyes, face, head, and extremities; protective clothing; and protective shields and barriers. PPE is required wherever it is necessary based on process or environmental hazards, chemical hazards, or mechanical irritants encountered that can cause injury or impairment to the function of any part of the body through absorption, inhalation, or physical contact. BEM's written PPE Program is provided in BEM's Corporate Safety and Health Plan (Attachment 4 to the APP).

BEM is not responsible for providing any PPE, as described herein, to subcontractor employees. Subcontractor employees working on the project must arrive on-site with their individually assigned PPE, as required for the project and described in the APP/SSHP and associated AHAs. The SSHO is responsible for ensuring that all personnel comply with the PPE requirements identified below.

The SHM has reviewed the applicable work plans and other available information and has evaluated each major work activity to determine the appropriate level of PPE needed for the work. This evaluation included a consideration of potential hazards present; work operations to be performed; potential routes of exposure; concentrations of contaminants present or reasonably expected; characteristics, capabilities, and limitations of PPE; and any hazards that the PPE may create or exacerbate (e.g., heat stress). Evaluation findings and recommendations for use of PPE during specific tasks are listed in the AHA matrix.

The initial and basic level of PPE required on the project site (commonly referred to as "Level D"), as identified in 29 CFR 1910.132, includes: 1) a hardhat when overhead hazards are present, such as when working around heavy equipment or if otherwise specified by the client (e.g., facility requirements), 2) safety glasses with side shields (including the appropriate lens tint), 3) safety boots that comply with American Society for Testing and Materials F2413, 4) leather work gloves (as appropriate per the hazard assessment), 5) standard work clothes (long pants, shirt with ¾-length sleeve, at a minimum), 6) earplugs when working around power tools and heavy equipment or other sources of noise, 7) a Class 2 high-visibility vest when working around traffic or heavy equipment, 8) weather-appropriate clothing and 9) life vests when working on watercraft or at areas of standing water.

During sampling and other tasks where workers may have hand contact with potentially contaminated groundwater, workers will wear disposable nitrile gloves.

Reasons to upgrade the level of protection selected for the work activities include:

- known or suspected presence of dermal hazards;
- occurrence or likely occurrence of gas or vapor emission;
- change in a work task that will increase contact or potential contact with hazardous materials; and/or
- request by the individual performing the task;

Reasons to downgrade the level of protection selected for the work activities include:

- new information indicating that the situation is less hazardous than was originally thought;
- change in the site conditions that decreases the hazard, and/or
- change in the work task that reduces contact with hazardous materials.

The SSHO will oversee the implementation of the PPE program on-site, will confirm that workers are trained in the use of the specific PPE, and will ensure proper use of the PPE, including proper donning/doffing and disposal of the PPE. Used PPE will be managed based on considerations of the contaminants and concentrations of contaminants that are or may have been in contact with the PPE and applicable federal and state regulations. Any time PPE is modified from the plan or initial AHA, the SHM must be contacted for additional instruction. Additional tasks not included in the AHA matrix will also be reviewed by the SSHO and SHM.

7.0 MEDICAL SURVEILLANCE

BEM requires that site workers involved in certain tasks participate in a medical surveillance program that meets the requirements of 29 CFR Part 1910.120(f) and 29 CFR Part 1926.65(f). The medical surveillance program, managed by the Corporate SHM will be instituted for the following employees:

- Employees who are, or who may be, exposed to contaminant-related hazards (including hazardous substances or health hazards) at or above the permissible exposure limits (PELs) or, if there is no PEL, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year.
- Employees who wear a respirator for 30 days or more a year or as required in 29 CFR Part 1910.134.
- Employees who are injured, become ill, or develop signs or symptoms due to a possible overexposure during an emergency response or hazardous waste operation involving hazardous substances or health hazards.

Employees who are expected to participate in on-site activities where they are potentially exposed to health or safety hazards will be required to complete a baseline physical examination. Workers who must enter an exclusion zone (EZ), and/or who meet the criteria listed above, must provide the SSHO with a written opinion from a licensed physician attesting to the employee's fitness for duty at a hazardous waste site. A physician's written opinion of the employee's ability to wear a respirator is also required when there is a reasonable possibility that a respirator may be required for site work. The physician's written opinion must be dated within the previous 12-month period, or an alternative time period as determined by the physician, for continued work. The required physician’s written opinion will be made available upon request to the PM and the AFCEC RPM or COR.

8.0 EXPOSURE MONITORING/AIR SAMPLING PROGRAM

Periodic air monitoring for volatile organic compounds (VOCs) in the breathing zone will be conducted. The results of the air monitoring shall be recorded in the field logbook on a daily basis.

8.1 Action Levels

Air monitoring instrumentation will include a photoionization detector (PID) equipped with a 10.2 electron volt (eV). If VOCs are encountered in the breathing zone during soil intrusion activities, then air monitoring instrumentation will also include a combustible gas indicator (CGI). The action levels in this HASP will apply to site work for the duration of activities at the project site. The level of protection to be employed by BEM personnel at the worksite will be based on action levels. If real-time air monitoring instrument in any work area exceeds an action level, as presented in **Table 1**, the level of protection will be upgraded. Actions may be taken as necessary to ensure that personnel are protected for the worst-case contaminant of concern until the presence of that compound can be negated.

Table 1 Action Levels

Potential Air Contaminant	Instrument	Action Levels	Level of Respiratory Protection
Explosive Vapors	**CGI (if necessary)**	**< 19.5% oxygen, >23.5% oxygen, or > 10% LEL**	**Leave Area**
Explosive Vapors	CGI (if necessary)	> 19.5% < 23.5% oxygen, < 10% LEL	Level D
Volatile Organic Compounds	**PID**	**Continuous sustained readings of <100 ppm above background as an 8-hr TWA in the breathing zone and no visible dust.**	**Level D**
	PID	Sustained (> 5 min.) readings up to 5,000 ppm above background as an 8-hr TWA in the breathing zone and/or sustained dust clouds.	Level C, using full-face respirator with an OV/P100 cartridge
	PID	**If concentrations >5,000ppm above background as an 8-hr TWA and/or sustained dust clouds, work will be stopped and personnel will be required to leave the area until dust suppression techniques are implemented.**	**Evacuate the work area and suppress dust.**

8.2 Instrument Calibration

Instrument calibration shall be performed in the field at least once per work shift and shall be documented in the field logbook.

9.0 HEAT AND COLD STRESS

A Heat and Cold Stress Monitoring Plan (HCSMP) is included in Section 9.19 of the APP. The HCSMP complies with Section 06.J of EM 385-1-1. In addition, a summary of heat and cold stress prevention guidelines is available in the form of Physical Agent Data Sheets (PADS) provided in Attachment 10 of the APP.

10.0 STANDARD OPERATING PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

This section identifies (or provides a reference to) the standard operating procedures (SOPs), engineering controls, and work practices that must be followed for this project, as applicable.

The order of precedence regarding the requirements for any project is as follows:

1. All laws and regulations
2. The contract (including EM 385-1-1 and other referenced and contract-required manuals or instructions)
3. The site-specific APP, SSHP, and any referenced SOPs (including those in the Quality Assurance Project Plan [QAPP])

10.1 Site Rules/Prohibitions

In addition to those specified elsewhere, the basic site rules and prohibitions that BEM expects its employees and subcontractor personnel to follow during this project are specified below.

- Attend each day's work briefing and other safety training as scheduled.
- Comply with all work plans and procedures and inform your supervisor immediately if any changes are made to the work plan.
- Inform your human resources manager if you are taking prescribed medication for allergies or other requirements that could impact your ability to perform the tasks assigned. The human resources manager will review the matter in necessary with the project safety and management personnel to determine whether you can safely work on-site while taking the medication to perform your assigned task in accordance with this safety plan, (i.e. operation of heavy machinery while taking medicine that could impact vision or cause drowsiness).
- Wear the PPE specified in the APP/SSHP and AHAs.
- Become familiar with the on-site hazards, work zones, PPE requirements, and decontamination methods.
- Immediately report any incident, accident, injury, safety hazard, or symptoms of possible exposure, no matter how minor, to your supervisor or safety representative. If you are unable to obtain resolution at the project level, notify the SHM at the phone number indicated on a project emergency contact list that is found on every project site or call the Compliance Hotline at 1-800-886-2577.
- Stop work if an imminent danger exists.
- Follow proper decontamination procedures.
- Obey all authorized safety signs and demarcations. Do not place or remove these items except as authorized by the SSHO.

- Follow lockout/tagout procedures when working on equipment that has moving parts or hazardous energy sources. Install and remove locks and tags only in accordance with the procedure and only when authorized.
- Use the buddy system when performing operations in hazardous areas, when working with hazardous contaminants, when physical capabilities may become stressed (heat stress), when working in proximity to operating machinery or equipment.
- Follow the work/rest regimens and other practices required in accordance with the heat/cold stress procedures.
- Do not operate equipment unless you are properly trained and authorized to do so in a manner consistent with the owner/operator's manual.
- Do not operate motor vehicles without a valid driver's license.
- Use vehicle or equipment seat belts any time the vehicle or equipment is in operation.
- Inspect equipment and hand or portable manual and power tools such as groundwater pumps prior to use. Remove defective tools and equipment from service and either dispose of them or have them properly repaired.
- Always use ground fault circuit interrupters for cord-and-plug equipment used outdoors or in damp locations. Keep electrical cords out of walkways and out of accumulations of water unless protected and rated for such service. Inspect cords daily. Ground electrical generators while they are in use.
- Do not improperly use, mishandle, or tamper with health and safety equipment and samples.
- Do not engage in horseplay of any kind. Do not run or jump from equipment, except as necessary in an emergency.
- Do not bring, keep, or use alcoholic beverages, controlled substances, or unauthorized weapons on site. The following are prohibited:
    - illegal drugs (under federal regulations), illegal look-alike drugs, designer drugs, and drug paraphernalia;
    - controlled substances, such as medications, when usage is abused;
    - valid medications, when not kept in marked prescription bottles;
    - alcoholic beverages;
    - unauthorized firearms, weapons, and ammunition;
    - unauthorized explosives;
    - stolen property or contraband;
    - unauthorized cameras or photographic equipment; and
    - unauthorized recording devices.
- Do not bring pets on project premises.

- Become familiar with the Emergency Response Plan or Emergency Action Plan (as applicable) so that you can respond properly in an emergency.
- Become familiar with the locations and types of emergency equipment, such as fire extinguishers or air horns.
- Practice contamination avoidance techniques.
- Obtain help to lift or move bulky or heavy objects and any object weighing more than 50 pounds.
- Keep work, storage, and access areas orderly and free of debris.
- Implement, adhere to, and follow established rules, guidelines, procedures, plans, etc., as specified.
- Stop work and ask questions of your supervisor when you are uncertain about a procedure or equipment use.
- Perform all tasks in a safe and approved manner.
- Participate in the evaluation or investigation of any accident or incident when you are requested to do so.
- Do not bring visitors or children on project premises without the express written permission of the project manager, construction supervisor, or their designee.

All workers have a responsibility to ensure that all project activities proceed efficiently and safely. There will be instances when additional or different health and safety rules or requirements must be followed, or when a situation may arise for which a project rule or requirement may become inappropriate. Should this occur, the SSHO, after careful evaluation, may authorize a variance to the rule or requirement. Variances will also require the approval of the PM. When a variance is granted, it will be allowed to continue only so long as the conditions for which it was evaluated continues to occur.

10.2 Drug-Free Workplace

BEM has a drug-free workplace program. All BEM personnel, craft, and subcontractors on this project are subject to drug and alcohol testing at any time. Supervisors and managers are required to determine the fitness of their workers, including assessing whether their workers may be under the influence of any alcohol or drugs, including over-the-counter and prescription medications. During the initial site orientation and training conducted at the beginning of the project, all workers are reminded of the program and policies. The program and policies are also described in the work rules above. Workers are encouraged to confidentially list their medications on a medical information form that is provided to them and retained by the SSHO. If a worker is injured or involved in an accident, the worker(s) involved may be asked to be tested. If a supervisor observes any worker who appears to be under the influence of drugs or alcohol, they may request testing of the worker.

10.3 Work Permit Requirements

Work permit requirements (contractor and client, as appropriate) for specific types of work are addressed within appropriate sections of the APP.

10.4 Material Handling Procedures

Not applicable.

10.5 Drum/Container/Tank Handling Procedures

Drums and other containers utilized to temporarily store and transport investigative derived waste (IDW) shall be properly labeled in accordance with Department of Transportation, OSHA, and Base-specific requirements.

All drum and IDW staging or storage areas will be approved by Base staff and will contain the necessary secondary containment if necessary. Wastes will be stored onsite until obtaining waste characterization analytical results. All wastes requiring offsite disposal will include proper profile and manifest documentation. All waste disposal manifests will be returned to the AFCEC RPM and will be included within an appendix of the technical report.

10.6 Comprehensive AHA of Treatment Technologies Employed at the Site

Not applicable.

11.0 SITE CONTROL MEASURES

Staff shall incorporate methods to control their immediate work area. This may include the use of traffic cones, barricades, or high visibility tape indicating the extent of the area required to prevent unauthorized access by non-essential personnel or to prevent exposure to potentially contaminated media. If necessary, vehicles may be staged at specific areas to prevent or deter staff's interaction with traffic. Any methods utilized to control or alter traffic patterns will require the preparation of a traffic management plan that will require Base approval.

12.0 PERSONAL HYGIENE AND DECONTAMINATION

Section 9.12.3 of the APP contains personal hygiene and decontamination requirements and equipment decontamination requirements for this project. The FTL/ SSHO is responsible for maintaining appropriate equipment and personnel decontamination areas and ensuring that BEM employees and subcontractors follow this plan. All workers are responsible for following site-specific and task- or area-specific decontamination requirements when leaving the EZ to avoid contamination. Decontamination procedures will involve using engineering controls and prescribed PPE, as specified in the APP/SSHP and AHAs, as well as implementing proper hygiene, such as washing of hands and face, when appropriate, following completion of the decontamination sequence (and prior to eating, smoking, drinking fluids, etc.).

13.0 EMERGENCY EQUIPMENT AND FIRST AID

Information on the emergency equipment required to be present on-site for emergencies is addressed in Section 9.2.4 (Emergency Equipment) of the APP. A list of emergency equipment and the location of the equipment is contained in Table 9-1 of the APP. Information regarding first aid and cardiopulmonary resuscitation personnel is provided in Section 9.2.8.2 (Medical Emergencies) of the APP.

14.0 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

The following sections describe the emergency response and contingency procedures that will be followed during the project.

14.1 Correlation to the Emergency Plans in the Accident Prevention Plan

29 CFR Part 1910.120 defines *emergency response or responding to emergencies* as a response effort by employees from outside the immediate release area or by other designated responders (mutual aid groups, local fire departments, etc.) to an occurrence that results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel, are not considered to be emergency responses within the scope of this standard. Responses to releases of hazardous substances where there is no potential safety or health hazard are not considered to be emergency responses. BEM Emergency Response Plans such as those described below or those that are contained in the APP, constitute an Emergency Action Plan as required by 29 CFR Part 1910.38. Section 9.2 (Emergency Plans) of the APP contains the required Emergency Response Plans for this project, all of which meet the requirements of 29 CFR Part 1910.38 – Emergency Action Plans. These plans include:

- Spill Emergency Plan – Section 9.2.6 of the APP
- Fire Emergency Plan – Section 9.2.7 of the APP
- Medical Emergencies – Section 9.2.8 of the APP, including:
  - Decontamination During Medical Emergencies – Section 9.2.8.1 of the APP
  - First Aid – Section 9.2.8.2 of the APP
- Inclement Weather – Section 9.2.9 of the APP
- Earthquake – Section 9.2.10 of the APP

14.2 Pre-Emergency Planning

The elements of the Emergency Action Plan related to pre-emergency planning are contained in Section 9.2.1 of the APP.

14.3 Personnel and Lines of Authority for Emergency Situations

The elements of the Emergency Action Plan related to personnel and lines of authority for emergency situations are contained in Section 9.2.2 of the APP.

The FTL is the primary emergency coordinator (EC) for the project and the SSHO is the backup EC. The EC will take charge and determine, direct, and delegate personnel and resources to manage the emergency.

The key responsibilities of the EC are to:

- initiate evacuation if needed;
- initiate emergency response agency notification;

- evaluate and assess emergency situations to ensure that response activities are commensurate with the level of the emergency and, as discussed in this plan, are implemented; and
- interface and coordinate with outside agencies responding to on-site emergencies.

14.4 Criteria and Procedures for Emergency Recognition and Site Evacuation

The elements of the Emergency Action Plan related to the criteria and procedures to follow for emergency recognition and site evacuation are included in the APP as follows:

- Emergency Signal, Assembly, and Evacuation Procedures are contained in Section 9.2.3 of the APP.
- The evacuation areas and routes to evacuation areas are discussed in Section 9.2.3 of the APP and are shown on Figure 2 of the APP.

14.5 Decontamination and Medical Treatment of Injured Personnel

The elements of the Emergency Action Plan related to decontamination and medical treatment of injured personnel are contained in Section 9.2.8.1 of the APP.

14.6 Route Map to Emergency Medical Facilities and Phone Numbers for Emergency Responders

The elements of the Emergency Action Plan that include the route map to emergency medical facilities and phone numbers for emergency responders are included in the APP, as follows:

- Medical emergencies are addressed in Section 9.2.8 of the APP.
- The route map and directions to the closest emergency medical facility to the project site are shown in Figure 2 of the APP.
- Phone numbers for emergency responders are included in Table 9-2 in the APP.

14.7 Criteria for Alerting Local Emergency Responders

The proposed work efforts (groundwater sampling of existing monitoring wells) do not require a medical support agreement for this project. First aid requirements and capabilities are contained in Section 9.2.8.2 of the APP.

15.0 REFERENCES

BEM Systems, Inc. 2018 Health and Safety Program Manual. July.

Occupational Safety and Health Administration (OSHA). 2019. Occupational Safety and Health Standards for General Industry (CFR 1910) and Regulations for Construction (29 CFR 1926). Retrieved from https://www.osha.gov/laws-regs/regulations/standardnumber 24 April 2019.

USACE. 2014. Engineer Manual (EM) 385-1-1, Safety and Health Requirements. November 30.

Attachment 2:

Coronavirus Disease 2019 (COVID-19) Best Practice Procedures – Version No. 3

BEM Systems, Inc. Coronavirus Disease 2019 (COVID-19)
Best Practice Procedures
September 03, 2020
Revision 3 changes highlighted in yellow

Introduction

There is currently no vaccine to prevent coronavirus disease 2019 (COVID-19). To prevent illness, avoid being exposed to this virus by maintaining safe distance.

- Between people who are in close contact with one another (within about 2 meters or about 6 feet).

Employees with symptoms of acute respiratory illness should stay home until they are free of fever and any other symptoms.

- Report to HR and your supervisor if any of the following applies when you are actively supporting and/or performing work on behalf of BEM Systems, Inc.:
  - Fever (100.4° F [38.0° C]) signs of a fever, and any other flu-like or cold-like symptoms for at least 24 hours, without the use of fever-reducing or other symptom-altering medicines (e.g. acetaminophen).
  - Been in close contact* with anyone who has been diagnosed with COVID-19 or who are exhibiting any of the symptoms listed above.

    * Close contact is defined as:
    a) being within approximately 6 feet (2 meters) of a COVID-19 case for a prolonged period of time; close contact can occur while caring for, living with, visiting, or sharing a healthcare waiting area or room with a COVID-19 case or
    b) having direct contact with infectious secretions of a COVID-19 case (e.g., being coughed or sneezed on y by someone who has been diagnosed).
- All air travel will require Executive Sponsor and HR Manager approval. Employees will have to comply with the arriving and departing State(s) travel advisory/restrictions and self-quarantine/COVID-19 testing requirements for outgoing and incoming travel from the home state and to the project site.
- Minimize all in-person meetings with clients to remote meetings to avoid unnecessary contact.
- When in public (e.g., at a business meeting or for a field work), cover your mouth and nose with a cloth face cover or other, disposable face covering, at all times except wearing N95 NIOSH rated facial facepiece/mask. For example, if you are

to go into a store to purchase ice or drop off laboratory samples and go inside the lab building, you must don a face covering for the protection of you and others.

- Avoid touching your eyes, nose, or mouth with unwashed hands. Be conscious of every hand movement to your face. It is very common for individuals to unknowingly touch your mouth, eyes and noise.
- Wash hands often with soap and water for at least 20 to 30 seconds and drying with a clean towel or air dry them. An alcohol-based hand sanitizer that contains at least 60% alcohol can also be used, but hand washing is preferable if hands are visibly dirty.
- Cough and sneeze into a tissue, then immediately throw away the tissue and wash your hands. Cough and sneeze away from the person you are in contact with at the client site if outdoors. Cough and sneeze into your elbow if indoors if no tissue available.

PRE-FIELD MOBILIZATION REVIEW

Prior to moving forward with the field work, Program/Project Managers or their designee, shall review the following questions to determine if they should proceed with scheduled field activities or delay field activities. If a team member answers “yes” to any of the following questions, the project team shall pause on proceeding with mobilizing and elevate engagement to the Human Resources (HR) so that supervisor and Program/Project Managers can be contacted to make appropriate arrangement to either revise the field plan, reschedule or delay field activities.

- Are there any federal, state, or local restrictions impacting ability to access the site?
- Does the client or the client’s prime consultant/contractor have restrictions impacting ability to access the site?
- Does any member of the field team express concern with proceeding with the field activities as being asked?

Field Work Precautionary Health and Safety Procedures

In response to the current threat of the COVID-19 outbreak, the following steps should be followed by all employees when performing field investigations and also comply with the BEM’s Health & Safety Plan (HASP). However, each contractor and subcontractor must assume direct responsibility for the health and safety of its own employees.

- Field personnel including subcontractors on a daily basis should sign a tailgate wellness log.
- Some clients may have implemented Temperature screening as a site entry requirement as it is allowable during a pandemic under employment laws.
- BEM employees will drive separately to worksites, and do not use mass transit to avoid crowds. Subcontractors and subconsultants will follow their company policies but will have to sign BEM's daily tailgate wellness log.
- Do not shake hands when greeting others including contractors or clients who are assisting or escorting BEM personnel. If anybody from the BEM team (BEM employees and contractors/subcontractors) shows up in the field with fever, sneezing and coughing should be asked to go home, rest and recover.
- Try to maintain 6 feet from other employees and contractors by splitting up responsibilities and moving away from each other by at least 6 feet. If multiple crews are working on the construction site, maintain a safe distance of 3 to 6 feet at all times and avoid close contact or sharing field equipment's.
- Field personnel should presume that surfaces in the field are potentially infected and take applicable precautions including maintain an adequate supply of cleaning and disinfection products.
    - Routinely clean all frequently touched surfaces and interior surfaces in vehicles subject to hand contact, including but not limited to steering wheel, shifter, seats (if not cloth) door handles, console, etc. should be disinfected to the extent possible prior to use and frequently throughout the workday using disinfectant wipes as directed by product label.
- Use orange safety cones to create a worker exclusion zone during groundwater sampling and for soil boring/monitoring well installation, specially to avoid contact with public in the busy service areas.
- Utilize personal protective equipment (PPE) (Modified Level D) when conducting outside field work in open areas. The modified level D should include the following:
    - Disposable Tyvek coveralls (as applicable),
    - Hard hat (when working around heavy equipment),
    - Steel-toed work boots (for all activities),
    - Non-Latex or disposable nitrile gloves (double layers, as applicable),
    - Safety glasses,
    - Hearing protection (as applicable),
    - Sun protection (sunscreen) (as applicable), and
    - Cold weather protection (as applicable).

- Use double layers of gloves and discard outer layer when coming in contact with potentially contaminated surfaces or any surface that has not known to be contaminated. Essentially once out of the house you should have your hands constantly covered by a clean pair of latex gloves paying specific attention to not touch your face until you have removed the gloves and washed your hands as described above..
- Wipe down PPE and equipment such as respirators, drilling handles, soil and groundwater sampling equipment, sampling boxes, sampling media jars/sleeves, sample collection devices, vapor phase remediation sensor pumps, water quality testing instruments, camera systems, PID and Aerosol meters, etc. with Clorox or Alcohol (greater than 70%) wipes. Use the wipes as directed on the containers to ensure it is effective in sanitizing the surfaces. All wipes and other discarded materials should be bagged in garbage bags and disposed of along with waste generated during field investigation.
- Wipe down the coolers with Clorox or Alcohol (greater than 70%) wipes as necessary without compromising the integrity of the sampling jars.
- If inside the building avoid contact with others and maintain 6 feet safe distance. If in close proximity inside the building than utilize a minimum of Modified Level D, double layer nitrile gloves, and N95 NIOSH rated facial facepiece/mask or regular medical mask for protection.

Additional information on COVID-19 precautions can be found on these websites

From OSHA: https://www.osha.gov/SLTC/covid-19/

From NIOSH: https://www.cdc.gov/niosh/emres/2019_ncov.html

From CDC: https://www.cdc.gov/coronavirus/2019-ncov/index.html

From CDC for Employers about getting their businesses ready: https://www.cdc.gov/coronavirus/2019-ncov/specific-groups/guidance-business-response.html

https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face-coverings.html

In New Jersey, this is mandated under Executive Order 122.
https://nj.gov/infobank/eo/056murphy/pdf/EO-122.pdf

Attachment 3:

Activity Hazard Analyses

ACTIVITY HAZARD ANALYSIS 04 Boating

Date:	**16 November 2020**	Overall Risk Assessment Code (RAC) (Use highest code)					**M**
		Risk Assessment Code (RAC) Matrix					
Project:	**RI for PFAS at Various Sites at Eielson AFB, AK Contract: FA8903-16-D-0041 Task Order: FA8903-20-F-1108**	**Severity**	**Probability**				
			Frequent	Likely	Occasional	Seldom	Unlikely
Activity:	AHA-04 Boating	Catastrophic	E	E	H	H	M
		Critical	E	H	H	M	L
		Critical	H	M	M	L	L
		Marginal	M	L	L	L	L
Activity Location:	**Eielson AFB, AK**	**Step 1:** Review each hazard with identified safety **"Controls"** and determine RAC (see above)					
		"Probability" is the likelihood to cause an incident, near miss or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely				**RAC Chart**	
Prepared by:	Ben Siewic	**"Severity"** is the outcome/degree if an incident, near miss or accident did occur and identified as: catastrophic, Critical, Marginal or Negligible				**E = Extremely High Risk**	
Reviewed by:	Chris Pisarri	**Step 2:** Identify the RAC (Probability/Severity) as E, H, M or L for each hazard on AHA. Annotate the overall highest RAC at the top of AHA.				**H = High Risk**	
						M = Moderate Risk	
						L = Low Risk	

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
Boat Operations	Drowning/Falls Overboard/Capsizing	• Review Man Overboard Plan and check that equipment for rescue is available and worn. • Wear personal flotation device (PFD). Know location and proper use of lifesaving devices (throw ring, throw bag, reach poles, cargo net, ladder). • Do not exceed boat capacity ratings for person weight (200 lbs.) or total weight (775 lbs.) • When loading equipment into the boat, balance the load within the boat and check for stability of the load at the shore, before launching. • Personnel on board will avoid sudden movements or weight shifts, and only one person at a time will shift weight or change position.	**M**
	Vehicular Traffic	• Follow safe boat handling procedures as listed below. Use caution when approaching shoreline. Be aware of shallow regions along the shore.	**L**
	Slip, trip, falls	• Identify and review slip, trip, and fall hazards and avoid walking in locations with unstable ground surfaces. • Maintain good housekeeping, and keep deck clear of hoses, vessel tie-off, and miscellaneous tooling.	**L**
	Media Collection	• Refer to Surface Water and Sediment Sampling AHA • Do not lean over boat edge to collect sample • Maintain stability within the boat	**M**

ACTIVITY HAZARD ANALYSIS 04 Boating

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
Site General	Heat Stress	• See AHA-01, Mobilization and Demobilization	
	Cold Stress	• See AHA-01, Mobilization and Demobilization	
	Biological Hazards	• See AHA-01, Mobilization and Demobilization	
	Inclement Weather	• See AHA-01, Mobilization and Demobilization	

Equipment to be Used	Training	Inspection
1. Boat: 2015 Tracker Topper model # 1542 LW:Length: 15 feet • Beam: 5 feet • Bottom width: 3 feet, six inches • Transom height: 16.5 inches; draft 6.6 inches • Capacity: Max. weight 775 lbs.; max. # people 3; max. person weight, 400 lb. 2. Personal Protection Equipment – Level D • -Hard Hat • -Safety glasses (if eye hazards are present) • -Steel-toed boots • -Chemical Resistant Gloves • -Work gloves (leather or equivalent) • -Hearing protection (foam ear plugs) • -PFD 3. Mobile Phone 4. Marine Radio 5. First Aid Kit 6. Fire Extinguisher 7. Boat Safety Kit and Spill Kit 8. Boat Paddles	Competent Person: Jay Erickson, CDSO 9. 40-hour Hazwoper 10. Site-Specific Safety training and AHA training 11. First AID/CPR/AED training (at least two onsite) 12. USCG Boat Safety	13. Water Risk Assessment Form 14. Inspect all PPE prior to use and throughout the day. 15. Check that all tools are in good condition. If not, they are to be tagged and not used for this work. 16. Vehicle Inspection Checklist

ACTIVITY HAZARD ANALYSIS 04 Boating

Analyzed/ Approved By:	Position Or Title	Signature

Briefing Record					
Print Name	**Signature**	**Date**	**Print Name**	**Signature**	**Date**

AHA-05 Investigation-Derived Waste Handling

Date:	**16 November 2020**	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project:	**RI for PFAS at Various Sites at Eielson AFB, AK Contract: FA8903-16-D-0041 Task Order: FA8903-20-F-1108**		
Activity:	**AHA-05 Investigation-Derived Waste Handling**		
Activity Location:	**Eielson AFB, AK**		
Prepared by:	Ben Siwiec		
Reviewed by:	Chris Pisarri		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
	M	L	L	L	L

Step 1: Review each hazard with identified safety **"Controls"** and determine RAC (see above)

"Probability" is the likelihood to cause an incident, near miss or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely

"Severity" is the outcome/degree if an incident, near miss or accident did occur and identified as: catastrophic, Critical, Marginal or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M or L for each hazard on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
(1) Moving buckets of purge water (2) Moving empty drums or supersacks. (3) Opening drums with tools. (4) Transferring water or soil between containers	Slip, trips, and falls – walking on uneven surfaces.	• Inspect work areas for slip, trip, and fall hazards and wear appropriate PPE (sturdy boots). • Hazards shall be marked, barricaded, or eliminated, if feasible. Use care in work area; look for depressions and obstructions.	L
	Heavy lifting – Buckets of water. Moving drums.	• Team lift awkwardly shaped items and heavy items. • Lift with your legs, keeping back straight, and avoid twisting of back while lifting. • Use two team approach when lifting heavy equipment. • Do not attempt to move heavily laden drums. Have machinery move the drum.	L
	Eye hazards	• Personnel will wear safety glasses rate ANSI Z87.1 in case of splashing from contaminants and preservatives.	L
	Hand hazards, pinch points	• When working with drums or opening bungs protect hands from pinching by wearing protective gloves.	L

AHA-05 Investigation-Derived Waste Handling

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Exposure to Contaminants including PFAS, PFOA, other AFFF constituents as well as VOCs, GRO, DRO, RRO and PCBs	• Wear appropriate PPE when working with contaminated materials such as IDW. • Personnel will receive site specific training for recognition and testing of potential contaminants.	**L**
	Inclement Weather – rain, snow and high winds	• Check weather updates before you visit the site. If there is bad weather such as high winds or heavy rain post-pone site visit until site condition improve.	L
	Vehicles	• Use barrier controls with a height of at least 36 inches, if required. • Wear Minimum ANSI Type II traffic reflective vest. • Use defensive driving techniques.	L
	Cold Stress	• Wear protective clothing and use of shelter. Be aware of the signs and symptoms of cold stress; particularly hypothermia and frost bite.	L
	UV Radiation	• Wear protective clothing. • If sunscreen is used, be sure to be PFOS/PFOA free.	L

Equipment to be Used	Training	Inspection

AHA-05 Investigation-Derived Waste Handling

Equipment to be Used	Training	Inspection
• Personal Protection Equipment – consisting of safety toe boots, leather gloves, long sleeve shirts, nitrile gloves (as needed), hard hat (as needed), safety glasses and respirator (as needed). • Vehicle • Hand tools such as bung wrench, Crescent wrench, or electric drum opener.	• General Construction Worker HAZWOPER 40-hr unless escorted • First AID/CPR/AED training • Use hand tools according to manufacturer instructions and with all recommended PPE.	• Inspect PPE daily and before use. Ensure it is in good working order. Replace any PPE that is worn or damaged.

AHA-05 Investigation-Derived Waste Handling

Analyzed/ Approved By:	Position Or Title	Signature
	Safety and Health Officer	
	Project Manager	

Briefing Record

Print Name	Signature	Date	Print Name	Signature	Date

AHA-01 Mobilization and De-mobilization To and From Site

AHA-01 Mobilization and De-mobilization To and From Site

Date:	**04 September 2020**	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project:	**RI for PFAS at Various Sites at Eielson AFB, AK Contract: FA8903-16-D-0041 Task Order: FA8903-20-F-1108**	**Risk Assessment Code (RAC) Matrix**	
Activity:	**AHA-01 Mobilization and De-mobilization To and From Site**	**Severity** / **Probability**	
Activity Location:	**Eielson AFB, AK**	**Step 1:** Review each hazard with identified safety **"Controls"** and determine RAC (see above)	
Prepared by:	Lesa Zimnawoda	**"Probability"** is the likelihood to cause an incident, near miss or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely	**RAC Chart**
Reviewed by:	Chris Pisarri	**"Severity"** is the outcome/degree if an incident, near miss or accident did occur and identified as: catastrophic, Critical, Marginal or Negligible **Step 2:** Identify the RAC (Probability/Severity) as E, H, M or L for each hazard on AHA. Annotate the overall highest RAC at the top of AHA.	**E = Extremely High Risk** **H = High Risk** **M = Moderate Risk** **L = Low Risk**

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
	M	L	L	L	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
(1) Performing pre-trip inspections (2) Vehicle loading and unloading (3) Operating motor vehicle on and off-road (4) Routine vehicle maintenance	General hazards associated with motor vehicle operations	• All occupants (driver and passengers) must always wear a seatbelt while in the motor vehicle • Check mirrors and position as needed • Do not talk or text on a cell phone while operating a motor vehicle	**L**
	Cut scrapes to hands and fingers checking engine fluids.	• Wear protective gloves if reaching in poorly illuminated areas of the engine.	**L**
	Pinch/crush hazards to hands and fingers checking engine fluids or closing doors.	• Identify and keep hands fingers away from pinch hazards from doors and vehicle hood or tailgate (if present).	**L**
	Failure to inspect vehicle emergency equipment may result in extensive vehicle damage or delay treatment in the event of injury	• Conduct equipment inspections by visibly inspecting fire extinguisher and first aid kit for cleanliness, in date items/tags, readiness for use.	**L**

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Driving to and from site	• Use defensive driving techniques. • Inspect area inside vehicle making sure nothing is obstructing or potentially going to obstruct control and safety items inside vehicle(unsecured items falling into pedal area) • Avoid distractions such as cell phone usage during driving. • Make sure first aid and road emergency kit is in vehicle.	**L**
	Driving on site	• Wear minimum ANSI Type II traffic reflective vest. • Use barrier controls with a height of at least 36 inches.	**L**
	Burn hazards to hand from checking/replacing fluids in engine compartment.	• When practical, allow engine to cool prior to servicing or adding fluids. • Use protective gloves.	**L**

Equipment to be Used	Training	Inspection
• Protective Gloves • High visibility vest • Vehicle (Truck(s)) • GPS/cellphone • First aid and road emergency kit	• General Construction Worker HAZWOPER 40hr unless escorted • First AID/CPR/AED training	• Complete vehicle inspection checklist.

Analyzed/ Approved By:	Position Or Title	Signature
	Safety and Health Officer	
	Project Manager	

Briefing Record

Print Name	Signature	Date	Print Name	Signature	Date

AHA-02 Groundwater, Soil, Surface Water, Sediment, and Fish Tissue Sampling

Date:	**16 November 2020**	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project:	**RI for PFAS at Various Sites at Eielson AFB, AK Contract: FA8903-16-D-0041 Task Order: FA8903-20-F-1108**		
Activity:	**AHA-02 Groundwater, soil, surface water, sediment, and fish tissue sampling**		
Activity Location:	**Eielson AFB, AK**		
Prepared by:	Lesa Zimnawoda, Ben Siwiec		
Reviewed by:	Chris Pisarri		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
	M	L	L	L	L

Step 1: Review each hazard with identified safety **"Controls"** and determine RAC (see above)

"Probability" is the likelihood to cause an incident, near miss or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely

"Severity" is the outcome/degree if an incident, near miss or accident did occur and identified as: catastrophic, Critical, Marginal or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M or L for each hazard on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
(1) A) Collect groundwater samples.(or) B) Collect soil samples (or) C) Collect surface water samples (or) D) Collect sediment samples (or) E) Collect fish tissue samples. (2) Decontaminate sampling equipment. (3) Prepare labels and coolers for shipping.	Slip, trips, and falls – walking on uneven surfaces during the inspections and during maintenance and sampling activities.	• Inspect work areas for slip, trip, and fall hazards and wear appropriate PPE (sturdy boots). • Hazards shall be marked, barricaded, or eliminated, if feasible. Use care in work area; look for depressions and obstructions.	L
	Heavy lifting – Sample equipment and coolers.	• Team lift awkwardly shaped items and heavy items. • Lift with your legs, keeping back straight, and avoid twisting of back while lifting. • Use two team approach when lifting heavy equipment.	L
	Eye hazards	• Personnel will wear safety glasses rate ANSI Z87.1 in case of splashing from contaminants and preservatives.	
	Exposure to Contaminants including PFAS, other AFFF constituents as well as VOCs, GRO, DRO, RRO, Metals, and PCBs	• Wear appropriate PPE around known contaminated areas. • Personnel will receive site specific training for recognition and testing of potential contaminants.	
	Biological hazards – bears, mosquitos, stinging insects	• Don't let food garbage accumulate at the site. Regularly remove potential bear attractants. • Avoid mosquitos and stinging insects by wearing long sleeves. • Inspect well lids and locks for the presence of insects.	L

AHA-02 Groundwater, Soil, Surface Water, Sediment, and Fish Tissue Sampling

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Inclement Weather – rain, snow and high winds	• Check weather updates before you visit the site. If there is bad weather such as high winds or heavy rain post-pone site visit until site condition improve. • Do not wade into surface water bodies during high discharge events.	L
	Vehicles	• Use barrier controls with a height of at least 36 inches, if required. • Wear Minimum ANSI Type II traffic reflective vest. • Use defensive driving techniques.	L
	Cold Stress	• Wear protective clothing and use of shelter. Be aware of the signs and symptoms of cold stress; particularly hypothermia and frost bite.	L
	UV Radiation	• Wear protective clothing. • If sunscreen is used, be sure to be PFOS/PFOA free.	L
	Well Lids and Locks	• Take precautions when opening well lids and locks for insects. • Watch for sharp edges on well lids. • Be aware of pinch points on lids and locks.	L
	Drowning, cold water submersion	• Wear a personal floatation device while working near water of depth 3 feet or greater.	L
	Electrical Shock	• Follow operator instructions while on electrofishing boat. • Wear non-conductive shoes and gloves • Wear non-conductive waders and gloves when using backpack-mounted electrofishing equipment.	L
	Puncture injury from fishing hooks	• Use caution while handling sharp objects such as hooks or other tools and use protective gloves if possible.	

AHA-02 Groundwater, Soil, Surface Water, Sediment, and Fish Tissue Sampling

Equipment to be Used	Training	Inspection
• Personal Protection Equipment – consisting of safety toe boots, leather gloves, long sleeve shirts, nitrile gloves (as needed), hard hat (as needed), safety glasses and respirator (as needed). • Vehicle • Water sampling equipment (water quality meters and pumps as needed.) • Electrofishing backpack or boat • Fishing hooks and other fishing gear	• General Construction Worker HAZWOPER 40-hr unless escorted • First AID/CPR/AED training • Use electrofishing equipment and other fishing gear according to manufacturer instructions and with all recommended PPE. Follow boat captain's instructions if working on boat.	• Inspect PPE daily and before use. Ensure it is in good working order. Replace any PPE that is worn or damaged. • Operators must be properly trained in operation of the sampling equipment being used.

AHA-02 Groundwater, Soil, Surface Water, Sediment, and Fish Tissue Sampling

Analyzed/ Approved By:	Position Or Title	Signature
	Safety and Health Officer	
	Project Manager	

Briefing Record					
Print Name	**Signature**	**Date**	**Print Name**	**Signature**	**Date**

AHA-03 Borehole and Monitoring Well Installation

AHA-03 Borehole and Monitoring Well Installation

Date:	**16 November 2020**	Overall Risk Assessment Code (RAC) (Use highest code)					**L**
		Risk Assessment Code (RAC) Matrix					
Project:	**RI for PFAS at Various Sites at Eielson AFB, AK Contract: FA8903-16-D-0041 Task Order: FA8903-20-F-1108**	**Severity**	**Probability**				
			Frequent	Likely	Occasional	Seldom	Unlikely
Activity:	**AHA-03 Borehole and Monitoring Well Installation**	Catastrophic	E	E	H	H	M
		Critical	E	H	H	M	L
		Marginal	H	M	M	L	L
			M	L	L	L	L
Activity Location:	**Eielson AFB, AK**	**Step 1:** Review each hazard with identified safety **"Controls"** and determine RAC (see above)					
		"Probability" is the likelihood to cause an incident, near miss or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely				**RAC Chart**	
Prepared by:	Ben Siwiec	**"Severity"** is the outcome/degree if an incident, near miss or accident did occur and identified as: catastrophic, Critical, Marginal or Negligible				**E = Extremely High Risk**	
Reviewed by:	Chris Pisarri	**Step 2:** Identify the RAC (Probability/Severity) as E, H, M or L for each hazard on AHA. Annotate the overall highest RAC at the top of AHA.				**H = High Risk** **M = Moderate Risk** **L = Low Risk**	

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
(1) Drill rig setup (2) Direct push activities (3) Sleeve removal and sample collection (4) Demobilization	Bodily injury – hand, head, foot, back	• Leather work gloves for all work with potential for cuts from sharp edges or pinch points. • Hard hats required for all activities involved with setting up drilling unit. • Steel-toed boots required for all activities involved with setup. • Personnel instructed to lift with legs, not backs, and to ask for assistance with heavy, bulky items.	**L**
	Emergency notification	• Cell phone will be available at all times. Personnel will be trained with respect to emergency numbers for assistance.	**L**
	Environmental release	• Refueling will be conducted over containment.	**L**

AHA-03 Borehole and Monitoring Well Installation

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Electrical shock	• All electrical equipment inspected prior to each use. GFCI will be required for all wiring and/or extension cords.	L
	Defective equipment	• All equipment will be inspected prior to being brought onsite. Prior to each use, personnel will perform pre-inspection to ensure it is safe tooperate. SHSO will also perform routine audits and inspections	L
	Severe weather	• Operations will stop when weather interferes with safety or in event of severe weather. Personnel will move out of work zone and gather at assembly points.	L
	Biological hazards- Bears, mosquitoes, stinging insects	• Don't let food garbage accumulate at the site. Regularly remove potential bear attractants. • Avoid mosquitos and stinging insects by wearing long sleeves. • Inspect well lids and locks for the presence of insects.	L
	Fire	• Proper Fire extinguishers will be available onsite.	L
	Slips, trips, falls	• Good housekeeping requirements will be applied to work areas.	L
	Heat stress	• Personnel will be briefed on signs and symptoms of heat related • illnesses. SHSO will observe for heat related illnesses.	L
	Injury from motorized equipment or moving parts	• Personnel will be aware of location of motorized equipment, especially those with limited visibility. Back-up alarms will be required on equipment. All extremities will be kept clear of moving parts and machinery.	L
	Work zones	• Drilling area will be marked off and set up as an exclusion zone.	L
	Untrained personnel	• Only trained and certified personnel will operate the drilling	L
	Ultraviolet exposure	• Sunscreen is recommended on all areas exposed to the sun.	L
	Noise	• Drilling equipment operator will be required to wear hearing protection when rig is in operation. Other personnel required to wear hearing protection when in work zone.	L

AHA-03 Borehole and Monitoring Well Installation

Equipment to be Used	Training	Inspection
• Protective Gloves • High visibility vest • Vehicle (Truck(s)) • GPS/cellphone • First aid kit • Geoprobe drill rig • Sonic drill rig	• General Construction Worker HAZWOPER 40hr unless escorted • First AID/CPR/AED training • Equipment manual, experienced subcontractors, applicable specific safety training and certification.	• Before each use.

AHA-03 Borehole and Monitoring Well Installation

Analyzed/ Approved By:	Position Or Title	Signature
	Safety and Health Officer	
	Project Manager	

Briefing Record

Print Name	Signature	Date	Print Name	Signature	Date

Attachment 4:

Contractor Corporate Health and Safety Plan

BEM SYSTEMS, INC.

CORPORATE HEALTH AND SAFETY PROGRAM MANUAL

(OSHA PARTS 29 CFR 1910 AND 1926)

Mittul Patel

Vice President/Corporate Health and Safety Manager
BEM Systems, Inc.
July 2018, Revision 07

_____

Mark Nardolillo
President
BEM Systems, Inc.

Date: _____July 5, 2018_____

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Appendix A Incident Reporting Standard Operating Procedure and Form

BEM SYSTEMS, INC.
CORPORATE HEALTH AND SAFETY POLICY

BEM Systems, Inc. (BEM) strives to provide a safe working environment for all employees. This Corporate Health and Safety Program Manual has been developed in accordance with the various Occupational Health and Safety Administration (OSHA) standards deemed applicable to BEM, particularly the Hazardous Waste Operations and Emergency Response Standard, 29CFR1910.120. Additional OSHA standards relevant to work activities normally conducted by BEM, include: the Construction Standards, 29CFR1926, standards on Hazard Communication, Permit-Required Confined Spaces, Isolation of Hazardous Energies (Lockout-Tagout), and USDOT and FAA regulations for environmental sample shipment. This manual was prepared to both define BEM's plan for complying with these regulations, and to assist employees, participating in projects covered under the above regulations, in maintaining safe work practices.

The authority, responsibility, and accountability for safety, as outlined in this Corporate Health and Safety Manual, shall be viewed in the same manner as our business standards regarding quality and productivity.

The BEM corporate health and safety program requires cooperation and mutual commitment between management and each employee. Management intends that the safety program will provide employees with the work place conditions, equipment, materials, and training needed to perform their job function in a safe and efficient manner. Employees are requested to remain familiar with the program and its contents, implement the program, address issues and concerns with the Corporate Health and Safety Manager, and adhere to safe work practices.

Mark Nardolillo
President and CEO

Date: July 5, 2018

BEM SYSTEMS, INC.
CORPORATE HEALTH AND SAFETY PROGRAM

1.0 PURPOSE AND SCOPE

The BEM Systems, Inc. (BEM) Corporate Health and Safety Program has been developed to provide its technical employees with the health and safety procedures necessary to identify, evaluate, and control safety and health hazards, and provide for emergency response during hazardous waste operations in accordance with the following regulations and standards:

- Occupational Health and Safety Administration (OSHA) hazardous waste operations and emergency response (HAZWOPER) worker regulations (29 CFR 1910.120);
- OSHA construction regulations (29 CFR 1926.65);
- Hazard Communication regulations (29 CFR 1910.1200, 29 CFR 1926.59 and portions of 1915, 1917, and 1928);
- U.S. Department of Transportation (USDOT) regulations (HM181/126f); and,
- Applicable industry standards and guidelines such as the most current edition of the ACGIH TLVs® and BEIs® publication.

The Corporate Health and Safety Program incorporates the following:

- The BEM organizational structure, regarding health and safety;
- The comprehensive health and safety work plan;
- The health and safety training program;
- The BEM medical surveillance program;
- BEM health and safety standard operating procedures; and,
- The safety and control plan for emergency procedures.

The Corporate Health and Safety Program is available to BEM's employees, clients, and subcontractors engaged in operations involving hazardous substances; OSHA compliance and inspection personnel; and, personnel of other federal, state, or local agencies with regulatory authority over a site at which BEM is the environmental consultant.

Each employee is expected to accept the responsibility for proper use of health and safety equipment and materials, to follow the work procedures and rules as described herein, and to assist management in identifying and correcting unsafe conditions.

2.0 HEALTH & SAFETY PROGRAM ORGANIZATION AND RESPONSIBILITIES

2.1 Corporate Management

The President of BEM Systems, Inc. has established the Corporate Health and Safety Program and has designated qualified staff to implement it. They are responsible for the implementation of the Corporate Health and Safety Program with guidance from the BEM's Vice President/Corporate Health and Safety Manager (CHSM). The CHSM is responsible for maintaining awareness among the employees that their safety is of the highest priority. The

CHSM is also responsible for allocating the time and resources required for the safe accomplishment of assigned tasks.

2.2 Corporate Health and Safety Manager

The CHSM reports directly to the President. The responsibilities of the CHSM, or the designated Assistant CHSM, include:

- Development, monitoring, and maintenance of the BEM Corporate Health and Safety Program;
- Submission of recommendations to BEM management to improve the quality of the BEM Corporate Health and Safety Program;
- Maintaining currency with evolving applicable government standards, industry standards, and guidance documents and protocols;
- Establishment of training program guidelines to allow employees to perform their jobs in a safe and healthful manner in accordance with the BEM Corporate Health and Safety Program and applicable government regulations, guidance documents, protocols, and industry standards;
- Determining the level and nature of training required by employees for each task assigned;
- Health and safety orientation for new employees;
- Review and dissemination of health and safety information pertaining to changes in federal regulations, or industry specific guidelines particular to the construction/industrial work place;
- Management of the BEM medical surveillance program;
- Suggest acquisition of appropriate health and safety-related equipment;
- Review and approval of all BEM site-specific health and safety plans (HASPs), program specific health and safety templates and, as necessary, BEM subcontractor HASPs; and,
- Direction of the health and safety auditing program to ensure that health and safety policies and procedures are implemented and maintained.

Health and safety orientation for new employees:

- Scheduling of entrance/annual/exit physicals;
- Obtain/maintain health and safety equipment (e.g., respirators, air monitoring equipment, safety glasses);
- Schedule required health and safety training such as construction, Cardio Pulmonary Resuscitation (CPR)/first aid, supervisor, site-specific training;
- Periodic health and safety audits (supplemented by audits by CHSM);
- Coordinate preparation/implementation of regional site-specific health and safety plans;
- Coordinate with CHSM on health & safety-related accidents/incidents;
- Maintenance of health and safety project files; and,
- Coordinate with CHSM on all health and safety-related issues.

2.3 Certified Industrial Hygienist/Certified Safety Professional (CIH/CSP)

The CIH/CSP reviews each HASP as requested by the Project Manager (PM). Modifications, corrections, and additions are then issued to Project Manager for his or her approval. The

CIH/CSP conducts the 8-hour HAZWOPER refresher for all employees who require it. The CIH/CSP also advises the CHSM on other topics of concern such as Ergonomics.

BEM's CIH/CSP is from Phase Associates, LLC:

Mr. Gary Schwartz, CIH, CSP, CMC

Office Phone: 973-597-0750
Mobile Phone: 973-568-7851

2.4 Site Safety Officer

The Project Manager will assign a qualified site safety officer (SSO) for each BEM field project. The SSO will report to the PM and will direct the health and safety activities at each work site.

An SSO is defined by OSHA as "an individual who is located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements" (29 CFR 1910.120(a)(3)).

The OSHA definition of an SSO, along with the responsibilities of the SSO listed below, dictate that BEM personnel designated as SSO's will be required to have eight hours of additional supervisory training beyond the initial 40-hour HAZWOPER training and the annual 8-hour refresher HAZWOPER training.

The primary responsibilities of the SSO are:

- Implement the site-specific HASP;
- Perform on-site health and safety monitoring (e.g., air monitoring, personnel monitoring);
- Supervise and maintain safe work practices during field work;
- Conduct air monitoring and ensure the working conditions of the health and safety monitoring equipment (e.g., PID, FID);
- Verify that the site-specific HASP and program specific templates address site-specific health and safety concerns and recommend changes to the CHSM, as necessary;
- Investigate and report accidents, illnesses, and incidents occurring on a project-related site;
- Conduct daily safety meetings and site-specific training for onsite personnel;
- Transport field personnel with non-life-threatening situations to the hospital, as necessary;
- Call emergency personnel for field personnel with life-threatening situations;
- Order shut down of any project-related site activities upon determination of an imminent health or safety hazard; and,
- Accompany OSHA and other government agency personnel visiting the site in response to health and safety issues, as necessary.

2.5 Employees

Each employee participating in HAZWOPER and/or construction oversight activities is responsible for complying with the requirements of the Corporate Health and Safety Program and the BEM standard operating procedures (SOPs). Personnel required to participate in

fieldwork will adhere to the site-specific health and safety plan and program specific compliance requirements.

Under OSHA, certain employees are required to participate in the medical monitoring and training programs. These employees will accept only those duties for which they have been trained. The medical surveillance program is presented in this Plan.

2.6 Multiemployer Worksites

Safety and health protection and regulatory compliance are incorporated into our standard contract language and purchase order requirements. It is advisable to avoid "directing the work," relating to safety issues. Staff are advised to identify, observe, and question the safety of an uncertain practice and permit the contractor to determine whether they are meeting their contractual obligations and correct the observed deficiency and/or hazard.

If project personnel are exposed to a risk created by a contractor, we have an obligation to act. If a situation is life threatening, the condition must be averted and personnel notified at once. This is a more suitable option from a liability standpoint than owning the entire safety program for all of our contractors. If we were to assume the responsibility for the actions of each contractor under the multi-employer worksite policy, and this then would dramatically increase our liability, our cost, and does not increase our total productivity.

Multi-employer worksites involve personnel from various companies, likely with different corporate structures, operating procedures, and safety values and culture. It is in the best interest of BEM personnel to be aware of contractor and subcontractor work activities that have the potential of causing harm, injury or illness, or project disruption during site activities. If an unsafe behavior or action is observed, it is recommended that the employee inform the responsible party, employee supervisor, or Site Supervisor/PM of the condition. It is not necessary for BEM field personnel to suggest or implement corrective action for other company employees. If the condition persists, and the condition presents an unsafe work environment, contact the PM or CHSM for notification and advisement.

Subcontractors will provide BEM with a task specific construction HASP for the work to be performed and the associated safety procedures. Personnel training and medical clearance/fit testing certificates (as applicable) along with the most recent Experience Modifier Rate (EMR) and OSHA 300 log will be provided and retained in the project files.

2.7 Subcontractors and Visitors

Visitors are required to report to the SSO prior to entering the main site or the various defined work zones. The SSO will document decisions regarding access to the site. If granted limited access, visitors must provide the SSO with proper documentation that shows compliance with the training and medical requirements of this HASP, compliance with other applicable sections, and satisfy additional conditions placed on them as deemed appropriate by the SSO to ensure visitor safety. The SSO will provide site briefing information to all site personnel and visitors. Visitors must sign in and out daily under the SSO’s direction for the duration of their approved visit. Appropriately trained personnel shall escort all visitors throughout the site.

It is important for site personnel to be informed of the applicable project hazards and protective measures. The following items will be included in, but not necessarily be limited to, the site

orientation. The SSO will provide this information to site personnel and document the orientation for the project files.

- Acute and chronic health effects of contaminants of concern, hazard communication program;
- Physical and mechanical hazards;
- Personal hygiene procedures;
- Work zones;
- Personal Protective Equipment (PPE);
- Evacuation plan and assembly area;
- HASP review;
- Air monitoring program; and,
- Hazard recognition, reporting, and site safety.

2.8 Medical Consultant

BEM maintains a medical monitoring program for relevant personnel, in accordance with applicable OSHA regulations. Various regionally specific occupational medical providers have been selected to assist with BEM's Corporate Medical Program to maintain regulatory compliance and ensure the health and wellbeing of our employees. The responsibilities of the medical consultant include:

- Providing medical oversight review of the BEM medical surveillance program;
- Performing annual physicals on BEM employees enrolled in the medical monitoring program;
- Providing entrance and termination exams on employees beginning or ending their employment term with BEM;
- Providing medical clearance documentation for each individual enrolled in the medical surveillance program based on the results of the questionnaire review and the comprehensive physical exam; and,
- Monitoring and reporting the results of the BEM medical surveillance program to the CHSM.

3.0 HEALTH AND SAFETY DOCUMENTATION

Health and safety records will be maintained in a consistent manner that meets both regulatory requirements and company objectives. Project files should maintain an easily retrievable record of project activities with regard to health and safety.

3.1 Responsibilities

The CHSM is responsible for managing and maintaining employee health and safety qualification records, medical records, field exposure assessment and monitoring data, and health and safety training program documentation.

The SSO is responsible for forwarding site-specific health and safety records to the responsible PM for storage in project files.

3.2 Employee Health and Safety Qualification Records

The employee health and safety qualification record will contain the following:

- Medical Qualifications – these records will include a "certification for hazardous waste work and respirator use" issued by the medical monitoring physician and, if necessary, the completed employee release of medical records form. The actual test results are not necessary for inclusion in the employee's safety files.
- Training Records – training records consists of documentation that an employee has completed required health and safety training including OSHA HAZWOPER, USDOT (shipment of hazardous materials), CPR/First Aid/Automatic External defibrillator (AED), client-specific training, etc. Training records are maintained at BEM's Corporate Headquarters.

3.3 Employee Medical Surveillance Records

The employee medical record will contain all records associated with the physician's medical qualification for an employee to perform assigned work, medical monitoring or surveillance records, medical treatment records, and—in the event of an injury—a letter of clearance from the attending physician. Medical records maintenance will be the responsibility of the CHSM. The individual regional medical service providers maintain these records. Access to these records is limited to the employee and their designated representative. Medical records maintenance and privacy information is referenced in OSHA 1910.1020.

3.4 Project Health and Safety Records

Project Health and Safety Records are part of the overall project records will be maintained in project files and corporate health and safety files for each BEM project where employee health and safety information are generated or required, especially employee exposure records.

The Project Health and Safety Record will contain the following information, as applicable:

- Health and safety-related correspondence including memoranda, letters, incident reports, internal or external audit or inspection reports, faxes, written phone conversation summaries, hard copies of e-mail, and similar documentation;
- Project health and safety plan with signatures from personnel involved;
- Health and safety log books;
- Safety data sheets (SDS) and materials specific to an individual project;
- Exposure sampling and air monitoring records which may include air sampling/calibration data sheets, real-time air monitoring data (e.g., PID/FID, O2/LEL, etc.); and,
- Project final report to support potential exposure records for any soil, water or air sampling results.

3.5 Recordkeeping and Record Retention

Records pertaining to specific compliance programs will be maintained according to the requirements indicated in the respective regulations. These records will include, but not be limited to:

- Training agendas and sign-in logs;
- Occupational exposure monitoring;

- Sound level survey monitoring;
- Medical surveillance;
- OSHA injury and illness logs;
- Safety Data Sheets; and,
- Exposure assessment documentation.

4.0 MEDICAL SURVEILLANCE PROGRAM

Potential exposure to toxicants is inherent in hazardous waste operations; therefore, a Medical Surveillance Program is necessary to assess and monitor worker's health and fitness for employment in hazardous waste operations and during the course of work; to provide emergency and other treatment, as necessary; and to keep accurate records for future reference [29 CFR 1910.120(b)(ii)(F)]. Medical surveillance requirements vary depending on the chemical hazards involved and the tasks performed. The corporate health and safety manager has the discretion in determining when and how to implement relevant surveillance procedures.

4.1 Applicability

The medical surveillance program applies to those BEM personnel:

a) Who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits (PELs), above the published exposure levels for those substances without regard to the use of respirators, for 30 days or more per year as required by 29 CFR 1910.120(f)(2)(i); or,
b) Who wear a respirator for 30 days or more a year or as required by 29 CFR 1910.120(f)(2)(ii) and 29 CFR 1910.134; or,
c) Who are injured, become ill, or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation as required by 29 CFR 1910.120 (f)(iii).

The BEM medical surveillance program includes components specified in OSHA regulations (29 CFR 1910.120 and 29 CFR 1926.65) and governmental guidance (National Institute for Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/U.S. Environmental Protection Agency (USEPA), 1985). The medical surveillance program provides the following components:

- Surveillance;
- Baseline medical examination;
- Periodic medical examination and follow-up examinations, as appropriate;
- Termination examination;
- Treatment;
- Emergency;
- Non-emergency (on a case-by-case basis);
- Recordkeeping; and,
- Program review.

4.2 Medical Monitoring

The medical monitoring program consists of two essential components for designated BEM employees:

- Routine medical monitoring (including entrance/baseline, periodic and exit/termination physical exams); and,

Pre-Employment Screening	- Medical history. - Occupational history. - Physical examination. - Determination of fitness to work wearing protective equipment. - Baseline monitoring for specific exposures.
Periodic Medical Examinations	- Yearly update of medical and occupational history; yearly physical examination; testing based on (1) examination results, (2) exposures, and (3) job class and task. - More frequent testing based on specific exposures
Recordkeeping and Review	- Maintain and provide access to medical records in accordance with OSHA and state regulations. - Report and record occupational injuries and illnesses. - Review Site Safety Plan regularly to determine if additional testing is needed. - Review program periodically. Focus on current site hazards, exposures, and industrial hygiene standards.
Termination Examination	This examination may be limited to obtaining an interval medical history of the period since the last full examination (consisting of medical history, physical examination, and laboratory tests) if all three following conditions are met: - The last full medical examination was within the last 6 months. - No exposure occurred since the last examination. - No symptoms associated with exposure occurred since the last examination. If any of these criteria are not met, a full examination is medically necessary at the termination of employment

- Emergency medical care and treatment.

4.2.1 Routine Medical Monitoring

Routine medical monitoring will consist of a basic medical examination and completion of a medical questionnaire to establish the individual's general state of health, baseline physiological data, suitability for assignment, and suitability to utilize respiratory protective equipment. The entrance/baseline examination is completed within 30 days of the start of employment with BEM or 30 days prior to reassignment to a field activity requiring medical monitoring. An exit examination from a previous employer may be substituted for an entrance examination, provided required tests have been completed and the examination results are less than six months old. The annual exam may include additional tests depending on possible field exposure and exposure concerns.

The licensed occupational physician prior to the employee's last working day being employed by BEM will perform termination exams. The employee's supervisor or Human Resources (HR) Manager shall notify the CHSM in order to ensure that the appropriate actions are taken to limit BEM's liability and that the necessary exam parameters are selected. It is pertinent that each employee enrolled in the medical surveillance program receive an exit examination to "close out" their employment term with BEM and that any future exposure not be resultant of, or associated with, being employed by BEM.

Additional exams may be performed at more frequent intervals, if:

- The examining physician determined that more frequent examinations are warranted;
- Regulatory standards require additional testing;

OR

An employee has:

- Developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards;
- Been injured; or,
- Been exposed to toxicants above the PEL or published exposure levels in an emergency situation as determined by the CHSM.

The baseline and exit examination given to BEM personnel enrolled in the medical monitoring program typically consists of:

A. Detailed, self-administered health questionnaire (including respiratory protection use and asbestos work) reviewed with the patient by the examining physician.
B. Complete physical evaluation, including neurological examination.
C. Laboratory tests including:
    1. Hematology
    2. Urinalysis
    3. Chest x-ray – Standard 14 x 17-inch posterior-anterior exposure. The film will be read or reviewed by a board-certified radiologist or equally competent medical specialist. Subsequent periodic chest X-rays will be performed only when clinically indicated and not as a routine measure.
    4. Pulmonary function tests. Measures forced expiratory volume in one second (FEV1) and forced vital capacity (FVC).

5. Audiometry
6. Vision screening (optional)
7. EKG (as determined by the physician's review of the medical questionnaire, the employee's work load, and current physical condition).

Annual chest x-rays are performed only on those persons with potential asbestos exposure at or above the permissible exposure limit for a combined 30 days or more per year as per OSHA regulations (29 CFR 1910.1001 and 1926.1101). Pulmonary function tests may be performed depending on the Medical Consultant advice. Particularly if the employee patient will be wearing a respirator.

Diagnostic tests will be performed by a licensed hospital or clinical laboratory that participates in a proficiency testing program(s) and maintains a rigorous quality assurance program. These laboratories will be able to provide additional tests that might be essential.

Special medical tests may also be required based on potential exposure to specific toxicants in the work environment, by the medical history or conditions of the person examined, or as required by federal, state, or local health and safety regulations. The Medical Consultant, in coordination with the CHSM, shall determine what special medical tests are appropriate and the manner in which these exams will be conducted based on the physician's review of the medical questionnaire and the employee's work activities.

4.2.2 Emergency Medical Care

The site-specific HASP addresses emergency medical care and treatment of BEM personnel, including possible exposure to toxicants and injuries due to accidents or physical problems. Medical provisions are to be included in a site-specific HASP, as defined in the Corporate Health and Safety Program.

During preparation of the site-specific HASP, the preparer should determine if the local health care facility could provide care and treatment of personnel working at a potential hazardous waste site. A map and clear written directions for locating the facility will be included in the HASP along with the name, address, and phone number of the facility. The map and directions should be prominently posted in the field vehicle or trailer (support zone) and a copy of the map be maintained in the designated emergency vehicle. In addition, emergency telephone numbers should be prominently posted in the trailer listing police, fire, ambulance, poison control center, and state/federal/facility emergency response unit.

The SSO is responsible for ensuring that any site employee requiring medical care due to injury or illness receives emergency medical care by a qualified and trained emergency medical technician. BEM personnel requiring emergency medical treatment will not be permitted to resume work activities without a physician's written release.

4.3 Responsibility

The CHSM is responsible for maintaining the medical surveillance program and has the following responsibilities:

- Designate all employees who shall participate in the medical monitoring program;
- Retain qualified occupational physician(s) to conduct necessary medical examinations;

- Obtain a written statement from the examining physician indicating the employee's availability for assignment for various field activities, including but not limited to, suitability to use a respirator;
- Maintain copies of the physician's statement for all employees participating the medical surveillance program and ensure compliance with all medical retention requirements;
- Ensure that all personnel medical examinations are conducted within the prescribed time frame;
- Review the employee roster annually to ensure that all appropriate personnel are participating in the medical monitoring program;
- Coordinate with HR on medically-related issues for record-keeping purposes; and,
- Assure that original medical records for BEM personnel are maintained by BEM for the time period of the duration of employment plus 30 years (29 CFR 1910.1020).

4.4 Confidentiality

The information contained in the employee medical files will be available only to current and former BEM employees, their designees, the medical consultants, and examining and consulting physicians and staff according to HIPAA industry standards. Employee medical files include:

- Original medical records;
- Physician's clearance statement;
- Disclosure agreements; and,
- Requests for copies of medical records for employees.

4.5 Medical Records Information

Information requested in the medical/occupational history questionnaire will provide the examining and consulting physician(s), employers and Health and Safety information on the general health status and establish the medical/occupational history of an individual. These forms will be completed by all designated personnel prior to their exam and will be kept as part of the employee's medical record.

5.0 TRAINING

5.1 Applicability

BEM personnel working on sites that may be in relative proximity to hazardous substances, health or safety hazards shall receive training as outlined in Section 5.2 before they are permitted to engage in site-specific operations that may result in potential exposure to hazardous substances, safety, or health hazards. Employees will not be permitted to participate in, or supervise, field activities until they have been trained to the level required by their job function and responsibility.

5.2 Required Training Elements

BEM technical personnel will undergo training for hazardous waste operations to include the elements listed below, in accordance with 29 CFR 1910.120(e)(2). In addition, certain BEM personnel will be trained in lead and asbestos procedures, in accordance with OSHA regulations 29 CFR 1910.1025 and 29 CFR 1910.1001.

- Names of designated personnel and alternates responsible for health and safety;
- Safety, health, and other recognized or potential hazards present on the site;
- Use of PPE;
- Work practices to minimize risks from hazards;
- Safe use of engineering controls and equipment on site;
- Medical surveillance requirements, including recognition of symptoms and signs, which might indicate overexposure to hazards;
- Decontamination procedures;
- Emergency response plans;
- Confined space entry procedures;
- Spill containment and contingency programs;
- CPR/First Aid/Bloodborne Pathogens; and,
- Hazard recognition and control.

BEM personnel will receive annual refresher training, in accordance with OSHA regulations to ensure that employees are:

- Aware of the hazards of their jobs and able to perform their work in a manner that reduces the risk and ensures their health and safety within reasonable limitations;
- Aware of BEM's concern for the health and safety of other workers, the public and the environment;
- Aware of, and compliant with, current applicable laws, rules, and regulations; and,
- Knowledgeable about their tasks to enable employees to perform their job functions safely as well as respond correctly to emergency situations.

5.3 40-Hour HAZWOPER Training

BEM employees engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards will receive a minimum of 40 hours of classroom instruction and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor (29 CFR 1910.120 (e)(3)).

Training will include, but is not limited to, those items listed in Section 5.2.

5.4 24-Hour HAZWOPER Training

Employees that are onsite for a specific task and are unlikely to be exposed over the OSHA PELs or published exposure limits (e.g., Threshold Limit Values) if no PELs exist, will receive a minimum of 24 hours training and one day of actual field experience under the direct supervision of a trained, experienced supervisor as defined by 29 CFR 1910.120 (e)(3)(ii).

OR

Employees on sites that have been fully characterized indicating that exposures are under PELs or published exposure limits, where respirators are not necessary, and the characterization indicates that there are no health hazards or possible emergency situations for hazardous materials, will receive 24 hours of instruction off the site and one day actual field experience under the direct supervision of a trained, experienced supervisor as defined by 29 CFR 1910.120 (e)(3)(iii).

5.5 8-Hour Annual Refresher Training

Designated BEM employees will ideally receive 8-hour refresher training within 30 days of the one-year anniversary of their initial 40-hour training, 24-hour training, or their previous 8-hour refresher training, as applicable. The training will review the items presented in the 40-hour training, critique of incidents that occurred in the past year, and other relevant topics as defined by 29 CFR 1910.120 (e)(8). BEM employees will receive the 8-hour annual refresher training in house, through an experienced training provider, or via the internet, as feasible. A certificate will be presented to the employee upon completion and a copy maintained in their respective safety files.

5.6 8-Hour Supervisor Training (per project and scope)

According to OSHA, the definition of a supervisor is "the individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements" as defined by 29 CFR 1910.120(a)(3).

As warranted by the project, BEM employees directly responsible for or who supervise employees engaged in hazardous waste operations shall complete at least eight additional hours of specialized supervisory training at the time of job assignment. This additional training as defined by 29 CFR 1910.120(e)(4) will include, but is not limited to:

- BEM Corporate Health and Safety Program;
- BEM Training program;
- PPE selection;
- Accident prevention and investigations;
- Direct and indirect costs associated with accidents, injuries, and property damage;
- Spill containment program; and,
- Health hazard monitoring procedures and techniques.

Upon completion of the 8-hour supervisor training, employees will receive a certificate.

5.7 First Aid/CPR/AED

Whenever feasible, or required by contract, select BEM personnel will be trained in community or workplace first aid and CPR. Training will be conducted by qualified, licensed instructors and cover basic life support and proper procedures for stabilizing an individual in the field, bloodborne pathogen protection, potential liability, and personal protection.

5.8 Confined Space Entry

As necessary, specific BEM personnel will receive confined space entry training that will meet the requirements to ensure a safe working environment within and around confined space operations by evaluating confined space hazards, implementing necessary controls, and regulating employee entry into confined spaces, in accordance with 29 CFR 1910.146, "Permit-Required Confined Spaces." It is the responsibility of the BEM PM to inform the CHSM if confined space entry procedures and associated training is required for a particular job/task.

5.8.1 Confined Space Training Program Requirements

Training in confined space entry will be provided to each affected employee:

1. Before the employee is first assigned duties for confined space entry;
2. Before there is a change in assigned duties;
3. Whenever there is a change in permit space operations that present a hazard in which the employee has not been previously trained;
4. If the employer has reason to believe that there are deviations from the permit space entry procedures (as required in 29 CFR 1910.146 (d)(3)) or there are inadequacies in the employee's knowledge or use of these procedures; and,
5. Training shall establish employee proficiency in the duties required under the regulation and introduce new or revised procedures as necessary.

BEM personnel will receive confined space entry training from qualified personnel.

5.9 Asbestos

Under the OSHA Asbestos Regulations (29 CFR 1926.1101 and 29 CFR 1910.1001), BEM will provide a training program for employees who are exposed to airborne concentrations of asbestos at or above the PELs and/or excursion limits prior to or at the time of initial assignment and annually thereafter.

5.9.1 Applicability

BEM employees conduct asbestos sampling for general air quality characterization purposes only. BEM does not conduct site characterizations to identify asbestos nor does BEM enter asbestos work zones. BEM may subcontract these tasks as well as remedial tasks to subcontractors who are certified by regulatory agencies as required for individual job sites.

BEM subcontractors may perform oversight duties for the following activities:

- Class I asbestos work involving the removal of asbestos containing thermal surface insulation and surfacing asbestos-containing materials (ACMs);
- Class II asbestos work involving the removal of non-thermal system insulation (TSI) or surfacing material such as wallboard, floor tiles, etc.; and,
- Class III asbestos work where ACM is likely to be disturbed.

5.10 Crystalline Silica

Under the OSHA Crystalline Silica Regulations (29 CFR 1926.1153), BEM will provide a training program for employees who are exposed to airborne concentrations of Crystalline Silica at or above the PEL and/or excursion limits prior to or at the time of initial assignment and every year thereafter. Additionally, BEM shall use engineering and work practice controls to reduce and maintain employee exposure to respirable crystalline silica to or below the PEL, unless BEM can demonstrate that such controls are not feasible. Wherever such feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PEL, BEM shall nonetheless use them to reduce employee exposure to the lowest feasible level and shall supplement them with the use of respiratory protection that complies with 29 CFR 1910.134.

5.10.1 Applicability

BEM employees have the potential for Crystalline Silica exposure under the following scenarios:

- Abrasive sand blasting
- Rock/ well drilling
- Heavy machinery running on construction sites
- Concrete or brick drilling, grinding, crushing, cutting and sawing
- Tunneling operations

5.11 Lead

The lead training program will provide the necessary information to satisfy the environmental and construction lead standards (29 CFR 1910.1025 and 29 CFR 1926.62, respectively) for any BEM employee that may be occupationally exposed to lead. BEM employees have the potential for lead exposure under the following scenarios:

- Sampling of lead-based paint for characterization purposes;
- Soil sampling or active removal of soils suspected or verified to contain lead dust; and,
- Oversight duties on any lead abatement project or during demolition of materials with lead-based paint.

5.11.1 Applicability

The following activities constitute a partial list of regulated operations that are applicable to BEM personnel:

- Demolition or salvage of structures where lead or materials containing lead are present;
- Removal or encapsulation of materials containing lead;
- Lead contamination/emergency cleanup;
- Site operations involving hot work (welding, cutting, brazing) on lead coated structures or materials; and,
- Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed.

5.11.2 Lead Training Program Requirements

If an employee is involved in oversight of activities listed in Section 5.10.1, the employee will be trained in accordance with the regulations for lead. Training will commence within 180 days from the effective date employees are covered and will include:

- An overview of the OSHA lead regulations;
- The specific nature of the operations which could result in exposure to lead above the action level of 0.03 mg/m^3;
- The purpose, proper selection, fitting, use, and limitations of respirators;
- The purpose and description of the medical surveillance program and a discussion of adverse health effects;
- Engineering controls and work practices associated with the employee's job assignment;
- Contents of any compliance plan in effect; and,
- Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed occupational physician.

BEM employees will not engage in activities described in Section 5.11.1 without first receiving lead training, as outlined in OSHA regulations (29 CFR 1926.62 and 29 CFR 1910.1025).

5.12 Hexavalent Chromium

The chromium training program will provide the necessary information to satisfy the environmental and construction standards (29 CFR 1910.1026 and 29 CFR 1926.353 and 1926.1126) for any BEM employee that may be occupationally exposed to hexavalent chromium. BEM employees have the potential for chromium exposure under the following scenarios:

- Soil sampling or active removal of soils suspected or verified to contain hexavalent chromium;
- Oversight duties on any chromium abatement project or during demolition of materials with chromium contamination; and,
- Oversight duties of operations with welding, torch cutting, or other heating of metals, particularly where a chrome finish may be present.

5.12.1 Applicability

The following activities constitute a partial list of regulated operations that are applicable to BEM personnel:

- Removal or encapsulation of materials containing hexavalent chromium;
- Hexavalent chromium contamination/emergency cleanup;
- Site operations involving hot work (welding, cutting, brazing) on chrome coated structures or materials; and,
- Transportation, disposal, storage, or containment of materials containing hexavalent chromium on the site or location at which construction activities are performed.

5.12.2 Chromium Training Program Requirements

If an employee is involved in activities listed in Section 5.11.1, the employee will be trained in accordance with the regulations for hexavalent chromium. Training will commence within 180 days from the effective date employees are covered and will include:

- An overview of the OSHA hexavalent chromium regulations;
- The specific nature of the operations that could result in exposure to hexavalent chromium above the action level of 2.5 micrograms per cubic meter (2.5 ug/m3);
- The purpose, proper selection, fitting, use, and limitations of respirators;
- The purpose and description of the medical surveillance program and a discussion of adverse health effects;
- Engineering controls and work practices associated with the employee's job assignment;
- Contents of any compliance plan in effect; and,
- Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed occupational physician.

BEM employees will not engage in activities described in Section 5.11.1 without first receiving hexavalent chromium training, as outlined in OSHA regulations 29 CFR 1910.1026 (l), communication of chromium (VI) hazards to employees, and 29 CFR 1910.1200 Hazard Communication Standard.

5.13 Hazard Communication

5.13.1 Purpose

The purpose of this section is to ensure that the hazards of all chemicals produced or imported are evaluated and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of a comprehensive hazard communication program, which include container labeling and other forms of warning, safety data sheets, and employee training.

5.13.2 Scope

The Hazard Communication program applies to operations where employees may have potential exposure to hazardous materials/chemicals as a result of their normal jobs/duties under 29 CFR 1910.1200 and 29 CFR 1926.59. Materials NOT covered by this program include:

- Pesticides defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 USC 136 et seq.);
- Chemical substances or mixtures defined under the Toxic Substances Control Act (15 USC 2601 et seq.);
- Food, food additive, color additive, drug, cosmetic, or medical or veterinary device or product;
- Any distilled spirits;
- Any consumer product or hazardous substance as defined under the Consumer Product Safety Act (15 USC 2051, et seq.);
- Any hazardous waste as defined by the Solid Waste Disposal Act and amended by the Resource Recovery Conservation Act (RCRA) (42 USC 6901 et seq.);
- Any hazardous substances as defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC 9601 et seq.) when the hazardous substance is the focus of a remedial or removal action;
- Tobacco or tobacco products; or,
- Wood or wood products.

5.13.3 Responsibilities

Under the Hazard Communication Program, individuals within the company have responsibilities, which are outline below:

President/Vice President – Provide management support and corporate commitment for program implementation and communication.

PM – Inform CHSM of potential hazardous materials associated with field activities at the site.

CHSM – Develop, implement, and ensure compliance with the Hazard Communication and Safety Manager Standard and program. Provide Safety Data Sheets (SDS) to the offices/jobsites upon request. Keep current with regulation changes and relay changes to staff. Maintain up-to-date SDS and inventory at each office with the assistance of the designated Regional Health and Safety Officer. Train employees on proper use and handling of hazardous materials. Review the Hazard Communication program annually and update it as necessary.

SSO – Notify and advise contractors and subcontractors of the site-specific program. Keep an up-to-date file of SDS & make them available on request to site personnel. Maintain proper labeling on containers.

Employee – Use proper PPE as required by standards, policies and SDS. Know location of emergency equipment. Inform supervisors of potential hazardous situations/events.

5.13.4 Hazard Communication Methods

OSHA has outlined various methods by which information on hazardous materials is conveyed. These methods include:

1. Labels/Hazard Identification System
   - The primary means of warning employees about products; and,
   - As of June 1, 2015, all labels will be required to have pictograms, a signal word, hazard and precautionary statements, the product identifier, and supplier identification.
2. Safety Data Sheets
   - As of June 1, 2015, SDSs must be in uniform format and include the section numbers, the headings, and associated information under the headings below:
     - Section 1, Identification: includes manufacturer name, address, phone number, emergency phone number, recommended use, restrictions on use;
     - Section 2, Hazard(s) identification: includes all hazards regarding the chemical, required label elements;
     - Section 3, Composition/information on ingredients: includes information on chemical ingredients, trade secret claims;
     - Section 4, First-aid measures: includes important symptoms/effects, required treatment;
     - Section 5, Fire-fighting measures: lists suitable extinguishing techniques, equipment, chemical hazards from fire;
     - Section 6, Accidental release measures: lists emergency procedures, protective equipment, proper methods of containment and cleanup;
     - Section 7, Handling and storage: lists precautions for safe handling and storage, including incompatibilities;
     - Section 8, Exposure controls/personal protection: lists OSHA's Permissible Exposure Limits (PELs), Threshold Limit Values (TLVs), appropriate engineering controls, personal protective equipment (PPE);
     - Section 9, Physical and chemical properties: lists the chemical's characteristics;
     - Section 10, Stability and reactivity: lists chemical stability and possibility of hazardous reactions; and,
     - Section 11, Toxicological information: includes routes of exposure, related symptoms, acute and chronic effects, numerical measures of toxicity.
   - Copies shall be retained at each office or worksite (i.e., attached to the site-specific health and safety plan for field locations). You may also find current Safety Data Sheet information at (https://iaspub.epa.gov/sor_internet/registry/substreg/LandingPage.do) or (https://chemicalsafety.com/sds-search/)

- Primary source of information utilized in training of employees in the physical/chemical hazards of site materials.

3. Subcontractors
   - Subcontractors should be informed of potential exposures by reviewing the applicable SDS.
   - Subcontractors should likewise submit a list of hazardous materials and SDS if BEM employees have the potential for exposure or are handling the materials.
4. Employee Information and Training
   Curriculum covers:
   - Labeling system;
   - SDS availability & interpretation;
   - Hazard communication standard & program;
   - Review of hazardous materials/chemicals;
   - Use of PPE; and,
   - Storage & handling procedures.

5.13.5 Procedures – Hazardous Materials Identification System

There are three systems used to identify hazards:

1. National Fire Protection Association (NFPA) 704 M System
   - Used on small containers and storage tanks (fixed facility)
   - Identifies health, flammability, reactivity hazards, and special considerations
   - A standardized system which uses numbers & colors to define hazards
2. USDOT Hazardous Materials 181 System
   - Required by 49 CFR Parts 107, 171-180, and 390-397
   - Used exclusively on containers & tanks transported in interstate commerce
   - A standardized system which also uses numbers & colors to define hazards
   - Placards identify materials by a class system of numbers and colors

The system used on chemical containers used by BEM is the NFPA 704 M system:



BLUE – HEALTH HAZARD

4 Very short exposure could cause death/major injury.
e.g., acrylonitrile, bromine, parathion

3 Short exposure could cause temporary injury
e.g., aniline, sodium hydroxide, sulfuric acid

2 Materials with intense, continuous, but not chronic exposure could cause incapacitation or possible residual injury or illness.

1 Exposure would cause irritation and minor injury.
e.g., acetone, methanol

0 Exposure under fire conditions would offer no unusual hazard



WHITE – SPECIAL INFORMATION

Designated for special information about the chemical (e.g., radioactive, water reactive)

RED – FLAMMABILITY HAZARD

4 Burn easily and
(1) Vaporize at normal temperatures & pressures or
(2) Disperse in air
e.g., 1,3-butadiene, propane, ethylene



3 Can be ignited under almost all ambient conditions
e.g., phosphorous, acrylonitrile



2 Shall be heated or exposed to high ambient temperatures before ignition can occur.
e.g., 2-butanone, kerosene

1 Shall be preheated before ignition can occur. e.g., sodium, red phosphorous

0 Will not burn

YELLOW – REACTIVITY HAZARD

4 Capable of detonation, explosive decomposition or reaction at normal temperatures & pressures
e.g., benzoyl peroxide, picric acid

3 (1) Capable of detonation or explosive reaction with an initiating source;
(2) shall be heated before ignition; or,
(3) react explosively with water.
e.g., diborane, ethylene oxide, 2-nitropropadene



2 (1) Normally unstable & will readily undergo violent chemical change (not detonation);
(2) may react violently with water; or,
(3) may form potentially explosive mixtures with water.
e.g., acetaldehyde, potassium

1 Materials normally stable but which can
(1) become unstable at high temperatures; or,
(2) react with water with release of energy but not violently.
e.g., ethyl ether, sulfuric acid

0 Normally stable, even with exposure to fire & does not react with water.

3. OSHA Hazard Communication Standard

As of June 1, 2015, the Hazard Communication Standard (HCS) will require pictograms on container labels to alert users of the chemical hazards to which they may be exposed. Each pictogram consists of a symbol on a white background framed within a red border and represents a distinct hazard(s). The pictogram on the label is determined by the chemical hazard classification.

HCS Pictograms and Hazards

Health Hazard



- Carcinogen
- Mutagenicity
- Reproductive Toxicity
- Respiratory Sensitizer
- Target Organ Toxicity
- Aspiration Toxicity

Flame



- Flammables
- Pyrophorics
- Self-Heating
- Emits Flammable Gas
- Self-Reactives
- Organic Peroxides

Exclamation Mark



- Irritant (skin and eye)
- Skin Sensitizer
- Acute Toxicity
- Narcotic Effects
- Respiratory Tract Irritant
- Hazardous to Ozone Layer (Non-Mandatory)

Gas Cylinder



- Gases Under Pressure

Corrosion



- Skin Corrosion/Burns
- Eye Damage
- Corrosive to Metals

Exploding Bomb



- Explosives
- Self-Reactives
- Organic Peroxides

Flame Over Circle



- Oxidizers

Environment



- Aquatic Toxicity

Skull and Crossbones



- Acute Toxicity (fatal or toxic)

5.14 Overview of USDOT Regulations

The requirements necessary for shipment of hazardous materials are outlined under the USDOT regulations (49 CFR 171-178). BEM personnel do not ship hazardous materials but may conduct oversight of subcontractors performing this task. BEM personnel do ship environmental samples and the following sections explain the proper shipment techniques.

5.14.1 Environmental Samples Versus Hazardous Materials Samples

Samples collected are classified as either environmental or hazardous materials samples. In general, environmental samples are collected from streams, farm ponds, small lakes, wells, and soils that are not expected to be contaminated with hazardous materials. Samples of highly contaminated on-site soils or water, and materials collected from drums, bulk storage tanks, obviously contaminated ponds, impoundments, lagoons, pools, and leachates from hazardous waste sites are considered hazardous materials samples. Samples of product are to be considered as hazardous. A distinction shall be made between the two types of samples in order to:

- Determine the appropriate USDOT procedures for transportation of samples. If there is any doubt, a sample should be considered hazardous and shipped accordingly.
- Protect the health and safety of laboratory personnel receiving samples. Special precautions are used at laboratories when samples other than environmental samples are received.

5.14.2 Environmental Samples

Environmental samples may be packaged and shipped according to the following procedures.

PACKAGING

Environmental samples shall be packaged according to the following procedure:

- Place sample container, properly identified with a sealed lid in a polyethylene bag and seal the bag.
- Place sample in a USDOT-approved fiberboard container or rigid cooler that has been lined with a large polyethylene bag.
- Pack container with enough noncombustible, absorbent, cushioning material to minimize the possibility of the containers breaking, and to absorb any material that may have leaked from the sample jars. Vermiculite is recommended.
- If there are multiple samples, make certain that there is sufficient cushioning material between the sample containers (each in its individual polyethylene bag) to prevent breakage due to dropping or severe shock.
- Seal large bag, add more absorbent if necessary.
- Seal outside container with duct tape or strapping tape.

Environmental samples may be packaged following the procedures outlined below for samples classified as "flammable liquids."

Before any samples are placed in their final shipping containers, the exterior of sample containers should be wiped clean with a detergent solution.

MARKING/LABELING

Sample containers shall have a completed sample identification tag and the outside container shall be marked "Environmental Sample(s)." The appropriate side of the container shall be marked "This End Up" and arrows should be drawn accordingly. No USDOT marking and labeling are required. Assure that all sample containers are labeled identically to the labeling on the shipping container.

SHIPPING PAPERS

No USDOT shipping papers are required.

TRANSPORTATION

There are no USDOT restrictions on mode of transportation. An overnight carrier is recommended.

CHAIN OF CUSTODY

Chain of custody documentation may be required depending upon the requirements of the project.

5.14.3 Hazardous Material Samples

Samples not determined to be environmental samples or samples known or expected to contain hazardous substances shall be considered hazardous material samples and transported according to the following requirements:

KNOWN MATERIALS

If all the hazardous material in the sample is known or can be accurately identified, it is packaged, marked, labeled, and shipped according to the specific instructions for that material as

detailed in the USDOT Hazardous Materials Table 49 CFR 172.101 (see attached "USDOT Chart 9").

UNKNOWN MATERIALS

- For samples of hazardous substances of unknown content, the appropriate transportation category is selected through a process of elimination. While it is probable that most unknown hazardous materials samples shipped by personnel will not contain radioactive materials or "Poison A" materials (e.g., hydrocyanic acid, nitrogen tetroxide), it is essential that a gradient hierarchy be considered (see attached Table I).
- If radiation survey instruments demonstrate, or reasonable probability exists, that the unknown hazardous sample is radioactive, the appropriate USDOT shipping regulations for "radioactive material" shall be followed. Contact the CHSM.
- If the radioactive material category is eliminated, it shall then be considered that the sample contains "Poison A" material. USDOT defines "Poison A" as an extremely dangerous poisonous gas or liquid of such a nature that a very small amount of gas, or vapor of the liquid, will be dangerous to life. Most "Poison A" materials are gases and would not be found in glass or "drum-like" containers. All samples taken from closed containers do not have to be shipped as "Poison A's." Based upon information available, a judgment shall be made whether a sample from a closed container is a "Poison A."
- If "Poison A" is eliminated as a shipment category, the next two classifications are "flammable' or "nonflammable" gases. Since an open container is not expected to contain a significant amount of gas, "flammable liquid" would be the next applicable category. With the elimination of radioactive material, "Poison A," "flammable gas" and "nonflammable gas," the sample can be classified as "flammable liquid," and shipped accordingly.
- These procedures would also suffice for shipping any other samples classified flammable liquids in the USDOT classification table.
- For samples containing unknown material, other classifications listed below flammable liquid are generally not considered. In order to eliminate classifications that appear below flammable liquid, a flashpoint test is required. Flashpoint testing is impractical and possibly dangerous. Thus, unless the sample is known absolutely to be a material or have a classification that is classified below flammable liquid, it is considered a flammable liquid and shipped as such.

5.14.4 Packaging Samples Classified as Flammable Liquid

Applying the words "flammable liquid" to a sample does not necessarily mean that it is in fact flammable or liquid. Rather, it prescribes the class of packaging to be used pursuant to USDOT regulations. This is permitted under 49 CFR Part 172.402h. As a matter of practice, all hazardous samples are to be shipped as "Flammable Liquids" unless an exception is granted or a higher hazardous materials classification applies.

SHIPMENT OF FLAMMABLE LIQUID

The following instructions shall apply for shipment of a flammable liquid by cargo carrying aircraft, rail car or other common carrier.

- Collect the sample in a glass or polyethylene container no larger than 16 fluid ounces with a non-metallic, Teflon-lined screw cap. To prevent leakage, fill container no more than 90

percent full. If an air space in the sample container would affect sample integrity (for example, the case of a VOC vial), place that container with a second container to meet the 90 percent requirement.

- Before any samples are placed in the final shipping container, the exterior should be wiped clean with detergent solution.
- Complete sample identification tag and attach securely to sample container. The sample identification tag shall contain information needed to trace the sample to its point of origin and to the sample taker as well as any quality assurance/quality control information.
- Seal container and place in 2-mil thick (or thicker) polyethylene bag, one sample per bag. Position identification tag so it can be read through bag. Seal bag.
- Place sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape or other positive means to secure can lid.
- Place one or more metal can(s) into a strong outside container such as a picnic cooler or a USDOT approved fiberboard box. Surround cans with noncombustible, absorbent, cushioning material for stability during transport. Total sample volume in the picnic cooler or fiberboard box shall not exceed ten gallons. A separate Air Bill and Shipping Declaration shall be processed for each container or combination of containers such that the total sample volume on any air bill will not exceed ten gallons.

CHAIN OF CUSTODY

Include a chain of custody record, properly executed, in the outside container if it is anticipated that sample analysis will be used in litigation.

SHIPMENT BY LAND

The following instructions shall apply for land shipment of sample by car or truck (not by common carrier).

- The instructions above for flammable liquids shall apply.
- Additionally, sample containers are firmly secured such that they will not bounce against sides of the vehicle during transit or in the event of accident.
- Limit shipments to 1,000 pounds or less. Under 1,000 pounds, there are no placarding requirements (49 CFR 172.504 (c) (1)).

MARKING AND LABELING SAMPLES CLASSIFIED AS FLAMMABLE LIQUID

- Use abbreviations only where specified.
- Place the following information on each paint can:
- Laboratory name and address.
- “Flammable Liquid, NOS UN1993.” The designation “NOS” means “Not Otherwise Specified.” Use an approved USDOT label.
- “Dangerous When Wet” shall be used if the material is water reactive.
- Information placed on cans shall also be placed on at least one side of the outside shipping containers. If labeling is placed on more than one side, it shall be affixed to all visible sides.
- “Cargo Aircraft Only” shall be used on all outside shipping containers.

- Print "Laboratory Samples" and "This End Up" or "This Side Up" clearly on top of the outside shipping container. Outside containers shall also contain the statement "Inside packages comply with prescribed specifications." Put upward pointing arrows on all four sides of container.

SHIPPING PAPERS

Shipping papers shall be provided for shipment of all samples (including those land carried by rental or personal car).

BILL OF LADING/CERTIFICATION STATEMENT

Complete bill of lading and sign certification statement (if carrier does not provide, use standard industry form). Provide the following information in the order listed. One form may be used for more than one outside container.

- "Flammable Liquid, NOS UN1993."
- "Limited Quantity" (or Ltd. Qty.).
- Net weight or net volume (weight or volume may be abbreviated) just before or just after "Flammable Liquid, NOS UN1993."
- Further descriptions such as "Laboratory Samples" are allowed if they do not contradict required information.
- BEM personnel shall not sign or approve shipment of materials or waste generated by a client or site contractor.

TRANSPORTATION

- Transport unknown hazardous material samples classified as flammable liquids or solids by rented or common carrier truck, railroad, express overnight package services, or as appropriate.
- Do not transport by any passenger-carrying air transport system. Ship only by airlines that carry cargo only (i.e., Federal Express, Airborne, etc.).

5.14.5 Exceptions for Small Quantities

SMALL QUANTITY REQUIREMENTS

If the sample is a hazardous material, the next step is to determine if the quantity is regulated by the DOT. The regulations in 49 CFR Part 173.4 state that small quantities are not subject to the DOT regulations if:

- The maximum quantity of sample per container is limited to:
  - 30 ml for liquids
  - 30 g (1 oz) for solids,
- The container is plastic with a minimum thickness of 0.2 mm, earthenware, glass or metal
- Each container has its top held securely in place with wire, tape, or other positive means
- The completed package is capable of sustaining free drop tests as specified in 49 CFR Part 173.4 (a)(6) and a compressive load as specified in 49 CFR Part 178.606 (c)l
- The weight of the completed package does not exceed 64 pounds; and,
- The outside of the package is marked:

"This package conforms to conditions and limitations specified in 49 CFR Part 173.4."

Environmental samples packaged for transport by BEM field personnel will generally not be subject to the USDOT regulations because the samples will either not contain sufficient concentration of a regulated material or will not be sufficient quantity to subject the sample to regulation. However, certain requirements established by the USDOT may be applicable, specifically for polychlorinated biphenyls contaminated material.

Table 1 DOT Hazardous Materials Classification (49 CFR 173.2) Listed in Order of Descending Hazard

1	Radioactive Material.
2	Poison A.
3	Flammable Gas.
4	Nonflammable Gas.
5	Flammable Liquid.
6	Oxidizer.
7	Flammable Solid.
8	Corrosive Material (liquid).
9	Poison B.
10	Corrosive Material (Solid).
11	Irritating Material.
12	Combustible Liquid (in Containers having Capacities Exceeding 110 Gallons).
13	ORM-B (Other Regulated Materials - Series B).
14	ORM-A (Other Regulated Materials - Series A).
15	Combustible Liquid (in Containers having Capacities of 110 Gallons or Less).
16	ORM-E (Other Regulated Materials - Series E).

The following phone numbers are provided as an information source regarding the classification, health effects, and emergency procedures for hazardous materials:

Information Sources

Emergencies	
National Response Center	800-424-8802
Bureau of Explosives (Association of American Railroads)	202-639-2222
Regulatory/Technical	
EPA Superfund and RCRA Hotline	800-424-9346
EPA Toxic Substances Control Act Hotline	202-554-1404
EPA Safe Drinking Water Act Hotline	800-426-4791
EPA Chemical Emergency Preparedness Program/Community Right to Know Hotline	800-535-0202
EPA Asbestos Technical Information Center	800-334-8571 Ext. 6741
EPA Radon Technical Information Center	800-334-8571 Ext. 7131
Centers for Disease Control, Agency for Toxic Substances and Disease Registry	404-329-3311
OSHA Technical Data Center	202-523-9700 202-382-3648
Department of Transportation Hotline	202-426-2075
FEMA/DOT Hazardous Materials Information Clearinghouse	202-366-4900
National Pesticide Information System	800-845-7633
Bureau of Alcohol, Tobacco & Firearms	800-424-9555
US Department of Commerce, Weather Div.	704-259-0682
Halogenated Solvents Industry Alliance	800-332-HSIA
American Petroleum Institute	202-682-8000
Chemical Manufacturers Association	202-887-1100
Chemical Manufacturers Association	202-887-1100
Chemical Referral Center	800-CMA-8200
Spill Control Association of America	313-552-0500

5.14.6 Shipping Field Monitoring Equipment

Field monitoring equipment, specifically FID's, shall have excess hydrogen gas removed from the meter's storage cylinders. FID's will not be shipped with hydrogen gas remaining inside the meter. If hydrogen or other hazardous gases are to be shipped, the appropriate labeling, shipping forms, and packaging shall be used to comply with applicable USDOT regulations and signed by an authorized employee.

5.15 Site-Specific Training

Site-specific training may be necessary and/or required for certain clients (e.g., railroad safety, launch complex safety training, etc.). The CHSM or PM will arrange to implement this training and maintain record of such training for the appropriate personnel.

6.0 HEALTH AND SAFETY PLAN

6.1 HASP Requirements

A site-specific HASP shall be prepared for each project requiring field activities involving possible hazardous substances. The HASP shall be reviewed and signed by the CHSM prior to field activities. The HASP shall meet the following objectives:

- Maintain the health and safety of all site personnel,
- Protect the public and the environment,
- Provide strategy for contingencies to environmental problems (such as accidental releases) resulting from site work,
- Adhere to BEM corporate health and safety policies and applicable federal, state, and local regulations.

In accordance with OSHA regulations [29 CFR 1910.120(b)(4); 29 CFR 1910.120, Appendix C], the HASP shall include the following information:

1. Site control program comprised of:
   - Site map
   - Background site data including, but not limited to:
   - Analytical results of environmental media sampling
   - Site history
   - Site work zones
   - Buddy system guidelines
   - Onsite communication guidelines
   - General safety practices
2. Identification of key personnel including:
   - Lines of authority within BEM and client-specific lines of authority
   - Responsibilities
3. Site Safety Workplan encompassing:
   - Hazard assessment associated with each site task or operation
   - Physical,
   - Chemical, and
   - Biological hazards
   - Recommended level of personal protective equipment
   - Monitoring equipment/materials
   - Work limitations
4. Decontamination
   - Equipment and personnel
   - Disposal of site-generated materials
5. Site emergency procedures
   - Emergency contacts/phone numbers
   - Route to hospital map/directions
   - Utility Verification Services

6. Employee training
7. Medical surveillance
8. Spill containment procedures
9. Confined space entry procedures
10. Tailgate safety meeting
11. Project specific safety programs.

It is the responsibility of the PM to advise and discuss with the CHSM that the project will require a HASP. A detailed HASP will be required for larger projects, according to site-specific complexity and requirements.

BEM HASPs will be reviewed and approved by the CHSM, or designee. The SSO has the authority to suggest changes to the site-specific HASP. Changes shall be made only with the approval of the CHSM.

ALL BEM employees involved with the project shall receive a copy of the HASP, review the HASP, and sign a statement confirming their understanding of the HASP, prior to onsite activities.

BEM will obtain the applicable safety records (OSHA 300 log, EMR), project specific safety plan, and employee training certificates for subcontractors working for BEM on project sites.

6.1.1 Safety Plan Updates

During extended field operations, the health and safety plan shall be reviewed periodically (at least once every six months) for relevancy and correctness. In addition, health and safety plans shall be updated if new information is acquired, new tasks are added to any project, or if new regulations or guidelines are published. This may be accomplished by completing an addendum to the original HASP with the concurrence of the CHSM.

6.2 Site Specific Health and Safety Templates

OSHA requires that in addition to a site-specific HASP, supplemental program specific plans be generated to cover those employees who may potentially be exposed to or affected by materials covered by the following regulatory programs:

- Bloodborne Pathogens
- Permit required confined space entry
- Fall protection
- Hazard communication
- Hearing conservation
- Lock out / Tag out
- Personal protective equipment
- Respiratory protection

The CHSM shall communicate with the PM to discuss the requirements and applicability of each template to their specific project, as necessary. The SSO shall complete each applicable template prior to project inception.

7.0 ACCIDENT AND INCIDENT REPORTING AND INVESTIGATIONS

7.1 Accident/Incident Reporting

The SSO will maintain logs and reports covering health and safety aspects of the project throughout the duration of work activities. In the event of an on-site accident resulting in an exposure or injury, the SSO will immediately complete an Incident Report (Attachment 8) and send a copy to PM within 24 hours.

7.2 Accident Investigations

Accidents are usually complex. An accident may have 10 or more events that can be causes. A detailed analysis of an accident will normally reveal three cause levels: basic, indirect, and direct. At the lowest level, an accident results only when a person or object receives an amount of energy or hazardous material that cannot be absorbed safely. This energy or hazardous material is the direct cause of the accident. The direct cause is usually the result of one or more unsafe acts or unsafe conditions, or both. Unsafe acts and conditions are the indirect causes or symptoms. In turn, indirect causes are usually traceable to basic causes such as poor management policies and decisions, or to personal or environmental factors.

Most accidents are preventable by eliminating one or more causes. Accident investigations determine not only what happened, but also how and why. The information gained from these investigations can prevent recurrence of similar or perhaps more disastrous accidents. Accident investigators are interested in each event as well as in the sequence of events that led to an accident. The accident type is also important to the investigator. The recurrence of accidents of a particular type or those with common causes shows areas needing special accident prevention emphasis.

The initial investigation has three purposes:

1. Prevent further possible injury and property damage
2. Collect facts about the accident
3. Collect and preserve evidence

The SSO will be responsible for the reporting associated with an accident and for obtaining all relevant information. The SSO will be responsible for the reporting of the accident and for promptly informing the PM and CHSM. The SSO will take the following steps:

a. Secure the area. Do not disturb the scene unless a hazard exists.
b. Prepare the necessary sketches and photographs. Label each carefully and keep accurate records.
c. Interview each victim and witness. Also interview those who were present before the accident and those who arrived at the site shortly after the accident. Keep accurate records of each interview. Use a tape recorder if desired and if approved.

8.0 SAFE WORK PRACTICES IN THE FIELD

8.1 General Safe Work Practices

The key to safe operations at a site is the control of potential employee exposure to hazardous materials and situations, which requires designating hazardous areas and restricted access zones,

the size and boundaries of which are determined from the site assessment and hazard evaluation procedures. In order to minimize employee exposure to hazardous materials and situations, all BEM employees that work in hazardous materials operations should adopt the following practices:

- Do not work on a hazardous waste site without formal authorization, compliance with medical monitoring, adequate OSHA training, or compliance with an approved HASP.
- Change clothing daily and wash hands and face frequently to limit exposure to hazardous materials.
- Seek first aid for minor cuts/scratches to reduce the potential for exposure.
- Contact lenses may be worn in the work zone, but protective eyewear shall be utilized when required by site activities or the hazard assessment. Suitable and protective measures shall be implemented to ensure that the wearing of contact lenses in the work area does not place the employee or adjacent personnel at risk, create a hazardous work condition, or hinder work activities.
- Avoid unnecessary contact with contaminated materials. Do not sit down, kneel or lay equipment on contaminated surfaces.
- Refrain from eating, drinking, chewing gum, chewing tobacco, or smoking in the work zone.
- Facial hair, make-up, or jewelry that interferes with the satisfactory fit of a tight-fitting respirator is prohibited.
- Entering the site under the influence of alcohol or recreational drugs is strictly prohibited and in violating of the BEM Controlled Substances Policy (see BEM Employee Manual). Personnel using prescription drugs should inform the CHSM, who will inform the physician in charge of the medical monitoring program to determine if synergistic effects are possible.

If BEM personnel are injured, or experience symptoms as a result of exposure to contaminated media, report the incident immediately to the SSO. The SSO should inform the CHSM within 24 hours of the incident and file an incident report form.

8.2 Working On or Near Water

8.2.1 Boating Safety

BOAT OPERATORS

BEM personnel who operate a boat during the course of a project shall demonstrate to the site manager that they are experienced in operating boats that will be used for the project and that they are knowledgeable in the USCG Boating Safety requirements (33 CFR Subchapter S). The boat operator shall be responsible for the safety of all personnel on board the boat he/she is operating and for the integrity of the boat's safety equipment. During boat operation, at least one person shall remain onshore.

BOAT PASSENGERS

Project personnel riding as passengers in a boat shall comply with US Coast Guard requirements, as presented below.

FLOAT PLAN

The SSO shall be aware of the location of all project boats and personnel. If several boats and crews are involved or are traveling to remote areas, each designated boat operator shall file a written float plan with the SSO to include the following:

- Names of boat operator and passenger;
- Description and registration number of the boat;
- Radio call sign or cellular telephone number;
- Trip itinerary with expected time of return; and,
- Contingency plan for SSO to follow if the expected return time is exceeded.

EQUIPMENT

All boats shall comply with USCG or state boat registration and numbering requirements. Project boats will meet or exceed USCG requirements for safety equipment for small craft (less than 12 meters in length). If larger craft are necessary, consult with the PM or local authorities.

FIRE PREVENTION

All gasoline engines, except outboard motors, installed in a boat shall have an approved flame arrester (backfire preventer) fitted to the carburetor. Boats with motors shall have an approved fire extinguisher (ABC-rated) onboard at all times.

SOUND SIGNALING DEVICE

BEM project boats will carry at least one air horn or similar sound-signaling device.

PERSONAL FLOTATION DEVICES

Persons riding in any project boat shall wear an approved personal flotation device at all times. A positively buoyant wet suit or dry suit may be substituted for a personal flotation device. The personal flotation device shall be a Type II or higher (i.e., capable of turning its wearer in a vertical or slightly backward position in the water). In addition, each boat shall be equipped with at least one Type IV personal flotation device (e.g., buoyant boat cushion, float ring), designed to be thrown to a person in the water and grasped by the victim.

Personnel should be aware of project or region-specific safety requirements as they pertain to the use of PFD's a specified distance from the water's edge.

NAVIGATION LIGHTS

Any boat operated at night shall be equipped with navigation lights to be utilized at all times between sunset and sunrise. Navigational lights shall be in compliance with USCG requirements.

VISUAL DISTRESS SIGNALS

Project boats shall carry a selection of pyrotechnic (red flares, orange smoke, aerial red meteor, parachute flares) and on pyrotechnic visual distress signals (orange distress flag, flashlight or other electric light) to account for as many conditions as possible. Pyrotechnic visual distress signals shall not be used past the expiration data stamped on them.

POLLUTION CONTROL

The Refuse Act of 1989 prohibits the throwing, discharging, or depositing of any refuse matter of any kind (including trash, garbage, oil, and other liquid pollutants) into the waters of the

United States. The Federal Water Pollution Control Act prohibits the discharge of oil or hazardous substances in quantities that may be harmful into the US navigable waters. No person may intentionally drain oil or oily waste from any source into the bilge of any vessel. Larger vessels equipped with toilet facilities shall be equipped with a USCG-approved marine sanitation device.

BEM employees shall report any significant oil spills to water to the Project Manager who shall report the spill to the US Coast Guard or other applicable regulatory agency. BEM personnel shall follow the SOP for incident reporting when reporting a spill (HS-001).

LOAD CAPACITY

Boats shall not be loaded (passenger and gear) beyond the weight capacity printed on the USCG information plate attached to the stern. Consider the following factors when loading a boat:

- Distribute the load evenly;
- Keep the load low;
- Do not stand up in a small boat or canoe; and
- Do not overload the boat.

SURVIVAL KIT

BEM boats utilized in remote areas shall carry a survival kit and will contain, at a minimum, a first aid kit, drinking water, blankets, heat source, signaling devices, waterproof matches and other items as necessary to ensure survival for a minimum of 24 hours for the entire crew. Survival suits may be required by the HASP in cold environments.

COMMUNICATIONS

BEM boats operated in remote areas shall carry a two-way radio or cellular telephone for communication back to the field headquarters or other pre-established location.

BOATING ACCIDENT REPORT

The USCG requires filing of a boating accident report within 24 hours of an accident. BEM personnel will follow the procedures established in the incident reporting SOP.

8.2.2 Working On or Near Water

The work practices in the following section are applicable to BEM technical personnel who work on or near water and are in accordance with OSHA and USCG regulations (29 CFR 1926. 106; 33 CFR, Subpart G).

BEM personnel working near water will be provided with USCG-approved life jackets or buoyant work vests. Ring buoys (Type IV personal flotation devices) with at least 90 feet of line will be provided and readily available for emergency rescue operations. Distances between ring buoys shall not exceed 200 feet. At least one life-saving skiff will be available to employees working near water, as necessary.

8.3 Heat Stress

Weather conditions are an important consideration in planning and conducting site activities. The combination of physical activity, high ambient temperatures, high humidity, and protective gear predisposes field personnel to heat illness and represents an acute health threat. Heat also causes indirect problems such as poor judgment, lowered efficiency, and worker discomfort.

The following will provide information on heat stress and its health effects, signs and symptoms, predisposing factors, monitoring techniques, prevention measures, and treatment of heat-induced injuries.

8.3.1 Effects of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Under normal conditions, the body produces 65-85 kcal/hour of heat. Moderate work can increase body heat by 400%. The body shall lose the same amount of heat as it produces to remain isothermic. If protective clothing is worn, normal heat exchange is restricted and natural body ventilation is reduced.

HEAT ILLNESS – CLINICAL SYNDROMES

There are six separate and distinct categories of heat stress:

1. **HEAT EDEMA** – This common condition has symptoms such as swelling of the feet and ankles, particularly during the first two-three days of heat exposure. It tends to be an all or none phenomenon and is more common in females.
   - **Treatment:** elevate legs higher than heart during work breaks and at night.
2. **HEAT RASH** – This condition is caused by continued exposure to heat and humid air and is aggravated by tight clothing. It decreases the ability to tolerate heat as well as being a nuisance.
   - **Treatment:** use a topical steroid such as hydrocortisone. Keep area dry.
3. **HEAT SYNCOPE** – This refers to the sudden and brief loss of consciousness (syncope) related to a prolonged upright position. The cause is multifactional: mild dehydration, decreased vasomotor tone, and marked venous pooling. It appears to be more common in conditions of sunlight, even in the absence of an elevated ambient temperature. Heat syncope occurs almost exclusively during tasks that require an erect posture, but without much movement, especially if isometric straining is involved (e.g., steadying a ladder or reaching up for an extended time frame).
   - **Treatment:** replace body fluids and elevate legs.
4. **HEAT CRAMPS** – Cramps occur with the onset of profuse sweating and inadequate fluid intake and chemical replacements (especially salts). Symptoms typical to heat cramps include muscle spasms and pain in the hands, feet and/or abdomen.
   - **Treatment:** Drink electrolyte replenishing liquids. Persistent or severe cramps require professional medical treatment.
5. **HEAT EXHAUSTION** – This condition is generally referred to as "heat toxemia" or "sunstroke." It occurs from increased stress on various body organs due to inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include pallor, cool moist skin, nausea, headache, dizziness, and "chills." Sweating is still present. Body temperature is elevated but is less than 104°F. The person is conscious but weak and tired and complains of a flu-like feeling. Deficiency in both water and electrolytes are thought to contribute to this condition. Although hyperthermic, the

person's physiological mechanisms are still intact (sweating, rapid breathing, thirst) and prompt attention leads to a full recovery.

- **Treatment:** Place individual in cool place. Administer fluids and monitor temperature. Serious cases should be transported to the hospital. Close monitoring is required on subsequent days as individuals are more susceptible to a repeat episode.

6. **HEAT STROKE** – This is the least common but most serious form of heat stress. It occurs when the body's normal regulatory mechanisms are overcome. Specifically, the normal responses of sweating, vasodilation, increased respiration, and higher brain functions will diminish markedly as the core temperature approaches 105°F (oral temperature may be 103°F). The temperature will continue to rise, culminating in death, unless external remedies are applied. Heat stroke is recognized by the presence of an altered mental state, red hot usually dry skin, nausea, and strong rapid pulse.

   - **Treatment:** Do not delay treatment, irreparable harm may ensue otherwise. THE INDIVIDUAL'S BODY TEMPERATURE SHALL BE LOWERED RAPIDLY; THEREFORE:
     - Move victim out of sun,
     - Remove constricting clothing,
     - Wet victim completely with water, especially the head,
     - Place victim in front of fan or have access to natural breezes,
     - Apply ice to victim's armpits, groin, and throat,
     - Monitor individual's body temperature,
     - When body temperature approaches 101°F, transport victim to hospital.

8.3.2 Predisposing Factors

Prevention of heat stress is preferable to treatment. Several factors have been identified as increasing an individual's risk and include:

- Infection
- Sunburn
- Diarrhea
- Chronic disease
- Lack of physical fitness
- Age
- Medication
- Dehydration
- Obesity
- Lack of acclimatization
  An individual's response to heat stress changes as they acclimate to warmer weather. During the first two-three weeks, the unacclimated individual may perspire at a rate of up to one liter/hour. This same individual, after acclimatization may perspire more abundantly (3-4 liters/hour); however, the salt concentration in the unacclimatized individual is greater than an acclimatized individual

- Alcohol and/or drug/medication use
  Alcohol directly affects the central nervous system (CNS), which then impairs temperature regulation. Additionally, the diuretic effect of alcohol leads to excess water loss and exacerbates heat-related dehydration.
  1. Diuretics – These are prescribed for hypertension and edematous conditions including swelling of the feet, premenstrual bloating, and dieting.
  2. Anticholinergics – These drugs are used for common gastrointestinal disturbances including peptic ulcers, gastritis, esophagitis (heart burn) as well as for diarrhea, some types of ear disorders, allergies/colds, and motion sickness.
  3. Antidepressants – These agents are the drugs used to treat depression and vascular headaches (migraines) and sometimes as prescribed as a sleeping pill.
  4. Tranquilizers – These drugs are used to treat emotional and mental disturbances as well as use as an anti-nauseant.
  5. Amphetamines – These are used as diet pills and as a treatment for narcolepsy.

8.3.3 Monitoring

All field workers, even those not wearing protective equipment, should be monitored for heat stress by monitoring a radial (wrist) pulse, body temperature, or visual observations in regions where ambient temperatures reach or exceed 95°F.

1. **Pulse Rate**
   Team members pulse rates should be monitored at the beginning of a rest period. The radial (wrist) pulse will be counted during a 30-second period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If the heart rate still exceeds 100 beats per minute at the next rest period, shorten the following work cycle by one third.
2. **Body Temperature**
   Body temperature should also be monitored at the beginning of the rest period, before drinking.
   - If the oral temperature exceeds 99.6°F, shorten the next work cycle by one third without changing the rest period.
   - If the oral temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by one third.

No one should wear semi-permeable or impermeable garments when his/her oral temperature exceeds 100.6°F.

Table 2 Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Temperature	Normal Work Clothing	Impermeable Work Clothing
90ºF or above	after each 45 minutes of work	after each 15 minutes of work
87.5ºF to 90ºF	after each 60 minutes of work	after each 30 minutes of work
82.5ºF to 87.5ºF	after each 90 minutes of work	after each 60 minutes of work
77.5ºF to 82.5ºF	after each 120 minutes of work	after each 90 minutes of work`
72.5ºF to 77.5ºF	after each 150 minutes of work	after each 120 minutes of work

8.3.4 Prevention

Taking the following steps can avert heat stress illnesses:

1. Adjust work schedules:
   - Mandate work slowdowns, as necessary,
   - Rotate personnel,
   - Perform work during cooler hours of day (early morning or late afternoon).
2. Provide shelter, such as air-conditioned vehicles or shaded areas, to allow workers to rest.
3. DRINK FLUIDS!!! Daily fluid intake shall equal body water lost through perspiration. The normal thirst mechanism is not sensitive enough to ensure enough water will be ingested to replace lost body fluids. When heavy sweating occurs, gradually drink liquids such as Gatorade, Sqwincher, or All-Sport.
4. Provide cooling devices to aid natural body heat exchange.

Figure 1 Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Apparent Temperature (°F)										
125	123	141								
120	116	130	148							
115	111	120	135	151						
110	105	112	123	137	150					
105	100	105	113	123	135	149				
100	95	99	104	110	120	132	144			
95	90	93	96	101	107	114	124	136		
90	85	87	90	93	96	100	106	113	122	
85	80	82	84	86	88	90	93	97	102	108
80	75	77	78	79	81	82	85	86	88	91
75	70	72	73	74	75	76	77	78	79	80
70	65	66	67	68	69	70	70	71	71	72
%	10	20	30	40	50	60	70	80	90	100
Percent Humidity										

Air Temperature (°F)

8.4 Cold Stress

This section is designed to provide information on the signs and symptoms of cold stress, as well as procedures to combat cold stress.

8.4.1 Definitions

Frostbite – local tissue damage caused by exposure to low temperature environmental conditions. Severe occurrence may lead to deep tissue damage, gangrene, and loss of the affected part.

Frost nip – a whitened area of skin, which is painful or gives a slight burning sensation.

Hypothermia – lowering of the body's core temperature due to prolonged exposure to cold.

Thermoregulatory Centers – centers in the hypothalamus that regulate heat production and heat losses so that normal body temperature is maintained. These centers are influenced by nerve impulses from cutaneous (skin) receptors and by blood temperature.

Windchill – the cooling effect wind has on exposed skin.

Equivalent Chill Temperature (ECT) – an index describing the effect of the cooling power of moving air on exposed flesh. The effect of wind velocity at a certain temperature is expressed as the equivalent cooling effect of lower temperature with still air (see subsequent Windchill Factor chart).

8.4.2 Cold Injuries - Clinical Syndrome

Two factors influence the development of a cold injury: ambient temperature and the wind velocity. Windchill is used to describe the chilling effects of moving air in combination with low temperature (see attached table). For example, an ambient temperature of 32oF with a wind of 15 mph is equivalent in chilling effect to still air at 13oF. As a general rule, the greatest incremental increase in windchill occurs when a wind of 5 mph increases to 10 mph. When using impermeable clothing (e.g., Saranex or Tyvek) and if the body is soaked with perspiration, the body is suddenly cooled when the PPE is removed. And, as water conducts heat 240 times faster than air, should there be a windchill when the body is perspiration-soaked, the effects of the cold are intensified.

The area of the body most susceptible to cold injury are those with high surface area to volume ration (fingers, toes, nose, ears). Severe injury to these extremities may occur with extreme cold temperatures. Prolonged exposure to extreme cold produces shivering, numbness, low body temperature, drowsiness, and marked muscular weakness.

There are three stages of cold injury:

1. **Frost Nip** – Frost nip is the first sign of frost bite and is the only form of local cold injury that can be definitively treated in the field. It is characterized by a whitened area of skin that has a burning or pain sensation.
2. **Frost Bite** – Frostbite is local tissue damage caused by exposure to low temperatures. It results when ice crystals form, either superficially or deeply, in the fluids and underlying soft tissue of the skin. The nose, cheeks, ears, fingers, and toes are most commonly affected.

   The victim's skin will be cold, hard, and white. There also may be blisters. The victim may not know there is frostbite as there is no pain sensation.

   With time, the victim experiences mental confusion and impairment of judgment. The victim may stagger and eyesight will fail. Eventually, the victim will become unconscious, go into shock, stop breathing, and die.

   - **Treatment:** The objectives for frostbite first aid are to protect the frozen area from further injury, warm the affected area rapidly, and maintain respiration. Never allow a thawed area to refreeze as it will cause more severe damage and may lead to amputation of the affected appendage.
     - Cover the frozen area and provide extra clothing/blankets to victim.
     - Bring victim indoors as soon as possible.
     - Have victim drink something warm.

- Rewarm the frozen part quickly by immersing it in warm water (not hot water), approximately 102-105of. This procedure may take up to 30 minutes and the victim will feel more and more pain as the tissues thaw.
- If warm water is not available or practical to use, wrap the affected area gently in a sheet/blankets/clothing.
- Once the affected area is re-warmed, have the victim exercise it.
- If fingers or toes are involved, place dry sterile gauze between them to keep them separated.
- If travel is necessary, cover the affected parts with sterile bandages or clean clothes and keep the injured areas elevated.
- Obtain medical assistance as soon as possible.

If the victim has frost bite, **DO NOT**:

- Rub the affected area. Rubbing may cause gangrene (tissue death).
- Apply heat lamps, heating pads, or hot water bottles.
- Let the victim bring the affected area near a hot stove or fire.
- Break blisters.
- Allow the victim to walk if the feet are the affected areas. However, walking on a frozen foot is better than staying in the cold.
- Allow the victim to smoke or drink alcohol.

3. **Hypothermia** – After prolonged exposure to the cold, the body's core temperature lowers. Hypothermia does not necessarily occur at temperature below freezing, but can occur if the person is hungry, wet, tired, and overexerted.

   Hypothermia begins with severe shivering, the body's mechanism for generating heat. Victims then display abnormal behavior characterized be decreased efficiency, decreased level of communication, forgetfulness, repetitive behavior, poor motor skills, poor judgment, and lack of concern for usual physical needs. As time goes on, victims become apathetic, listless, and sleepy; these symptoms may be followed by weakness, inability to walk, and repeated falling. Later stages consist of collapse, stupor, unconsciousness, and death, if not treated.

   - **Treatment:** All stages of hypothermia are treated by re-warming, either passive or active. Passive re-warming is accomplished by conservation of the victim's body heat; however, the victim shall have intact thermoregulatory mechanisms for this to be effective. Active re-warming is when heat is applied to the victim by some external source, either peripherally and/or through the core.
   - Prevent further heat loss in victim, remove to warm, dry place out of wind, cold, and rain/snow.
   - Remove wet or damp clothing piece-by-piece and dry underlying skin.
   - Dress victim in warm dry clothes with preference to central body core rather than extremities. Cover head with hat or blanket, and then wrap blankets around entire body.
   - Administer hot fluids only if victim is unconscious.
   - Monitor victim's temperature every 15 minutes.

TRANSFER VICTIM TO A MEDICAL FACILITY AFTER ABOVE STEPS HAVE BEEN INITIATED. WORKER SHOULD NOT RETURN TO WORK FOR AT LEAST 48 HOURS.

8.4.3 Work Practices at or below 10ºF Equivalent Chill Temperatures

1. The work rate should not be so high as to cause sweating that will result in wet clothing.
2. Precautions should be taken to ensure that employees become acclimated to the working conditions and required protective clothing.
3. Work should be arranged so that sitting still or standing still for long periods of time are minimized. Unprotected metal chair seats should not be used. The worker should be protected from drafts to the greatest extent possible.

WARM-UP BREAKS

If work is performed continuously in the cold at an ECT of 20°F or below, heated shelters should be provided during warm-up breaks. There are no limits to the amount of time a worker may spend in a 0°F-30°F environment. However, in temperatures below 0°F, the total allowed work time is four hours consisting of alternating one-hour work periods and one-hour break periods. A work-warming regimen (suggested by the ACGIH) is provided in an attached warm-up schedule.

CLOTHING

Adequate insulated clothing should be worn to maintain core temperatures above 97°F when work is to be performed below 40°F. If clothing becomes wet, change into dry clothes immediately. If available clothing does not give adequate protection for the prevention of hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

SPECIAL CONSIDERATIONS

Employees should be excluded from work in cold weather (30°F or below) if they are suffering from diseases or taking medication that interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to air temperature below 0°F with wind speeds less than five mph should be medically certified as suitable for such exposures. At air temperatures of 36°F or less, any worker who becomes immersed in water or whose clothing becomes wet will be immediately provided a change of clothing and treated for hypothermia, as necessary.

PMs have the discretion to shut down or postpone fieldwork as a result of high winds, frigid temperatures, or other inclement weather that presents safety hazards or difficulties to field staff to safely accomplish the scheduled tasks.

Table 3 Wind Chill Factors

Ambient Temperature, ºF											
Wind Speed (mph)	32	23	14	5	-4	-13	-22	-31	-40	-49	-58
Equivalent Temperature, ºF											
Calm	32	23	14	5	-4	-13	-22	-31	-40	-49	-58
5	29	20	10	1	-9	-18	-28	-37	-47	-56	-65
10	18	7	-4	-15	-26	-37	-48	-59	-70	-81	-91
15	13	-1	-13	-25	-37	-49	-61	-73	-85	-97	-109
20	7	-6	-19	-32	-44	-57	-70	-83	-96	-109	-117
25	3	-10	-24	-37	-50	-64	-77	-90	-104	-117	-121
30	1	-13	-27	-41	-54	-68	-82	-97	-109	-123	-137
35	-1	-15	-29	-43	-57	-71	-85	-99	-113	-127	-142
40	-3	-17	-31	-45	-59	-74	-87	-102	-116	-131	-145
45	-3	-18	-32	-46	-61	-75	-89	-104	-118	-132	-147
50	-4	-18	-33	-47	-62	-76	-91	-105	-120	-134	-148
LITTLE DANGER FOR PROPERLY CLOTHED PERSONS Maximum danger of false sense of security			**CONSIDERABLE DANGER** Danger from freezing of exposed flesh within one minute			**VERY GREAT DANGER** Flesh may freeze within 30 seconds					
Trenchfoot and immersion foot may occur at any point on this chart											

Work/Warm-Up Schedule For Four-Hour Shift

Air Temp. - Sunny Sky °F (Approximately)	No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-15° to 19°	Normal breaks	1	Normal breaks	1	75 min.	2	55 min.	3	40 min.	4
-20° to -24°	Normal breaks	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
-25° to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓	
-30° to -34°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease ↓		↓	
-35° to -39°	40 min.	4	30 min.	5	Non-emergency work should cease ↓		↓		↓	
-40° to -44°	30 min.	5	Non-emergency work should cease ↓		↓		↓		↓	
-45° & below	Non-emergency work should cease		↓		↓		↓		↓	

(Reference: ACGIH TLV and BEIs)

NOTES:

1. Schedule applies to any four-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the four-hour work period in warm locations. For light-to-moderate work (limited physical movement): apply the schedule one step lower.
2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   - 5 mph: light flag moves
   - 10 mph: light flag fully extended
   - 15 mph: raises newspaper sheet
   - 20 mph: blowing and drifting snow
3. TLV applies only for workers in dry clothing.

8.5 Hearing Conservation

An important physical hazard potentially encountered in hazardous site work is noise, which may cause hearing loss. Hearing loss can be caused by heat injury, infections, disease and noise. The loss can be cumulative but it can often be controlled and prevented. Each person is born with

about 40,000 hearing hair cells with the numbers decreasing with age. As the cells die, the sensitivity to sound decreases. The following are examples of various noises measured in decibels, dBA:

dBA Level	Noise description
10-20	barely audible
40-50	quiet, pleasant noise
60-65	normal city noise
75-80	drill rig
85-90	lawnmower
100-120	grinder, leaf blower
120-130	jet engine at close range. pain threshold
140+	rocket

PELs have been determined for noise (OSHA) as referenced in 1910.95:

Duration per day (hours)	Sound Level (dBA)
8	90
4	95
2	100
1	105
0.5	110
0.25	115
0.125	120*

***No exposure to continuous or intermittent noise is permitted above 140 dBA.**

Noise can be controlled through:

- Engineering controls (barriers, enclosures, acoustical tiles, noise absorbing pads, elimination of sources);
- Administrative controls (rotating workers from noisy work areas and reducing exposure time); and,
- Personal protective equipment (earplugs, earmuffs with an appropriate noise reduction rating to prevent noise exposure and not create communication difficulties. Hearing protection should not have a Noise Reduction Rating (NRR) <20 to effectively reduce exposure to less than 85 dBA).

BEM provides earplugs to employees with the potential for noise exposure and in situations where the OSHA Action Limit of 85 dBA is exceeded.

9.0 HEALTH AND SAFETY AUDIT PROCEDURES

Regular health and safety audits will be conducted to assure compliance with BEM corporate health and safety procedures, the health and safety plan as well as compliance with applicable safety regulations. Auditing will be performed by the CHSM, or designee, on any BEM site and will include an evaluation of work activities in regards to health and safety. The audits will be unannounced and at randomly selected intervals and locations.

When conducting audits, the CHSM, or designee, will complete the health and safety audit form and note minor, significant, and/or major deficiencies as defined in the following table:

Deficiency	Definition	Examples
Minor	An action or procedure which deviates from the health and safety plan requirements resulting in a small probability of an injury or incident.	• Emergency contact list not in onsite vehicles or field trailer. • Monitoring equipment calibration records missing.
Significant	An action or procedure which deviates from the health and safety plan requirements resulting in a moderate probability of an injury or incident.	• Documentation for tailgate safety meetings missing or lack of meetings. · • Lack of, or incomplete, hazard assessment.
Major	An action or procedure which deviates from the health and safety plan requirements resulting in a high probability of an injury or incident.	• Working at heights without fall protection. • Handling hazardous materials w/o use of PPE.

HAZARD PRIORITY RANKING SYSTEM

Hazard Priority Ranking (U.S. National Safety Council)

The first ranking estimates the severity of the problem if the potential accident/incident were to occur:

1. Imminent Danger (e.g., causing death, widespread occupational illness, loss of facilities)
2. Serious (e.g., severe injury, serious illness, property and equipment damage)
3. Minor (e.g., non-serious injury, illness, or damage)
4. Negligible (e.g., minor injury, requiring first aid or less)

The second ranking estimates the probability (think in terms of risk assessment) of the accident/incident occurring:

A. Probable – likely to occur immediately or soon
B. Reasonably probable – likely to occur eventually
C. Remote – could occur at some point
D. Extremely remote – unlikely to occur

Each hazard is assigned both rankings, and the result is clear priorities in terms of corrective action. A hazard ranked 1-A obviously is more important than one ranked 1-D; 2-B comes ahead of 3-A, and so on.

Corrective Action Implementation Schedule

Ranking	Correction time (not to exceed)
1A, 2A, 3A	5 business days
1B, 2B, 3B, 4A	10 business days
1C, 2C, 3C, 4B	15 business days
1D, 2D, 3D, 4C	20 business days
4D	25 business day

Copies of the completed audit forms will be sent to the SSO and PM. If minor deficiencies are identified, it is the responsibility of the PM, Field Manager and the SSO to implement corrective action promptly. If major deficiencies are identified, the Vice President

will be notified. Failure to promptly correct major deficiencies by appropriate project personnel is cause for disciplinary action, including termination of employment.

10.0 BEM STANDARD OPERATING PROCEDURES FOR HEALTH AND SAFETY FIELD EQUIPMENT

BEM may use various field equipment's and associated SOPs for some of the field items that are either purchased or rented based on the project needs.

- CGI Oxygen Meter
- Photoionization Detectors
- Flame Ionization Detector
- Global Positioning System
- Horiba U-22
- Buck and Gilian Air Sampling Pumps
- Metrosonics IAQ meter
- Quest Noise dosimeter
- Boroscope
- Radiation meter
- TSI Velocicalc Air flow meter
- MultiRAE multi-gas meter
- Water level indicator
- Moisture Meter
- Drager CMS detector
- Andersen Bioaerosol sampler
- Illumination Meter
- Personal DataRam dust meter.

The equipment usage is required to be tracked by each individual project.

11.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

11.1 Purpose

The purpose of this section is to ensure that PPE selection is completed in accordance with 29 CFR 1910.132, properly used and maintained and that BEM personnel are properly trained in the inspection, use, and maintenance of PPE.

11.2 Definitions

PPE are items which are worn and designed to protect the health and safety of an employee. This includes, but is not limited to, chemical resistant boots, gloves, chemical protective clothing, hard hats, safety glasses, hearing protection, respirators, and reflective, high-visibility traffic vests.

11.3 Responsibilities

11.3.1 BEM Technical Staff

The BEM technical staff is responsible for understanding the specific PPE requirements for each project task and ensuring that PPE is provided, worn when required and in the intended manner.

Personnel required to use PPE are responsible for wearing the appropriate PPE when required, inspecting the PPE prior to use, properly wearing the PPE, and as necessary, properly maintaining the PPE.

11.3.2 Health and Safety Personnel

The Corporate Health and Safety Manager or the Regional Health and Safety Officer is responsible for:

- Ensuring that PPE is selected in accordance with the hazard assessment requirements of 29 CFR 1910.132 (d); and
- Approving changes to PPE requirements through HASP modifications or by incorporating criteria into the site-specific HASP which enables the Site Safety Officer to authorize changes to the PPE requirements.

The Site Safety Officer is responsible for:

- Monitoring PPE usage;
- Recommending modifications to PPE requirements to project management, as necessary; and,
- Ensuring that project personnel have the proper training on the PPE they are required to use and obtain training and retraining, as necessary.

11.4 Procedures

PPE is intended for use when engineering controls, administrative procedures, and/or work practices are not feasible, when control measures are shown to be ineffective for exposure minimization, as interim measures during the installation or implementation of control measures, when uncertainty exists regarding the nature and level of potential exposure, and as a precautionary measure, to prevent exposure due to accidental releases of hazardous materials.

11.4.1 Hazard Assessment and Selection

Hazard assessments are required during the preparation of all HASPs and include the following for consideration:

- Potential chemical, physical, and biological hazards present;
- Work operations to be performed;
- Potential routes of exposure;
- Concentrations of contaminants present; and,
- Characteristics, capabilities, and limitations of PPE, and any hazards that the PPE presents or magnifies, such as heat stress.

The hazard assessment shall include the identification of the workplace evaluated, the person certifying that the evaluation has been performed, and the date(s) of the hazard assessment.

11.4.2 PPE Requirements

PPE are required when engineering controls and work practices are not feasible. PPE are necessary to reduce doses of hazardous substances to concentrations below the PELs, as defined in 29 CFR 1910.120(g)(1)(ii). A PPE assessment is performed for all field tasks through the HASP. The following table provides guidance on action levels for PPE use.

Potential Air Contaminant	Instrument	Action Levels	Level of PPE Protection
Asbestos Lead-based paint	PCM or PDM Mini-Ram or equivalent [1]	> 1 fibers/cubic centimeter < 0.03 mg/m^3	Level C (w/powered air purifying respirator or ½ face air purifying respirator with HEPA filters)
Explosive Vapors	CGI	Oxygen levels ≤ 19.5% or > 10% LEL Oxygen levels > 19.5% or < 23.5% or < 10% LEL	Evacuate Area [2] Level D
Radiation	RAD	≤ 2 mRem/hr. > 2 mRem/hr	Level D Evacuate affected area [3]
Nuisance Particulates	Mini-Ram	< 5 mg/m^3 > 5 mg/m^3 to 15 mg/m^3 > 15 mg/m^3	Level D Level C Evacuate affected area
Organic Vapors	PID/FID PID/FID	Continuous sustained (> 5 min.) readings < 5 units above background in the breathing zone and no visible dust Sustained (> 5 min.) readings > 5 units but < 50 units above background in the breathing zone and/or sustained dust clouds	Level D Level C

[1] An equivalent unit shall be approved by the H&S manager.

[2] Designated BEM personnel are not trained for Level B work. At these levels, personnel shall leave the affected area for situation evaluation.

[3] BEM personnel are not trained for radiation work. If radiation levels exceed 2 mRem/hour, personnel shall evacuate the affected work area.

All PPE shall be of safe design and construction for the work to be performed and shall meet applicable American National Standards Institute (ANSI) standards, the NIOSH guidelines and/or OSHA regulations. PPE shall properly fit each employee. The Company will provide all PPE free of charge to employees.

Eye and/or face protection will be provided when hazards exist from flying particles, liquid chemicals, or chemical gases or vapors. Safety glasses shall always incorporate side shields. Safety glasses not equipped with side shields will require the addition of such equipment. Safety glasses must be used in conjunction with splash/face shields, as the face shields are not impact rated or ANSI tested and approved. If prescription glasses are utilized, larger safety glasses will be provided to fit over the employee's glasses and inserts to accommodate the lenses must be used for full face respirators so as to not compromise the face-to-facemask seal.

Hard hats will be provided whenever hazards from falling objects, overhead hazards, or low clearance hazards exist. Hard hats shall always be worn in the manner for which they are tested and designed. The hardhat brim shall always face forward. Hard hats shall be periodically inspected for cracks, gauges, or other defects that may not adequately protect the employee.

11.4.2.1 Mandatory PPE for All Field Assignments

Each employee is responsible for donning mandatory PPE for field work/ visits, which includes (but not limited to) hard hat, safety glasses, class III safety vest for road and railroad work, and steel-toed shoes with electrical resistivity. All other site-specific PPE will be listed in the site HASP.

11.4.3 Cleaning, Maintenance, and Disposal

Each employee is responsible for inspecting his/her PPE before and after each use. Any damaged or defective PPE is to be taken out of service immediately and repaired or replaced.

Used or disposable PPE items are to be properly contained at job sites and disposed in accordance with the site-specific HASP or workplan. Non-disposable items, such as hard hats and respirators, are to be decontaminated at the job site. Personnel are responsible for cleaning their own PPE after each work shift. Site-specific cleaning procedures are listed in the HASP.

11.4.4 Training

Training in PPE is conducted as part of the initial hazardous waste 40-hour training (Section 6.3), which provides the employee with an understanding of the inspection, use (including donning, doffing, adjusting, and wearing), limitations, care, and maintenance of PPE.

Annual training will be conducted as part of the annual 8-hour refresher training (Section 6.5) or if the employee does not demonstrate an adequate understanding of the PPE.

PPE training will be documented with the name of each person trained, the date(s) of training, and the identification of the subject of the certification. Training records will be maintained by the CHSM.

11.5 Respiratory Protection

11.5.1 Selection of Respiratory PPE

Respiratory equipment utilized on BEM projects shall be approved by the NIOSH. The type of respiratory protection selected is based upon the potential site-specific hazards. There are two general classes of respiratory protection available:

- Air-supplied devices
- Air-purifying devices.

In order to select the proper respiratory protection for a site, the following conditions shall be considered:

1. The potential for an oxygen deficient environment (i.e., <19.5%).
2. The potential for mists/fumes/dusts/vapors from hazards substances to exceed the established PELs or guideline concentrations.
3. The potential for concentrations of substances to exceed Immediately Dangerous to Life or Health (IDLH) concentrations.
4. The potential for the substance to be irritating to mucous membranes (e.g., eyes, nose).
5. The physical characteristics of the compound(s).
6. The flammability of the compound(s).
7. The corrosivity and toxicity of the compound(s)
8. The odor threshold of the compound(s).
9. The expected duration of exposure.
10. Identification of contaminants and concentrations.

Supplied air respirator (i.e., pressure demand SCBA's or airline systems) shall be used under any of the following circumstances:

- The hazardous substance has been identified and requires the highest level of protection based on the measured or potential for high concentrations of atmospheric vapors, gases, or particulates;
- Site operations involving a high potential for splash, immersion, or exposure to unexpected vapors gases, or particulates; or
- Operations conducted in confined, poorly ventilated areas that have the potential to contain hazardous concentrations of atmospheric vapors, gases, or particulates and/or reduced oxygen concentrations less than 19.5%. Escape packs are required to be used with all airline systems.

Negative pressure air purifying respirators, equipped with appropriate filter cartridges for the expected contaminants, may be used only when the atmospheric contaminants have been identified, and measured concentrations are within limits that can be effectively removed by the cartridges.

11.5.2 Fit Testing

A qualitative fit test is conducted when exposure data indicates overexposure concentrations during site activities, when the employee requests a respirator, and prior to respirator use and annually thereafter. Fit testing may also be performed when a condition that may affect the face fit of the respirator has occurred, such as weight gain or loss, dental work, facial surgery, or deformity. Employees shall be clean-shaven during fit testing and on site when there is a potential for respirator use.

Qualitative fit tests shall be administered using Bitrex solution, irritant smoke and/or isoamyl acetate in accordance with OSHA protocols (29 CFR 1910.134, Appendix A). Records of fit testing will be maintained in the employees' health and safety files. If quantitative fit tests are used, employees shall not smoke at least 60 minutes prior to performing a quantitative fittest when using a Portacount device or equivalent.

11.5.3 Use of Respiratory Equipment

The BEM technical staff are required to:

- Use PPE when required and in the proper manner;
- Inspect respiratory equipment prior to and after use and obtain replacement equipment if found to be defective;
- Properly care for respiratory equipment;
- Air purifying respiratory protective equipment shall not be shared by employees; and
- Be clean-shaven during fit testing and on site when there is a potential for respirator use.

Low temperatures and high humidity may fog the lenses of the respirator and use of anti-fog spray or a nose cup may be necessary. Nose cups are part of the NIOSH approval for air-supplied respirators for temperatures below freezing.

11.5.4 Voluntary users of respiratory protection

Employees are permitted to request a respirator to use during fieldwork where they feel that it provides a 'comfort level' against nuisance odors, does not present a safety hazard, and they have been medically cleared to wear the equipment.

11.5.5 Disposable dust masks

Filtering facepiece respirators (a.k.a. dust masks) that have ratings of N95 or greater may be used for protection against nuisance dust or bioaerosols, so long as this is consistent with site HASPs or other site-specific documents. Filtering facepiece respirators are not to be used for protection against airborne hazards that exceed OSHA PELs.

11.5.6 Cleaning and Storage

Each BEM employee who is issued a respirator is responsible for cleaning, disinfecting, and maintaining their individual respirators, in accordance with the training they have received. The following procedure shall be followed for cleaning and storage of respiratory protection equipment:

- Personal respirators shall be cleaned and disinfected after each day's use, or more frequently, as necessary;
- Routine cleaning shall be completed as follows:
- Remove filters and dispose or reuse as per site-specific HASP requirements;
- Wash respirator in disinfecting solution or use approved respirator wipes;
- Rinse respirator in clean water; and,
- Allow respirator to adequately air dry or gently wipe with low-lint cloth.
- Routine inspection shall be completed as follows:
- Check all connections for gaskets and "O" rings for proper tightness;
- Check the conditions of the face piece and its parts for tear, cracks, abrasions, or brittleness;
- Check the conditions of the connecting air hose, regulator, and harness, if applicable;
- Check the condition of the headband for tears, cracks abrasions, or brittleness;
- Inspect all rubber or elastic parts for pliability and signs of deterioration;
- Check alarms, if applicable;
- Report any worn, missing, or broken parts to the SSO immediately; and,

- Clean and dry respirators shall be stored in airtight plastic bags without cartridges. Keep respirators in a clean, dry place out of direct heat and sunlight.
- Cartridges are to be changed under the following conditions:
- Known airborne contaminant concentrations, when used with one of the OSHA mathematical models for cartridge change-out schedule, will determine the specific usage life of the individual cartridges;
- If extremely dusty conditions prevail and breathing through the cartridges becomes difficult; or,
- On a daily basis if respirators are worn for an extended period of time during an eight-hour period.

11.5.7 Immediately Dangerous to Life and Health (IDLH) Atmospheres

BEM PERSONNEL SHALL NOT ENTER IDLH ATMOSPHERES AT ANY TIME UNLESS SPECIFICALLY TRAINED, EQUIPPED, AND DESIGNATED TO PERFORM SUCH DUTIES.

11.5.8 Training

BEM technical personnel required to use respiratory protection shall be trained annually in the selection, use, and maintenance of the equipment. Respiratory protection training includes the following:

- Hazard identification to include symptoms of exposure;
- Use of engineering controls to minimize exposure or an explanation of why engineering controls are not feasible;
- Description of the type of respiratory protection chosen and the protection provided to the employee;
- Assurance that the employee understands the protection capabilities and limitations of the method of respiratory protection utilized; and,
- Thorough demonstration of the selected method of respiratory protection to include use, trouble shooting, and maintenance followed by hands-on training by the employee.

12.0 CONSTRUCTION SAFETY

BEM employees will not engage in these construction activities; however, BEM personnel will be performing oversight of such activities. Therefore, BEM personnel shall be familiar with the health and safety regulations covered under the OSHA construction code (29 CFR Part 1926).

- Fire Protection and Prevention (Subpart F)
- Electrical (Subpart K)
- Scaffolding (Subpart L)
- Motor Vehicles (Subpart O)
- Excavation and Trenching (Subpart P)
- Fall Protection (Subpart M)
- Underground Construction / Caissons / Cofferdams (Subpart S)
- Demolition (Subpart T)
- Blasting and Explosives (Subpart U).

12.1 Excavation and Trenching

12.1.1 Applicability

Any BEM personnel who conducts technical oversight of excavation and trenching activities should be familiar (competent) with the applicable health and safety regulations covering excavation and trenching (29 CFR 1926 Subpart P).

12.1.2 Responsibilities

The CHSM or their designated competent person is responsible for:

- Providing oversight on the implementation of the requirements contained in Subpart P;
- Conducting periodic reviews of open trenches and excavations;
- Consulting with the project manager/subcontractor on excavation issues; obtaining photographic evidence of excavation practices and conditions; and,
- Maintaining required records.

12.1.3 General Requirements

General safety requirements on construction site are:

- Surfaces surrounding open trenches and excavations shall have all surface hazards removed from within at least 2 feet of the edge of the excavation.
- All underground utilities shall be located and cleared at least three days prior to digging. When the excavation is open, utilities shall be supported and protected from damage and documented daily.
- Presently, each state has its own phone number to call utilities. Refer to www.nuca.com/safety/onecall.htm
- In New York, New Jersey, Delaware, and Pennsylvania, the one-call number is 1-800-272-1000.
- In other regions, obtain the number and list it as part of the HASP.
- If structural ramps are necessary for entering/exiting the excavation, the ramps will be installed in accordance with 29 CFR 1926.651(c)(1).
- A means of exiting (e.g., stairways, ladders, ramps) is required for all excavations greater than four feet in depth. Travel distance shall be no more than 25 feet between each accessible means of egress.
- Employees will not stand under suspended loads or during loading or unloading of equipment.
- When vehicles and machinery are operating adjacent to excavations, warning systems, such as stop logs or barricades, shall be utilized to prevent vehicles from entering the excavation
- Trenches/excavations shall be shored in accordance with OSHA requirements to prevent entrapment from eroding soil/rock.
- Barriers shall be designed and installed to withstand a force that will prevent inadvertent falls into the open excavation.
- Walkways or bridges with standard railing(s) shall be provided at points employees are to cross over excavations or trenches.

12.1.4 Hazardous Atmospheres

Hazardous atmospheres are defined as oxygen levels less than 19.5% or greater than 23.5% with a lower explosive limit (LEL) of 10%. The following procedures should be followed when hazardous atmospheres are encountered:

- If hazardous atmospheres are suspected or encountered, perform air monitoring using appropriate detection equipment (e.g., photoionization detector, LEL/oxygen/toxic gas meter) prior to permitting personnel to enter the excavation. At no time should BEM personnel enter an excavation with a hazardous atmosphere.
- Personnel entering an excavation with a hazardous atmosphere shall use PPE and other engineering measures to reduce employee exposure to concentrations below the established permissible exposure limits.
- Emergency equipment shall be provided when the potential for hazardous atmospheres exist. Required equipment (e.g., breathing apparatus, lifelines, stretchers) should be checked daily.

12.1.5 Hazards Associated with Water Accumulation

If water has collected or is seeping into an excavation or trench the following requirements shall be applied:

- Personnel shall not work in excavations in which water has, or is, accumulating without the use of additional protection, such as special support systems or water removal systems,
- Water removal monitoring will be performed by the SSO;
- Barriers, such as ditches and dikes, shall be used to divert runoff from excavations and trenches;
- A daily excavation inspection form will be used and completed by a competent person to document the trench conditions; and,
- Trenches shall be reinspected prior to re-entry after water accumulation due to heavy rainfall or seepage.

12.1.6 Stability of Adjacent Structures

When excavating or trenching near an adjacent structure, the following practices shall be implemented:

- Support systems, such as shoring, bracing, or underpinning shall be provided where the stability of building, walls, or other structures is endangered by excavation;
- Excavations at the bases or footings of foundations is prohibited unless support systems are used, the excavation is in stable rock, a professional engineer (PE) has determined the structure is sufficiently removed from the site as to not pose a hazard, or the PE determines that the excavation shall not pose a hazard to employees due to the structure;
- Support systems shall be used when it its necessary to undermine sidewalks, pavements, and appurtenant structures; and,
- Surcharge load sources and adjacent encumbrances shall be listed with the evaluation dates in the field notebook daily.

12.1.7 Sloping and Benching

All sloping and benching shall be done in accordance with 29 CFR 1926.652, Appendix B. Protective systems are required on all excavations over five feet in depth or in excavations less

than five feet if inspection indicates conditions that will result in a cave-in. Protection systems shall be one in accordance with 29 CFR 1926.652, Appendices C & D.

12.2 Fall Protection

Fall protection equipment is required if the following conditions require an employee is six feet or more above a lower level or six feet or more below a higher level:

- Unprotected sides/edges
- Leading edges
- Hoist areas
- Floor openings
- Form work and reinforcing steel
- Ramps, runways
- Excavations
- Dangerous equipment
- Overhead bricklaying and related work
- Roofing
- Precast concrete erections
- Wall openings
- Parapits

Fall protection equipment, consisting of guardrails, safety nets, or personal fall arrest systems (PFAS) shall be used in accordance with OSHA regulations (29 CFR 1926, Subpart M).

12.2.1 Engineering Controls

Climbing stairs, working at elevation (more than six feet above grade), on platforms roofs or scaffolding; working on ladders, or performing activities where falls could result in injury, immersion in water or contact with chemicals requires provisions for preventing falling. Ideally this prevention will be provided by engineering control, safety railings, and toe boards, etc. Ladder use, circumstances in construction at hazardous materials sites, or environmental assessments may require Fall Protection PPE in addition to or instead of engineering controls.

12.2.2 Personal Protective Equipment

Fall Protection Devices and Lifeline Systems consist of, full body safety harness, lanyards and safety lines. A rope-grabbing device may be used to connect the lanyard to the safety line and act as a brake.

Prior to use of Fall Protection Equipment, personnel shall be trained in use, maintenance and inspection of the PPE. General safety training is to be supplemented with site-specific training.

A Lifeline System shall meet the Standards and Criteria of OSHA 1926.104 and ANSI A10.32-2004, specifically:

1. The Anchorage point shall be able to support a minimum dead weight of 5,000 lb.
2. Lifelines shall be of 3/4 inch manila or equivalent and have a minimum breaking strength of 5,000 lb. Lifelines used for rockwork or which may be subjected to abrasion shall be 7/8 inch wire core manila rope.

3. Safety Belt Lanyard shall be a minimum of 1/2 inch nylon rope or equivalent, no longer than 6 feet and have a minimum breaking strength of 3,000 lb.
4. Bolts, shackles, D-rings, snap hooks, and metal links shall be able to bear a tensile load of 5,000 lb. without cracking, breaking, or permanent distortion.
5. All Lifeline System hardware shall be drop forged or pressed steel, cadmium plated in accordance with Type 1 Class B Plating specified in Federal Specification QQ-P-416. Surfaces shall be smooth and free of defects.

A person experienced in Lifeline Systems use shall inspect the entire system before and after each use and at regular (monthly) intervals between uses and document the findings. Lifeline System elements showing any sign of stress or damage or which have been used to break a free fall shall be taken out of service immediately and destroyed.

Choice of a lifeline system for each HASP will be based upon the actual needs of the activity and shall be approved by the Corporate Health and Safety Manager or the approved, trained, experienced designee.

12.2.3 Scaffolding - General

Scaffolding is to be used according to the general standards established below. Specific standards as prescribed by: 29 CFR 1910.28 and 1910.29, 29 CFR 1926.451 and 1926.452 whenever work cannot be done safely from the ground or solid construction.

There are many different types of scaffolds with specific safety requirements for each. Specific requirements for other types of scaffolding will be established on a case-by-case basis; listed below are the more general requirements which apply to wooden, single or double pole, tube and coupler, tubular welded frame steel, and manually propelled mobile type scaffolding.

12.2.4 General Scaffold Construction Criteria

- Sound footing shall be provided. Sound footing is rigid, and capable of supporting the maximum intended load plus the weight of the scaffolding without settling. Support poles shall be plumb and any protruding edges that an employee may have the potential of becoming impaled on covered by orange 4” x4” protective caps.
- Handrails shall be installed on all open sides of platforms more than 4 feet high and handrails and toeboards on platforms 10 feet high or higher. Install wire screen (18-gauge US Standard 1/2-inch mesh) between the toeboard and guardrail if people will work or pass under scaffolding.
- Scaffolds shall be able to support 4 to 6 times the maximum intended load, but never be loaded beyond the intended load rating.
- Scaffolds shall be erected and inspected before each use by competent persons. Any defects shall be repaired before use.
- Scaffolds shall be maintained in safe condition and should never be altered or moved horizontally, except under specific, controlled situations, when occupied.
- Nails and bolts shall be of sufficient number and size at each connection. Nails shall be driven full length and not subject to straight pull stress.
- Scaffold planking shall be scaffold grade, and planks or platforms shall overlap by at least 12 inches or be secured from moving. Planks that abut shall have flush joints centered on a pole and be supported by separate bearers for each plank end. Planking shall extend over their end supports by 6 to 18 inches and be placed with edges close together so tools or

fragments cannot fall through. When scaffolding extends around a corner, planking shall be placed to avoid tipping.

- Scaffolds shall be secured to permanent structures by use of anchor bolts or equivalent, but not by using window cleaners anchor bolts.
- Faces and ends of scaffolding shall have cross-bracing to prevent lateral movement or buckling and to keep scaffold square and plumb. There shall be cross bracing between inner and outer poles.

12.2.5 Scaffold Use Criteria

- A ladder or other safe form of access shall be provided for reaching platforms.
- A tagline shall be used for hoisting materials onto a scaffold.
- Overhead protection shall be provided for workers on scaffolds where overhead hazards exist.
- Employees may not work on scaffolds in storm conditions, high winds (>20 mph), or when covered with ice or snow.
- Walking surfaces of scaffolds shall be kept free of tools, materials, or debris.
- Hot work or cutting shall be prohibited on scaffolding secured by rope, polyethylene or nylon line. Protect rope or lines and scaffolding steel from effects of corrosive or chemical atmospheres.
- Handtools are recommended to be connected to a lanyard to prevent falling if dislodged from the user.

12.3 Demolition

12.3.1 Preparatory Operations

The following procedures should be followed prior to demolition activities:

1. An engineering survey of the structure to determine the conditions of the framing, floors, and walls, and possibility of unplanned collapse of any portion of the structure shall be completed and a written report submitted.
2. Walls and/or floors shall be shored or braced if the structure has been damaged by fire, flood, explosion or other cause.
3. Utilities shall be shut off, capped or otherwise controlled prior to building demolition.
4. If utilities are necessary, temporary lines will be provided and protected.
5. If previous studies or information indicate that pipes, tanks, or other equipment that exists on site may contain or may have contained hazardous chemicals, gases, explosives, flammable materials, or other dangerous substances, the Project Manager has the responsibility to forward that information to the CHSM and SSO so that testing and purging of materials can be performed and the hazard eliminated prior to demolition.
6. Glass hazards shall be removed prior to demolition.
7. If a fall hazard exists, opening shall be protected to a height of 42 inches.
8. If debris is dropped through holes in the floor, barricades shall be constructed in accordance with 29 CFR 1926.850(h) and signs shall be posted.
9. Floor openings shall be covered with a material sufficient to support the weight of any load which may be imposed.

10. Demolition of exterior walls and floor construction shall begin at the top of the structure and proceed downward.
11. Employee entrances, stairs, passageways, and ladders shall be completely protected in accordance with 29 CFR 1926.850(k) and 29 CFR 1926.851.
12. Material drop chutes shall comply with the standards in 29 CFR 1926.852.

12.4 Blasting and Explosives

Any BEM employee performing technical oversight of demolition activities should be familiar with the demolition safety procedures as outlined in 29 CFR 1926, Subpart T. Under no circumstances are BEM personnel to handle, load, detonate, or inspect blasting media.

12.4.1 Safety Precautions

The following safety precautions are applicable for demolition operations:

- Explosive safety requirements and criteria pertaining to the storage, handling, and transportation of explosives will be followed as per publications AFM 127-100, OP 5, TM 9-1300-206, and AMCR 385-100.
- Prompt action will be taken to control any hazard. If an immediately dangerous situation is encountered, operations in the vicinity will be shut down and personnel evacuated to a safe location. Operations will not resume until hazards have been eliminated.
- Do not conduct blasting or demolition operations during an electrical, dust, sand, or snow storm that produces atmospheric static electrical charges or if such a storm is impending.
- Do not ingest explosive materials.
- Avoid contact with and inhalation of the smoke of burning explosives.
- Do not permit more than the required types and amounts of explosive required for the operations to be brought to the demolition site.
- Do not use alkaline materials to wash TNT residuals.
- The explosive end of blasting caps, detonators, and explosive devices should be pointed away from the body during handling.

12.4.2 Storage

- Explosives should not be abandoned.
- Obviously deteriorated or damaged explosives or accessory equipment should not be used.
- Store explosives in a magazine which is constructed to be fire and bullet resistant and is clean, dry, well-ventilated, reasonable cool.
- Store explosives properly without the use of wood, paper, or other combustible materials and keep from heat sources.
- Ensure that any grass surrounding magazines is maintained low and at least 25 feet from each magazine.
- Sparking metal or metal tools should not be stored near an explosive magazine.
- Sources of fire or flame (e.g., smoking, matches) are not allowed within 100 feet of the area where explosives are stored or handled.
- Blasting caps shall be carried in approved containers and kept out of direct sunlight.
- Ensure that explosives are returned to their proper containers and the containers are closed after each use.

- Unauthorized or unnecessary personnel shall not be present when explosives are stored or handled.

The four construction safety practices listed are those that BEM personnel encounter most frequently. Others will be added, as necessary.

12.5 Shoring/Trenching

Shoring and trenching is covered under OSHA construction code (29 CFR 1926), Excavation and Trenching (Subpart P).

12.5.1 Applicability

Any personnel who conducts technical oversight of excavation and trenching activities should be familiar with the applicable health and safety regulations covering excavation and trenching (29 CFR 1926 Subpart P).

12.5.2 Responsibilities

The SSO or their designee is responsible for:

- Providing oversight on the implementation of the requirements contained in this procedure;
- Conducting periodic reviews of open trenches and excavations;
- Consulting with the PM/Subcontractor on excavation issues; and
- Maintaining required records.

12.5.3 General Requirements

- Surfaces surrounding open trenches and excavations shall have all surface hazards removed.
- All utilities shall be located and cleared at least three days prior to digging. In New York, New Jersey, Delaware, and Pennsylvania, call 1-800-272-1000 or reference www.nuca.com/safety/onecall.htm for additional regional information. When the excavation is open, utilities shall be supported and protected from damage and documented daily.
- If structural ramps are necessary for entering/exiting the excavation, the ramps will be installed in accordance with 29 CFR 1926.651(c)(1).
- A means of egress (e.g., stairways, ladders, ramps) is required for all excavations greater than four feet in depth. Travel distance shall be no more than 25 feet between means of egress.
- Employees will not stand under suspended loads during loading or unloading of equipment.
- When vehicles and machinery are operating adjacent to excavations, warning systems, such as stop logs or barricades, shall be utilized to prevent vehicles from entering the excavation
- Trenches/excavations shall be shored in accordance with OSHA requirements to prevent entrapment from eroding soil/rock.
- Barriers shall be employed to prevent inadvertent falls into the excavation.
- Walkways or bridges with standard railings shall be provided at points employees are to cross over excavations or trenches.

12.5.4 Hazardous Atmospheres

- If hazardous atmospheres are suspected or encountered, perform air monitoring using appropriate detection equipment (e.g., photoionization detector, LEL/oxygen meter/toxic gases). At no time should personnel enter an excavation with a hazardous atmosphere without performing air monitoring.
- Personnel entering an excavation with a hazardous atmosphere shall use PPE and other engineering measures to reduce employee exposure to concentrations below the published exposure limits.
- Emergency equipment shall be provided when the potential for hazardous atmospheres exist. Required equipment (e.g., breathing apparatus, lifelines, stretchers) should be checked daily.

13.0 PERSONAL AND FIELD EQUIPMENT DECONTAMINATION

13.1 Purpose

This section establishes general decontamination guidelines for activities involving known or potential hazardous substances. This section applies to all BEM field activities where exposure to hazardous substances may occur.

13.2 Responsibilities

13.2.1 Corporate Health and Safety Manager

The SSO is responsible for providing the technical staff with training in proper decontamination procedures.

13.2.2 Project Manager

The PM or designee will ensure that sufficient information has been provided to the SSO to prepare adequate decontamination procedures for inclusion in the site-specific HASP.

13.2.3 Site Safety Officer

The SSO is responsible for implementing adequate decontamination procedures to prevent contamination of individuals of the environment beyond the exclusion zone.

13.3 Introduction

Field activities include the potential for contact with contaminated environmental media. Contact with contaminated media is unacceptable for the health of contacted individual and the potential for contaminated media to be dispersed into the environment and cause adverse health effects to other individuals and the environment.

Therefore, contaminant avoidance is the first and best method to prevent the dispersal of contaminated media from a hazardous materials site. As part of the HASP, procedures shall be implemented to prevent the contamination of personnel and equipment. This includes contaminant avoidance procedures as well as decontamination procedures.

Decontamination involves physically removing contaminants and/or converting them chemically into innocuous substances. The extent of the decontamination depends on a number of factors, the most important being the types of contaminants and the end use of the items to be decontaminated. Cross-contamination from protective clothing to wearers, equipment to

personnel, and one area to another can be minimized through a combination of decontamination, the correct donning and doffing of protective clothing, and the zoning of site work areas.

13.4 Decontamination Plan

A decontamination plan shall be developed, as part of the site-specific HASP and set up prior to the beginning of work activities where personnel and equipment may be exposed to hazardous substances. The decontamination plan should include the following:

- The number and layout of decontamination stations;
- Equipment needed for decontamination of personnel and equipment;
- Appropriate decontamination methods;
- Procedures to prevent cross-contamination and prevent contamination from leaving the decontamination area;
- Procedures to minimize worker contact with contaminants during removal of PPE; and,
- Procedures to properly dispose of contaminated PPE and decontamination fluids.

13.5 Contaminant Avoidance Procedures

Each person involved in site operations shall regularly practice the basic methods of contamination avoidance:

- Know the limitations of any protective equipment being used;
- Do not enter a contaminated area unless it is necessary, you are authorized, and you have the appropriate protective equipment;
- When in a contaminated area, avoid unnecessary contact with contaminated materials;
- Walk around pools of liquids, discolored areas, or any area that shows evidence of possible contamination;
- Walk upwind of contamination, if possible;
- Do not sit or lean against anything in a contaminated area. In cases where you have to kneel (e.g., to take samples), use a plastic ground sheet;
- Before sampling any hazardous waste, read the label and manifest (if available) for all container to determine the identity of the substance to be sample and the potential contamination hazard. Be cautious, the label may not accurately reflect contents;
- Field personnel should check for potential incompatibility of wastes. These conditions might be caused by heat, fire, gas, and explosion; the contact of water and alkali metals; violent polymerization; or solubilization of toxic substances. Check waste containers for evidence of these conditions such as bulged drums, blistered paint, exploded drums, bubbles, corrosion, or melted plastic; and
- Use the proper tools necessary to safely conduct the study.

13.6 Site Control Zones

Prior to the initiation of any field activities, site control measures (i.e., establishment of work zones) shall be implemented to:

- Reduce accidental spread of hazardous substances by workers or equipment from contaminated areas to the clean area;
- Confine work activities to appropriate areas, minimizing likelihood of accidental exposure,

- Facilitate location and evacuation of personnel in case of an emergency.

In general, three work zones are used: the exclusion zone, the contaminant reduction zone, and the support zone. Each of these are discussed in the following sections.

13.6.1 Exclusion Zone

The exclusion zone is the area where contamination is either known or expected to occur and the greatest potential for exposure exists. The exclusion zone ("hot zone") separates the area of contamination from the rest of the site and should be physically secured (barrier tape, fences, chains) from the rest of the site. The hot zone:

- Provides sufficient space to protect personnel outside the zone from potential fire or explosions;
- Allows an adequate area in which to conduct site operations; and
- Reduces the potential for contaminant migration.

13.6.2 Contaminant Reduction Zone

The contaminant reduction zone (CRZ) is the transition area between the exclusion zone ("hot zone") and the support zone ("clean zone"). The CRZ is the area in which decontamination procedures take place so that contamination decreases while progressing from the exclusion zone to the support zone.

The SSO shall exercise professional judgment in determining how the Contamination Reduction Zone will be organized and what decontamination materials will be used. Factors to be considered include:

- The extent and type of hazard expected;
- Number of site personnel requiring decontamination facilities;
- Explosive potential;
- Meteorological conditions;
- Topography;
- Levels of protection selected; and,
- Availability of equipment and supplies.

13.6.3 Support Zone

The Support Zone is the uncontaminated area where workers are unlikely to be exposed to hazardous substances or dangerous conditions. The Support Zone is the appropriate location for the command post, medical station, equipment and supply center, field laboratory and any other administrative or support functions that are necessary to keep site operations running efficiently.

Access is restricted in the Support Zone to authorized site personnel. However, all personnel located in the Support Zone shall receive instruction in the proper evacuation procedures in case of a hazardous substance release or other emergency.

13.7 Selection of Decontamination Fluids

For the decontamination of most contaminated media, the USEPA and state regulatory agency advocate the use of an alconox (or equivalent) and water wash and water rinse for personnel. Vehicles are usually decontaminated with the steam cleaning. Decontamination of sampling equipment is dependent of the type of contaminant; however, the USEPA and state regulatory

agency advocate the use of an alconox (or equivalent) and water wash and water rinse followed by an acetone rinse and 10% nitric acid rinse (if analyzing for metals). For grossly contaminated media, the use of disposable sampling equipment may be advantageous. If this is not possible, the following table lists various contaminant groups and solvents useful for decontamination.

Decontamination Solvents

Solvent	Soluble Contaminants
Water	• Low-chain hydrocarbons • Inorganic compounds • Salts • Some organic acids and other polar compounds
Dilute Acids	• Basic compounds • Amines • Hydrazines
Dilute Bases e.g., detergents	• Acidic compounds • Phenols • Thiols • Some nitro and sulfonic compounds
Organic Solvents[1] • Alcohols • Ethers • Ketones • Aromatics • Straight-chain alkanes (e.g., hexane) • Petroleum products (e.g., kerosene, fuel oil)	• Nonpolar compounds (e.g., some organic compounds)

13.8 Decontamination Procedures

Decontamination procedures are dependent on the level of respiratory and dermal protection employed during site activities. The higher the level of protection, the more steps in the decontamination procedures. BEM personnel typically conduct field activities by utilizing Level C and Level D respiratory/dermal protection; therefore, this section discusses the full decontamination procedures for these PPE levels only. If Level B protection is required, specific procedures will be incorporated into the site-specific HASP and associated training provided accordingly.

Equipment necessary for decontamination of personnel should include:

- Plastic drop cloths;
- Plastic wash tubs;
- Long-handled brushes;
- Decontamination fluids (e.g., alconox, water);
- Paper towels;
- Spray units; and,

[1] WARNING: Some organic solvents can permeate and/or degrade protective clothing and gloves.

- Containers for collection of wash water (as necessary).

13.8.1 Level C Decontamination Procedures

The following section outlines the decontamination procedures for Level C respiratory/dermal protection, which consists of:

- Chemical resistant coveralls (e.g., Tyvek®, Saranex®);
- Air purifying respirator with appropriate cartridges;
- Chemically resistant boot covers;
- Steel toed boots;
- Chemical-resistant outer gloves;
- Nitrile gloves; and
- Hard hat (as required).

The following procedures assume that personnel and equipment are grossly contaminated. In general, these steps shall be followed; however, the decontamination procedures may be modified in the site-specific HASPs, with the approval of the CHSM.

1. Segregated equipment drops
2. Outer glove/coverall/boot cover wash and rinse
3. Outer glove/coverall/boot cover removal
4. Cartridge replacement/respirator removal, as applicable
5. Inner glove wash and rinse

Disposal of investigation-derived materials will be discussed in Section 13.9.

13.8.2 Level D Decontamination Procedures

The following section outlines the decontamination procedures for Level D dermal protection, which consists of:

- Steel toed boots
- Chemical-resistant outer gloves
- Nitrile gloves
- Hard hat (as required)
- Safety goggles

In general, the steps for Level D shall be followed; however, the decontamination procedures may be modified in the site-specific HASP, with the approval of the SSO.

1. Segregated equipment drops
2. Outer glove wash and rinse
3. Outer glove removal
4. Inner glove wash and rinse

Disposal of investigation-derived materials will be discussed in Section 13.9.

13.9 Disposal of Investigation-Derived Materials

Drill cuttings and field decontamination wastes are to be collected and drummed until laboratory analysis of the materials determines the constituents and their respective concentrations.

Disposal of the contaminated media is dependent on state-specific and RCRA regulations. The disposal of investigation-derived materials should be addressed in the site-specific HASP.

14.0 ERGONOMICS

This Ergonomics Program represents a logical approach to reducing occupational injuries and illnesses. The program addresses hazard recognition and prevention, as well as how employers respond to individual cases. Employers are required to address ergonomic concerns and employee complaints as covered under the OSHA General Duty Clause.

Ergonomics is the science of designing workstations and tools to accommodate peoples' physiques and movements. Ergonomic complaints are classified as Muscular Skeletal Disorders (MSDs) which include strains/sprains, back pain (pinched nerves, herniated discs), and Repetitive Motion Diseases such as Carpal Tunnel Syndrome.

Ergonomic injuries can occur suddenly, often from an awkward or sudden movement, such as crouching for hours and then straining your back when you get up and reach for something heavy on a high shelf. Ergonomic injuries can also develop gradually, such as pain and cramping in the hands when tendons in the wrist become inflamed after12 weeks of turning sheet metal screws in a factory.

14.1 Responsibilities

14.1.1 Corporate Health and Safety Manager

The CHSM is responsible for providing ergonomics general guidance on the preparation and implementation of this program. The CHSM will assign responsibilities and ensure the tasks associated with this program are completed. The CHSM will investigate developments in the promulgation of the former OSHA standard and industry practices and prepare revisions to this program as warranted. The CHSM will provide formal evaluation of the program and recommendations for improvement. The CHSM is part of the management review team that evaluates MSD complaints.

14.1.2 Ergonomics Program Manager

The CHSM will hire a subcontract Ergonomics Program Manager (EPM) or CIH/CSP to identify personnel who perform work activities that make this program applicable to them. This includes field managers who perform health and safety oversight and office personnel for whom typing is a core responsibility. The Program Manager will ensure these personnel receive training on hazard information, procedures for reporting MSDs, activity hazard analysis, and hazard control appropriate to their activities. The Program Manager will solicit complaints about workstations and job tasks from BEM personnel and make recommendations for measures to alleviate the discomfort or otherwise reduce the potential for injury.

14.1.3 Site Safety Officer

The SSO is responsible for evaluating work activities to determine if there are site personnel covered by this program. The SSO is also responsible for ensuring site personnel covered by this program receive training on hazard information, procedures for reporting MSDs, activity hazard analysis, and hazard control appropriate to their activities.

14.1.4 Human Resource Manager

The HR department manages BEM's Workers Compensation Program, including costs for medical treatment and services and other related workers compensation costs.

14.2 Hazard Information and Reporting

Employees are instructed to report MSD signs and symptoms to the EPM. The form provided in Appendix A shall be utilized to report an MSD complaint for evaluation. The EPM will issue a report, whereupon a management team will review the report and determine whether a covered MSD has occurred.

The following information will be provided to identify at risk employees:

1. Common MSD hazards;
2. The signs and symptoms of MSDs, and the importance of reporting them early;
3. How to report MSD signs and symptoms; and
4. A summary of the requirements of this standard.

14.3 Job Hazard Analysis and Control

The EPM or designee will analyze problem jobs to identify the "ergonomic risk factors" that result in MSD hazards. BEM will work to eliminate the MSD hazards, reduce them to the extent feasible, or materially reduce them using an incremental abatement process (described in this program). If the MSD hazards only pose a risk to an employee with an existing MSD, the job hazard analysis and control may be limited to that individual employee's job.

14.3.1 Ergonomic Hazard Analysis

The analyses of problem jobs will include a list of the employees in the problem job, inquires to affected employees whether performing the job poses physical difficulties and, if so, which physical work activities or conditions of the job they associate with the difficulties. The EPM or Field Manager will observe the employees performing the job to identify which of the following.

14.3.2 Ergonomic Hazard Control

The following measures are suggested as ways to control identified hazards.

- Employees in the problem job will be asked for recommendations about eliminating or materially reducing the MSD hazards;
- Identify, assess and implement feasible controls (interim and/or permanent) to eliminate or materially reduce the MSD hazards. This includes prioritizing the control of hazards, where necessary;
- Track the progress in eliminating or materially reducing the MSD hazards. This includes consulting with employees in problem jobs about whether the implemented controls have eliminated or materially reduced the hazards; and,
- Identify and evaluate MSD hazards when there are changes to design or the acquisition of equipment or processes in problem jobs.

PPE may be used to supplement engineering, work practice and administrative controls, but may only be used alone where other controls are not feasible. Where PPE is used, it is provided at no cost to BEM employees. Back belts/braces and wrist braces/splints are not considered PPE for the purposes of this program, however they may be recommended and/or furnished for certain

projects/tasks. BEM may make recommendations or stipulate requirements for PPE to subcontractors, as deemed appropriate by the PM.

BEM is not required to provide material handling equipment or PPE to subcontractor personnel, even when it is deemed necessary to control MSD risks. The subcontractor personnel should request PPE or other types of hazard controls with their employers.

14.4 Training

BEM will provide training to identify at risk employees so they know about MSD hazards and this corporate ergonomics program. Training will include measures for anticipation and recognition of ergonomic hazards as well as measures for eliminating or materially reducing the hazards. Training will be provided during new employee orientation and at least every three years. Training will also be provided initially for personnel hired or assigned into jobs identified as being at risk jobs.

Personnel to be trained include:

1. Employees in problem jobs;
2. Supervisors of employees in problem jobs; and,
3. Field Managers of subcontractor personnel engaged in problem jobs.

Following is a list of the subjects training must cover:

- How to recognize MSD signs and symptoms;
- How to report MSD signs and symptoms, and the importance of early reporting;
- MSD hazards in their jobs and the measures they must follow to protect themselves from exposure to MSD hazards;
- Job-specific controls implemented in their jobs;
- The ergonomics program and their role in it;
- The requirements of the former OSHA ergonomics standard;
- How to identify and analyze MSD hazards and measures to eliminate or materially reduce the hazards;
- How to evaluate the effectiveness of ergonomics programs and controls; and
- Question and Answer Discussion.

14.5 Recordkeeping

The following records will be kept for at least three years:

A. Employee reports and BEM responses;
B. Job hazard analysis;
C. Hazard control records;
D. Quick Fix control records, and,
E. Ergonomics program evaluation.

MSD management records will be maintained for the duration of the injured employee's employment plus three years.

15.0 DRUG FREE WORKPLACE

15.1 Controlled Substance Policy

BEM is a government contractor; as such, BEM is requirement under Federal Law to adopt a policy, which prohibits any illegal drug-related activity by personnel assigned to a government contract (Drug Free Workplace Act 1988, Public Law 100-690 and Federal Acquisition Regulation 97-06: Part 23, Subpart 23.5, Drug-Free Workplace). Due to the management difficulties, which would be faced in restricting the drug abuse policy to those employees now involved in such government contracts, the controlled substance policy will apply to all BEM personnel.

Illegal use of controlled substances constitutes a real threat to the safety of BEM personnel, as well as to the reputation and image of the company as a safe, efficient, and professionally oriented organization. Each of you should become familiar with the drug awareness program and adhere to the policy.

It is important that all BEM personnel maintain a workplace free of drugs. As part of the BEM Controlled Substance Program, the following information is provided concerning drug abuse, along with the corporate policy and operative aspects that will affect all BEM employees.

Any person who refuses to participate in the operational aspects of the policy, or has a positive test confirmed for the presence of controlled substances, or who is found using, possessing, manufacturing, distributing, dispensing, or selling any controlled subsistence type named in the policy is subject to disciplinary action, up to and including immediate suspension, discharge from employment, and criminal prosecution.

Persons discharged for controlled substance use may be considered for re-hire only under specific conditions. At its direction, the Company may make available an opportunity for the employee to seek professional counseling and assistance through outside rehabilitation services.

All employees are required to abide by the terms of this policy and notify HR of any criminal drug statute conviction for a violation occurring in or outside of the workplace no later than five days after such conviction.

The information explains employee participation in the BEM controlled Substance Program as a condition of employment. The HR Manager are jointly responsible for the ongoing maintenance of this program. Questions may be directed to either of those individuals.

15.2 Controlled Substance Policy Statement

BEM is committed to maintaining a safe and productive workplace free from drugs, for all employees. The Company recognizes that drugs and other controlled substance abuse will impair an employee's ability to perform properly and can have hazardous adverse effects on the Company in achieving its commitment. BEM strictly prohibits the use, manufacture, possession, distribution, dispensing, and sale on its job sites or facilities of any of the following controlled substances: intoxicants, narcotics, prescribed drugs (that are misused), synthetic drugs, and all other related drug paraphernalia. Company employees are prohibited from reporting for duty under the influence of any of the above-named substances or any other substance that may in any way adversely affect their working ability, alertness, coordination, response, or the safety of themselves or others on the job. Employees involved in serious on-the-job accidents or those

reasonably suspected as being under the influence of controlled substances are subject to drug testing.

15.3 The Dangers of Drug Abuse

The dangers involved in the abuse of controlled substances are well documented. The law (Drug Free Workplace Act) requires BEM, as a government contractor, to make each employee aware of how drugs can affect the individual. Specifically, drugs can:

- Altered confidence levels (e.g., individuals think they can do more than is actually possible).
- Impede perception (i.e., sense of time, space, and distance). This is especially dangerous when operating machinery or driving.
- Altered sense of responsibility, including:
- Increased lateness and absenteeism, increasing workload of others;
- Careless behavior;
- Increased theft to finance someone else's drug habit; and
- Increased errors, risking harm to the clients and endangering our professional reputation.
- On the job, drug abuse affects one's ability to think clearly, impairing one's awareness, decision making, judgments, reflexes, coordination, communication, and responsiveness -- all vital ingredients to hazard recognition and accident avoidance. Among the dangers in the workplace, drug abuse causes behavior that is inconsistent with the objective of working in a safe and efficient manner. An employee that abuses drugs attempts to function in a physically and mentally hampered condition. He/she presents a real danger to both himself/herself and others.
- Off the job, the illegal use of drugs also carries with it the possible eventual breakdown of many physical functions and responses associated with normal social behavior, as well as the very real possibility of eventual detection, followed by public embarrassment, loss of earnings, and criminal prosecution.

15.4 General Policy Provisions and Guidelines

15.4.1 Alcohol

No employee is allowed to possess alcohol products while operating a motor vehicle or performing a field or project related function during related business activities.

No employee is allowed to report for duty or remain on duty under the following circumstances:

- While having alcohol in his/her possession
- While having a breath alcohol concentration of 0.04 percent or greater as indicated by an alcohol breath test. An employee shall be removed from performing fieldwork if he/she has a breath alcohol concentration of .02 or greater. Such employee is subject to retesting and may be referred for assessment.
- While using alcohol.
- Within four hours after using alcohol.

In addition, any employee is prohibited from refusing to submit to an alcohol test and from using alcohol within eight hours after an accident, unless the test has been completed.

15.4.2 Controlled Substances

Use or possession of illegal substances by staff is prohibited while on the job, client property, or during corporate recognized and sponsored functions; no employee may have detectable levels of illegal substances while on duty. Any unauthorized use of controlled substances is prohibited. No employee shall be allowed to perform fieldwork while impaired by medication, including over-the-counter medications. Any employee who is impaired by medication must notify his supervisor immediately. An employee may be required to provide a physician statement that medications prescribed and/or over-the-counter medications, do not adversely affect the employee's ability to operate a motor vehicle. The supervisor shall take appropriate action such as approving leave or giving the employee an alternate assignment on a temporary basis.

15.4.3 Employee Responsibility

It is the responsibility of supervisors to report reasonable belief that an employee is under the influence of alcohol or illegal drug use in the workplace or during working hours. The supervisor must document the reasons outlining the belief and immediately forward and communicate with HR.

15.4.4 Who is Subject to Testing

The policy requires testing of employees (other than administrative positions or functions) upon joining the firm and randomly for those who perform field tasks. This policy is effective from the time an employee begins to work or is required to be in readiness to work until the time he/she is relieved from work and all responsibility for performing work. Tests for both alcohol and controlled substances are required for the circumstances listed below.

15.4.5 Entrance Exams

Tests will be conducted after an employee accepts an offer of employment and before an employee performs fieldwork for the first time. Tests must also be completed upon return to work when an employee has been on leave or otherwise out of the program for a period of six months or longer. A person will not be allowed to perform fieldwork unless the alcohol concentration is less than .04 and may be retested in 24 hours if the result is .02 or greater but less than .04. The controlled substances test must be negative as determined by applying limits set in the federal guidelines.

15.4.6 Post Accident

Alcohol and controlled substances tests will be conducted after accidents on field staff whose performance could have contributed to the accident, as determined by a citation for a moving violation, and for all fatal accidents, even if the employee is not responsible. Tests should be done as soon as practicable after the accident although there should be no delay in any medical treatment required. Alcohol tests should be completed within two hours and controlled substance tests will be administered within 32 hours of the accident.

15.4.7 Reasonable Suspicion

These tests are ordered when a trained supervisor observes and documents appearance, behavior, speech or body odors of an employee that are characteristics of the use of alcohol or controlled substances. The HR Manager will review this documentation and pertinent information to ascertain the suspicion. If he/she agrees, he/she will order the employee to submit to a controlled substances and/or alcohol test. No employee shall be allowed to perform any business-related

function when suspected of being impaired until a test reports that he employee is medically sound to do so.

15.4.8 Random Testing

Tests are ordered on a random, unannounced basis from the pool of employees identified as subject to this policy. Random selection of employees is done by using a random selection method.

An employee notified by his/her supervisor to report for a controlled substances or alcohol test must go immediately to the collection site.

An employee's name remains in the pool after being tested so that every field employee shall have an equal chance of being tested each time selections are made.

15.4.9 Return to Duty Testing

Return to Duty - any employee who tests positive under this policy must test again before returning to fieldwork. This test must be no more than 0.02 for alcohol and negative for controlled substances.

15.4.10 How Tests Will Be Conducted

Testing for the use of alcohol will be done using evidential breath testing devices approved by the federal government. A screening test will be conducted first and anything less than 0.02 is considered a negative test. If the alcohol concentration is 0.02 or greater, a second confirmation test must be conducted. BEM or our clients reserves the right to order a blood test as additional confirmation in extraordinary situations.

15.4.11 Controlled Substances

Controlled substance tests will be performed by urinalysis and will check for the following drugs:

- Marijuana (THC metabolite)
- Cocaine
- Amphetamines and Methamphetamines
- Opiates (including heroin and codeine)
- Phencyclidine (PCP)
- Barbiturates
- Methadone
- Propoxyphene
- Benzodiazepines

Samples will be given at a collection site designated or approved by one of BEM's occupational medical providers and analysis shall be conducted by a laboratory certified by the U. S. Department of Health and Human Services. If a screening test is positive for a controlled substance, a confirmation test is performed using the gas chromatography/mass spectrometry analysis.

15.4.12 Testing Procedures

An employee or applicant will be given a written memo from the HR Manager to report to a collection site for testing. He/she will then report to the collection site immediately. He/she will follow procedures established by the collection site.

A breath alcohol test will be conducted at the site and/or when ordered, the employee will give a urine sample for controlled substances. The urine sample will be split in case of the possibility of retest.

15.4.13 Notification of Results

All controlled substances tests are reviewed and interpreted by a physician designated by BEM before they are reported to the firm. If the laboratory reports a confirmed positive result to the physician, the physician will contact the employee to determine if there is an alternative medical explanation for the substances found in the employee's urine specimen. If the employee provides appropriate documentation and the physician determines that it is legitimate medical use of the prohibited substances, the result is reported as negative to BEM, although the employee may not be medically qualified to perform fieldwork. The HR Manager will notify the employee of test results.

15.5 Consequences of a Positive Test

15.5.1 Removal from Driving

An employee who tests positive for controlled substances or alcohol, refuses to submit to such tests, or attempts to tamper with the test is in violation of this policy and shall be removed from performing fieldwork pending further action. Refusal to submit includes failure to provide an adequate breath or urine sample for testing.

15.5.2 Return to Work and Follow-up

Employees with a confirmed positive test for controlled substances or alcohol will be removed from field activities and referred to a Substance Abuse Professional for evaluation as appropriate. No employee shall be allowed to return to the field until he/she submits to a return to work test with confirmed negative. In addition, any employee with a confirmed positive test shall be required to sign a Return-To-Work Agreement prior to his/her return to fieldwork.

15.5.3 Confidentiality

Controlled substances and alcohol testing results and records shall be maintained under strict confidentiality by BEM and their approved medical providers. These results cannot be released to others without the written consent of the employee. Exceptions to these confidentiality provisions are limited to a decision maker in litigation or administrative proceedings or officials designated in the federal regulations.

Employees involved in testing and the administration of this policy shall observe strict confidentiality of an employee's test results and treatment. Any employee who violates this requirement for confidentiality will be subject to disciplinary action.

15.6 Training

Information Program - A program will be presented for all employees covered by this policy to help them understand this policy. This will include training on:

- The provisions of the policy,
- Information about controlled substances and alcohol use, and
- Treatment resources which are available.

The policy will be made known to all new employees and the information will be incorporated in new employee orientation.

Supervisors - Supervisors of field staff shall attend a program of training. This program will be designed to teach supervisors how to identify and document substance use among employees and to familiarize them with the controlled substances testing program, provisions of this policy, and related laws.

15.7 Inspections, Searches, and Cooperation with Law Enforcement

BEM reserves the right to conduct searches of property or personal effects of employees for the purpose of determining whether or not there are or have been violations of the Controlled Substance Policy, with or without an employee's consent.

Illegal drugs, drugs believed to be illegal and drug paraphernalia found on BEM or BEM client's property will be turned over to the appropriate law enforcement agency and full cooperation given to any subsequent investigation.

15.8 Disciplinary Action

As the abuse of controlled substances affects one's behavior and satisfactory performance, all drug related activity, as outlined in the Controlled Substance Policy, is strictly forbidden in the workplace.

Appropriate disciplinary action will result from a violation of the Company's Controlled Substance Policy. Depending upon the circumstances, disciplinary action may range from suspension up to and including termination of employment. The Company may in its sole discretion determine that, as a condition of continued employment the employee participate in an approved substance abuse program.

Any employee who refuses to consent to drug and alcohol testing will be subject to disciplinary action including and up to termination.

An employee that is terminated for drug activity in the workplace other than its intended use will not be reconsidered for employment by the Company.

15.9 Drug Dependency: Employee Assistance

An employee may voluntarily admit to HR, prior to drug testing, that they have an abuse problem without fear of discipline or termination. Upon admission of a substance abuse problem, the employee must apply for a leave of absence (if required for treatment) and immediately enroll in a rehabilitation program at the employee's own expense or as covered by the employee's medical insurance. A leave of absence would be approved upon federal and state leave regulations and approved by a member of the Executive Committee. After satisfactorily completing the rehabilitation program and returning to work, the employee agrees to follow-up testing.

An employee who is in rehabilitation or who has completed rehabilitation will be permitted to return to work upon presentation of a written release signed by a licensed physician or

recognized rehabilitation professional. The release must include a statement that the employee's presence in the workplace will not constitute a safety hazard to the employee, co-workers, or others throughout the course of business activities.

Should you have a drug dependency problem, and wish to bring it to the Company's attention, the matter will be handled directly and in strict confidentiality. You should direct your inquiry to the BEM HR Manager, Ms. Dawn Bushey at 908.598.2600, ext. 114, who will assist you in identifying professional counseling and rehabilitation services.

BEM CONTROLLED SUBSTANCE POLICY
CONSENT AGREEMENT

CONSENT AGREEMENT

I, _____ (insert name), agree to fully comply with the BEM Systems, Inc. (BEM) Controlled Substance Policy, to help ensure a safe, productive, and drug-free workplace as a result of my employment with the firm. I agree, if requested, to supply a specimen of urine at the occupational medical provider's office as indicated for analysis per the Company policy. The purpose of the test is to determine or rule out the presence of illegal or controlled substances. BEM will select the sample collection facility, laboratory, receive the test results, and certify the absence of controlled substances in my system as a result of the test.

Should I be requested to submit to a drug screen, I agree to disclose to the specimen collection facility information and identity about any controlled substances, prescription medications, and over-the-counter drugs that I have used, consumed, or been exposed to in the past 21 days that may influence the test results. My general practitioner has my legal authorization to supply the BEM Human Resource Manager any information they request regarding authorized, prescribed medications.

I understand that a positive confirmation of the presence of controlled substances in my specimen, my refusal to supply a sample for analysis, or not abiding by the operative aspects of the Policy, is cause for BEM to discontinue employment or the employment consideration process.

All related information concerning the drug testing program will be maintained secure and confidential by BEM except as provided above and within BEM's Controlled Substance Policy.

I acknowledge and agree to the above.

_____

Name

_____ _____

Signature Social Security Number

_____ _____

Witness Date

Attachment 5:

Resumes

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Name/Role	Employed By	☒ BEM	☒ Team Member
Christopher Pisarri, PG Program/QC Manager	Company Name	BEM Systems, Inc.	

Education	Professional Certification(s)	Years Exp.
BA, Geology	OSHA 40-hour Hazardous Waste Operations 29 CFR 1910.120 and OSHA 8-hour Supervisor Training Course for Hazardous Waste Operations 29 CFR 1910.120 with refresher Professional Geologist, New York EPA and ASTM Qualified Professional for All Appropriate Inquire Investigations FEMA IS-001000 Introduction to the Incident Command System, ICS-100 FEMA IS-002000.a ICS for Single Resources and Initial Action Incidents, ICS-200	24

Brief Description of Experience Supporting the Proposed Role

Mr. Pisarri has 24+ years of environmental experience conducting/managing a variety of construction, demolition, and remediation projects. He has managed multi-million dollar contracts and has provided QA/QC oversight of Federal projects. Mr. Pisarri has experience as a site supervisor and as a field QA/QC officer for projects that have included asbestos containment and removal, building demolition, petroleum system closure and construction, remedial system installation, underground utility abandonment and closure activities, installation of petroleum and potable water backflow devices, and site restoration projects.

Relevant Project Experience

January 2010 – Present, Program Manager, Remedial Action-Operation and Long Term Management of Multiple Sites, AK: Mr. Pisarri is the BEM Program Manager for the Remedial Action-Operations and Long Term Monitoring being implemented on behalf of the USAF at various remote radar stations and sites throughout Alaska. Mr. Pisarri's responsibilities have included continued marketing of the firm to grow job opportunities under this ongoing task, as well as building strong relationships between the firm, USAF, USACE and ADEC. Mr. Pisarri is involved in client presentations, team meetings, and regulatory consultations to work through project issues when they occur. Mr. Pisarri also supports project planning, logistical coordination to maximize company efficiencies and minimize cost to the client, as well as deliverable quality control review to maintain impeccable document delivery to the client and the State of Alaska.

January 2013 – Present, Program Manager, North Slope PBR, AK: Mr. Pisarri is the Program Manager for the North Slope PBR being implemented on behalf of the USAF at Barter Island, Bullen Point, Oliktok and Point Lonely. Mr. Pisarri is responsible for the overall execution of the work at these remote sites. Mr. Pisarri has conducted technical and status meetings with the USAF and ADEC Project Managers to provide updates on the project progress. Mr. Pisarri has developed remediation approaches for the excavation, assessment and offsite disposal of landfills as well as for bulk fuel petroleum storage tanks systems. Mr. Pisarri provided onsite supervision for the collection of sediment, soil, surface water, pore water and paint samples (more than 200 analytical samples in 2014) at these installations and has conducted detailed logistical scheduling for equipment and staff mobilizations by rolligons, barge and aircraft.

March 2013 – February 2015, Project Manager, Site ST007 Remedial Action - Cleanup at Campion Air Station, AK: Mr. Pisarri was responsible for the development of the technical approach for this project and lead the field efforts associated with this PBR project. Mr. Pisarri was responsible for

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negotiating subcontractor costs and conducting reviews of subcontractor proposals. Mr. Pisarri's responsibilities included the preparation and Quality Control review of project work plans for this remote site. He has prepared project meeting agenda, attended project meetings (kickoff and status) and prepared project meeting minutes. Mr. Pisarri conducted soil lithologic profiling for more than 60 soil borings, collected over 100 soil samples for laboratory confirmation analysis, conducted headspace screening of more than 400 discrete samples and worked with ADEC for the establishment of seep water sample collection efforts as part of this investigation. Mr. Pisarri has prepared project invoices, monthly progress reports and the project planning schedule for the Campion Air Station Project. Mr. Pisarri still serves as the point of contact for the ADEC Contaminated Sites Manger for this project and conducts inspections of the landfarming activities that are implemented on a continuing O&M basis for the USAF that includes the collection of MI soil samples and treated leachate samples for laboratory analysis.

October 2011 – October 2013, Program Manager, ANG Environmental Services Contract, United States: Mr. Pisarri is the current Program Manager for ANG's Environmental Services contract. Mr. Pisarri is responsible for the management and quality of all task orders issued for this multi-year contract that has included projects located throughout the Continental United States, Alaska, and Hawaii. Mr. Pisarri is currently managing the completion of Hazardous Waste Management Plans at 19 individual installations and the completion of Stormwater Pollution Prevention Plans at 13 separate installations located throughout the geographic foot print of the continental United States, Puerto Rico and the Virgin Islands. Mr. Pisarri is responsible for the management of staffing resources, coordination with the installation staff, presentations to A7AN staff, Quality Control of project deliverables, preparation of monthly invoices and progress reports, review of subcontractor invoices and optimized report templates for consistency.

January 2010 – January 2011, Field Team Leader, Columbus AFB Pumphouse (PH) No. 2 Closure, MS: Mr. Pisarri was the Field Team Leader for the removal of approximately 7,500 SF of asbestos floor tiles and roof panels, removal and salvage of all petroleum system components associated with the PH No. 2, demolition of PH No. 2, excavation and recycling of eight, 50,000 gallon USTs, excavation of more than 5,000 tons of petroleum-impacted soil, proper manifest and disposal of more than 130,000 gallons of IDW wastewater, preparation of trip reports and daily field reports, photo documentation of project activities, preparation of hot work, confined space, underground utility locate/excavation, and recycling permits for the project conducted on an active aircraft taxiway. Mr. Pisarri was also responsible for the quarterly LTM groundwater sampling events conducted at two project sites to assess for the presence of free-phase and dissolved petroleum constituents in groundwater and proper disposal of the IDW liquids.

July 2008 – August 2009, Project Manager, Petroleum LTM Program, Cape Canaveral Air Force Station (CCAFS) and Patrick Air Force Base (PAFB), FL: Mr. Pisarri was the Project Manager for the CCAFS and PAFB Petroleum LTM Program for the 45th Space Wing. Mr. Pisarri was responsible for petroleum remedial management and groundwater quality assessments at both military bases, which included 20 separate facilities currently under compliance with FDEP Long-Term Monitoring programs. Mr. Pisarri was responsible for ensuring that the project activities did not interfere with the Base's security objectives and training mission. Mr. Pisarri was responsible for preparing meeting materials for the annual FDEP and PAFB petroleum partnering team meetings and conducted presentations for the installations' remediation advisory board. Mr. Pisarri provided the technical evaluation and management oversight for the implementation of innovative biological remedial efforts at seven facilities which resulted in a reduction of the concentration of dissolved petroleum constituents within six months to achieve No Further Action for these facilities. Mr. Pisarri also coordinated IDW disposal with the installation staff.

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Mittul Patel, PE, LSRP

Health & Safety Manager

Professional Summary

Mr. Patel has 21 years of experience providing comprehensive environmental services to both private sector (industrial/commercial) and public-sector clients. He has been extensively involved in providing H&S oversight, air monitoring, NEPA Environmental Documentation, Section 106, permitting, remediation, compliance, and software solutions for state agencies, infrastructure clients, and transportation agencies, including NJ TRANSIT, the Air Force, NJDOT, PANY&NJ, the MTA, and LMCCC. Over the past 10 years, he has served as Principal Engineer/Contract Manager for numerous task order contracts.

Education

- ME, Environmental Engineering, University of Hartford, West Hartford, CT
- BE, Civil and Environmental Engineering, D. D. Institute of Technology, India

Professional Registrations

- Professional Engineer (PE):
  - NJ License No. 24GE04563800
  - CT License No. 25273
  - NY License No. 083871-1
  - LA License No. 0036255
- NJ Licensed Site Remediation Professional (LSRP) No. 591566
- NJ Underground Storage Tank Certification, License No. 0022889 (Install [Entire], Closure, Tank Testing, Subsurface Evaluation, and Corrosion Tester)

Project Experience

Corporate Health & Safety Manager
BEM Systems, Inc. – 2010 to Present

Mr. Patel is responsible for planning, developing, and managing company policies for complying with local, State, and Federal health and safety regulations. He designs and develops Corporate Health & Safety Plans and Site-Specific Accident Prevention Plans. Mr. Patel directs the preparation, maintenance, and updating of safe-work practices, environmental policies, and procedure manuals. He is responsible for compliance with all environmental health and safety standards per OSHA and EM 385-1-1 standards.

Major clients:

- **New Jersey Transit Corporation (NJ TRANSIT)**
  Mr. Patel has been responsible for health and safety oversight for a multitude of NJ TRANSIT projects, including the Hudson-Bergen Light Rail Transit System (H-BLRTS), the River Line, the Portal Bridge Project, the NJ TRANSIT Resilience Program (NJTRP, formerly the Superstorm Sandy Emergency Response Action Program), and the THE Tunnel Project.
- **New Jersey Dept. of Transportation (NJDOT)**
  Mr. Patel has managed health and safety compliance for over 50 statewide NJDOT task orders valued at over $2M, including three ongoing remediation sites.

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Name/Role	Employed By	☒ BEM	☒ Team Member
Benjamin Siwiec, CPG Field Team Leader/Site Safety & Health Officer	Company Name	BEM Systems, Inc.	

Education	Professional Certification(s)	Years Exp.
MS, Geology BS, Geology	OSHA 40-hour Hazardous Waste Operations 29 CFR 1910.120 with and refresher FEMA IS-001000 Introduction to the Incident Command System, ICS-100 Certified Professional Geologist, Alaska	16

Brief Description of Experience Supporting the Proposed Role

Mr. Siwiec has over 16 years of experience as a professional geologist and has over 12 years of experience in environmental site and remedial investigations, frequently as field team leader. Mr. Siwiec is experienced in field sampling techniques, testing of petroleum and hazardous waste (RCRA and TSCA) contamination by soil sampling, sediment, surface water, and groundwater sampling, coordinating field and equipment logistics for sites in remote locations, shipping hazardous and RCRA wastes by truck and barge, monitoring well installation and development, and hydraulic testing, screening and characterizing soil and waste during removal actions.

Relevant Project Experience

July 2017 – March 2020, Field Team Leader, Legacy Wells Remediation Project, National Petroleum Reserve-Alaska: Mr. Siwiec coordinated and conducted environmental remediation during the plugging and abandonment of multiple historical oil and gas wells. He coordinated waste transportation and disposal, collected soil and water samples and directed contaminated soil excavations and sampling. He conducted sub-cm accuracy field surveys with Trimble GPS and processed survey data with GIS.

May-August 2018 – Field Environmental Coordinator, Trans-Alaska Pipeline, AK: Mr. Siwiec coordinated environmental remediation during decommissioning of the Pump Station 10 facility. Duties included waste disposal coordination and contaminated soil delineation, oversight of petroleum pipe decontamination, and education/training of all site staff on environmental policies and protocols.

2015-2019, Field Team Leader, Multiple Air Terminals, AK: Mr. Siwiec was the field team leader conducting sampling of soil borings and groundwater wells at sites in Barrow, Fairbanks, and Kotzebue airports on multiple occasions. He utilized drill rigs for borings and installed, developed, and sampled monitoring wells, used hand auger for shallow soil borings, and evaluated contamination plumes.

August 2017, Field Team Leader, Contaminated Soil Removal, Fairbanks, AK: Mr. Siwiec was the field team leader, lead sampler and surveyor during removal of POL-contaminated soil from Nike Site Love. He used Topcon GPS survey equipment to perform sub-cm accuracy RTK survey of all excavation areas and sample locations.

September 2017, Field Team Leader, Contaminated Site Investigation, Goose Bay, AK: Mr. Siwiec oversaw the drilling program and collected soil samples to characterize a contamination plume at Nike Site Bay. He worked with a drilling contractor, logged soil cores, and collected samples.

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Attachment 6:

Field Safety Forms

CONTRACTOR'S QUALITY CONTROL DAILY REPORT

REPORT NO. _____ SHEET 1 OF _____

PROJECT				CONTRACT NO.	DATE
PARK				CONTRACTOR'S REPRESENTATIVE ON THE JOB	
WEATHER (Rain, Snow, Cloudy, Windy, etc.)	RAINFALL Inches	TEMPERATURE MAX.	MIN.	GROUND CONDITIONS (Dry, Damp, Wet, Frozen, etc.)	

1. PRIME CONTRACTOR

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	Comments

WORK PERFORMED BY PRIME CONTRACTOR:

MATERIALS DELIVERED | OFFICIAL VISITORS TO SITE

2A. SUBCONTRACTOR, _____: (If more than one subcontractor use copies of following page.)

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	Comments

WORK PERFORMED BY SUBCONTRACTOR:

3. SPECIFIC INSPECTIONS: (Inspections performed, results, and corrective actions)

4. TESTING: ☐1 Check if any testing was performed today. (Complete and attach Test Report Information Sheets.)

Type and Location of Testing: _____

5. VERBAL INSTRUCTION RECEIVED FROM GOVERNMENT ON CONSTRUCTION DEFICIENCIES OR RE-TESTING REQUIRED:

6. REMARKS:

7. CERTIFICATION:

I certify that the above report is complete and correct and that I, or my authorized representative, have inspected all work performed this day by the prime contractor and each subcontractor and determined that all materials, equipment, and workmanship are in strict compliance with the plans and specifications except as may be noted above.

_____

Contractor's Quality Control Representative

SUBCONTRACTOR WORK CONTINUED:	CONTRACT NO.	REPORT NO. _____ SHEET ____ OF ____

2 SUBCONTRACTOR,

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	Comments

WORK PERFORMED BY SUBCONTRACTOR:

2 SUBCONTRACTOR,

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	Comments

WORK PERFORMED BY SUBCONTRACTOR:

2 SUBCONTRACTOR,

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	Comments

WORK PERFORMED BY SUBCONTRACTOR:

2 SUBCONTRACTOR,

NO. EMPLOYEES BY JOB CATEGORIES	Hours	HEAVY EQUIPMENT ON JOB	NO. UNITS	HRS. WORKING		
				YES	NO	COMMENTS

WORK PERFORMED BY SUBCONTRACTOR:

Daily Tailgate Safety Meeting

Project No.

Site Location: Date:

Work to be performed:

HSE Hazard Identification/Considerations

Hazard possiblities	Considerations	Comments
☐ Slips, trips & falls	☐ Hazard areas acknowledged	
☐ Adverse weather conditions	☐ Proper clothing available	
☐ Noise	☐ Hearing protection	
☐ Power tools/hand tools	☐ Inspected & in good working condition	
☐	☐ Operator familiar with proper use	
☐ Presence of heavy equipment	☐ Communication/eye contact w/ operator	
☐ Electrical	☐ GFCI/Power shut-off switch or breaker	
☐ Flam./explosive materials	☐ Correct storage/secure if transporting	
☐ Hazardous materials	☐ Spill prevention measures in place	
	☐ MSDS readily available	
☐ Travel to and from site	☐ Load secured	
	☐ Vehicle in good working condition	
☐ Wildlife interaction	☐ Right of way to wildlife/avoid interaction	
☐ Travel over sensitive areas	☐ Minimize unnecessary impacts	
☐ Hazardous atmospheres	☐ Atmospheric monitoring devices (i.e. PID)	
☐ Below ground utilities	☐ Utility location complete	
☐ Pinch Points	☐ Hand protection	
☐ Vibration	☐ Anti-vibration gloves	
☐ Overhead hazards	☐ Power lines, loose items, pipelines, etc.	
☐ Site traffic	☐ Reflective and/or bright colored clothing	
Other -- Perform site walk and talk through activities to recognize other hazards (Use comment section if necessary)		
☐	☐	
☐	☐	
☐	☐	

PPE (As necessary to reduce or eliminate hazards)

☐ Hard hats	☐ Foot protection (i.e. steel toes,	☐ H2S monitor, PID, Multi-gas meter
☐ Safety glasses	☐ Hand (i.e anti-vibration, nitrile)	☐ Respirators or dust guard
☐ Hearing protection	☐ Flotation devices	☐ Fall protection
☐ Fire resistant clothing	☐ Slip Protection (ice grippers)	☐ Face Shields
☐ Other:	☐ Other:	☐ Other:

Other considerations

☐ Spill kit	☐ Viable means of communication available	☐ Safe site access/egress
☐ Fire extinguisher	☐ Ensure necessary permits are in place	☐ Proper waste disposal
☐ First aid kit	☐ Confined space/trenching hazards	

Emergency gathering area:

Location of nearest medical facility:

Emergency contacts:

Police: Ambulance: Fire:

Other:

Comments or special considerations:

I understand the HSE hazards of this job and agree to work safe and work smart.

Print name/company	Signature

BALANCED ENVIRONMENTAL MANAGEMENT
BEM SYSTEMS

Tailgate Wellness Check Log DATE:_____

Instructions: If you agree with the statement add an "X" in reponse to each question below your name. If you do not agree, leave the box blank.

Printed Name of employee	**Signature of employee/contractor**	I do not currently have a fever, nor have had a fever within the past 24 hours (I.e., greater than 100.4°F / 38°C), respiratory symptoms, diarrhea, or other unexplained severe illness.	I have not had "close contact"* with someone with COVID-19 (within the last 14 days). I have complied with State(s) travel advisory/restrictions and self-quarantine/ COVID-19 testing requirements

**Note: "close contact" is defined as:*
a) being within approximately 6 feet of a COVID-19 case for a prolonged period of time; close contact can occur while caring for, living with, visiting, or sharing a healthcare waiting area or room with a COVID-19 case; or
b) having direct contact with infectious secretions of a COVID-19 case (e.g., being coughed or sneezed on by someone who has been diagnosed).

Attachment 7:

Safety Data Sheets

Safety Data Sheet
According to the (US) Hazard Communication Standard (29 CFR 1910.1200)

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name	Buffer Solution pH 4.00	
Catalog Number	**YSI 3821**	
Product Description	Laboratory chemical, for use in calibrating pH probes.	
Supplier	YSI, a Xylem brand Telephone: 937-767-7241 Emergency: CHEMTREC US/Can: 800-424-9300 International: 001 703-572-3997	1725 Brannum Lane Yellow Springs, OH 45387 MSDSinfo@ysi.com YSI.com Collect calls accepted
Manufacturer	NCL of Wisconsin, Inc. Telephone: 1-800-648-7836 Email: nclabs@nclabs.com	PO Box 8, Birnamwood, WI 54414 Fax: 715-449-2454 Emergency Contact: 1-800-424-9300 (Chemtrec)

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification	Not classified
Signal Word	Not applicable
Pictograms	None
Hazard Statements	Not applicable
Precautionary Statements	Not applicable
Other Hazards Not Contributing to the Classification	None under normal conditions.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Identity	Not applicable
Common Name	Not applicable

Mixture

Name	CAS #	Approximate %
Water	7732-18-5	>98.8
Potassium Hydrogen Phthalate	877-24-7	1.1
Red Food Coloring	Not found	<0.001

SECTION 4: FIRST AID MEASURES

Description of First Aid Measures

General First Aid Measures	Never give anything by mouth to an unconscious person. Seek medical advice if you feel unwell.
If Inhaled	Remove person to fresh air and keep comfortable for breathing. Allow victim to rest.
In Case of Skin Contact	Remove contaminated clothing and wash exposed skin with mild soap and water. Rinse with warm water.
In Case of Eye Contact	Immediately flush eyes with plenty of water. Remove contact lenses, if present and easy to do. Get medical attention if irritation develops.
If Swallowed	Rinse mouth. Do NOT induce vomiting. Get medical attention if you feel unwell.

Most Important Symptoms/Effects Acute and Delayed

Not expected to present a significant hazard under normal use.

Indication of Immediate Medical Attention and Special Treatment Needed

No additional information available.

SECTION 5: FIRE-FIGHTING MEASURES

Extinguishing Media

Suitable Extinguishing Media	Foam. Dry powder. Sand. Carbon dioxide. Water spray.
Unsuitable Extinguishing Media	Do not use high pressure water stream.
Special Hazards Arising from the Chemical	No additional information available.
Special Protective Actions for Fire-Fighters	Wear self-contained breathing apparatus and protective clothing. Keep exposed containers cool with water spray.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment (see section 8). Evacuate area of non-essential personnel. Eliminate ignition sources.
Environmental Precautions	Prevent entry to surface and ground waters.
Methods and Materials for Containment and Cleaning Up	Clean up spills with inert solids. Collect spillage. Store away from other materials. Ensure compliance with federal, state, and local regulations.

SECTION 7: HANDLING AND STORAGE

Precautions for Safe Handling	Avoid contact with eyes and skin. Avoid breathing vapors. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor.
Conditions for Safe Storage Including any Incompatibilities	Keep in a tightly closed container, stored in a cool, dry, ventilated area. Store away from strong oxidizers.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters	Not applicable
Appropriate Engineering Controls	Provide adequate general ventilation. Maintain eye-wash fountain and quick-drench facilities in work area.
Individual Protection Measures	Avoid all unnecessary exposure.
Eye/Face Protection	Use chemical safety goggles and /or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye-wash fountain and quick-drench facilities in work area.
Skin Protection	Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.
Respiratory Protection	Wear appropriate mask.
Other Information	Do not eat, drink, or smoke when using this product.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Color	Red to pink
Odor	Odorless
Odor Threshold	Not determined
pH	4
Melting Point/Freezing Point	Not determined
Initial Boiling Point and Boiling Range	Not determined
Flash Point	Not determined
Evaporation Rate	Not determined
Flammability (Solid, Gas)	Not determined
Upper/Lower Flammability/Explosive Limits	Not determined
Vapor Pressure	Not determined
Vapor Density	Not determined

Relative Density	1.00
Solubility	Soluble in water.
Partition Coefficient: n-octanol/water	Not determined
Auto-Ignition Temperature	Not determined
Decomposition Temperature	Not determined
Viscosity	Not determined

SECTION 10: STABILITY AND REACTIVITY

Reactivity	No data available
Chemical Stability	Stable under ordinary conditions of use and storage.
Possibility of Hazardous Reactions	No data available
Conditions to Avoid	Extremely high or low temperatures.
Incompatible Materials	Strong oxidizers.
Hazardous Decomposition Products	When heated to decomposition, can emit toxic gases, carbon dioxide, and carbon monoxide.

SECTION 11: TOXICOLOGICAL INFORMATION

Acute Toxicity Not classified

Potassium Hydrogen Phthalate (877-24-7)	
LD50 oral rat	≥3200 mg/kg
Water (7732-18-5)	
LD50 oral rat	≥90000 mg/kg

Skin Corrosion/Irritation	Not classified
Serious Eye Damage/Irritation	Not classified
Respiratory or Skin Sensitization	Not classified
Germ Cell Mutagenicity	Not classified
Carcinogenicity	Not classified
Reproductive Toxicity	Not classified
Specific Target Organ Toxicity (Single Exposure)	Not classified
Specific Target Organ Toxicity (Repeated Exposure)	Not classified
Aspiration Hazard	Not classified
Potential Adverse Human Health Effects and Symptoms	No data available
Other Information	Not available

SECTION 12: ECOLOGICAL INFORMATION

Toxicity	Not applicable
Persistence and Degradability	Not applicable
Bioaccumulative Potential	Not applicable
Mobility in Soil	Not applicable
Other Adverse Effects	Not applicable

SECTION 13: DISPOSAL CONSIDERATIONS

Methods of Disposal

Disposal Recommendations	Dispose of contents/containers in accordance with federal, state, and local regulations.
Other Information	Avoid release to the surrounding environment.

SECTION 14: TRANSPORT INFORMATION

UN Number	Not applicable
UN Shipping Name	Not applicable
Transport Hazard Class(es)	Not applicable
Packing Group	Not applicable
Environmental Hazards	Not applicable
Transport in Bulk	Not applicable
Other Precautions	Not applicable

SECTION 15: REGULATORY INFORMATION

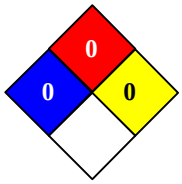
Potassium Hydrogen Phthalate (877-24-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Water (7732-18-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

SECTION 16: OTHER INFORMATION

Revision Date: 12/10/2014

NFPA Hazards

Health Hazard	0: Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.
Fire Hazard	0: Materials that will not burn.
Instability/Reactivity	0: Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health	0: No significant risk to health.
Flammability	0: Materials that will not burn.
Physical Hazard	0: Materials that are normally stable.
Personal Protection	A

YSI 3821	
Health	0
Flammability	0
Physical Hazard	0
Personal Protection	A

The information contained herein is provided in good faith and is believed to be correct as of the date hereof. However, NCL of Wisconsin, Inc. makes no representation as to the comprehensiveness or accuracy of the information. It is expected that individuals receiving the information will exercise their independent judgment in determining its appropriateness for their conditions of use. Accordingly, NCL of Wisconsin, Inc. will not be responsible for damages of any kind resulting from the use of or reliance upon such information.

END OF SAFETY DATA SHEET

Safety Data Sheet
According to the (US) Hazard Communication Standard (29 CFR 1910.1200)

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name Buffer Solution pH 7.00

Catalog Number **YSI 3822**

Product Description Laboratory chemical, for use in calibrating pH probes

Supplier

YSI, a Xylem brand
Telephone: 937-767-7241
Emergency: CHEMTREC
US/Can: 800-424-9300
International: 001 703-572-3997

1725 Brannum Lane
Yellow Springs, OH 45387
MSDSinfo@ysi.com
YSI.com
Collect calls accepted

Manufacturer

NCL of Wisconsin, Inc.
Telephone: 1-800-648-7836
Email: nclabs@nclabs.com

PO Box 8, Birnamwood, WI 54414
Fax: 715-449-2454
Emergency Contact: 1-800-424-9300 (Chemtrec)

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification Not classified

Signal Word Not applicable

Pictograms None

Hazard Statements Not applicable

Precautionary Statements Not applicable

Other Hazards Not Contributing to the Classification None under normal conditions

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Identity Not applicable

Common Name Not applicable

Mixture

Name	CAS #	Approximate %
Water	7732-18-5	>98
Potassium Phosphate Monobasic	7778-77-0	<1
Yellow Food Coloring	Not found	<0.001

SECTION 4: FIRST AID MEASURES

Description of First Aid Measures

General First Aid Measures Never give anything by mouth to an unconscious person. Seek medical advice if you feel unwell.

If Inhaled Remove person to fresh air and keep comfortable for breathing. Allow victim to rest.

In Case of Skin Contact Remove contaminated clothing and wash exposed skin with mild soap and water. Rinse with warm water.

In Case of Eye Contact Immediately flush eyes with plenty of water. Remove contact lenses, if present and easy to do. Get medical attention if irritation develops.

If Swallowed Rinse mouth. Do NOT induce vomiting. Get medical attention if you feel unwell.

Most Important Symptoms/Effects Acute and Delayed

Not expected to present a significant hazard under normal use.

Indication of Immediate Medical Attention and Special Treatment Needed

No additional information available.

SECTION 5: FIRE-FIGHTING MEASURES

Extinguishing Media

Suitable Extinguishing Media	Foam. Dry powder. Sand. Carbon dioxide. Water spray.
Unsuitable Extinguishing Media	Do not use high pressure water stream.
Special Hazards Arising from the Chemical	No additional information available.
Special Protective Actions for Fire-Fighters	Wear self-contained breathing apparatus and protective clothing. Keep exposed containers cool with water spray.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment (see section 8). Evacuate area of non-essential personnel. Eliminate ignition sources.
Environmental Precautions	Prevent entry to surface and ground waters.
Methods and Materials for Containment and Cleaning Up	Clean up spills with inert solids. Collect spillage. Store away from other materials. Ensure compliance with federal, state, and local regulations.

SECTION 7: HANDLING AND STORAGE

Precautions for Safe Handling	Avoid contact with eyes and skin. Avoid breathing vapors. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor.
Conditions for Safe Storage Including any Incompatibilities	Keep in a tightly closed container, stored in a cool, dry, ventilated area. Store away from strong oxidizers.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters	Not applicable
Appropriate Engineering Controls	Provide adequate general ventilation. Maintain eye-wash fountain and quick-drench facilities in work area.
Individual Protection Measures	Avoid all unnecessary exposure.
Eye/Face Protection	Use chemical safety goggles and /or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye-wash fountain and quick-drench facilities in work area.
Skin Protection	Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.
Respiratory Protection	Wear appropriate mask.
Other Information	Do not eat, drink, or smoke when using this product.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Color	Yellow
Odor	Odorless
Odor Threshold	Not determined
pH	7
Melting Point/Freezing Point	Not determined
Initial Boiling Point and Boiling Range	Not determined
Flash Point	Not determined
Evaporation Rate	Not determined
Flammability (Solid, Gas)	Not determined
Upper/Lower Flammability/Explosive Limits	Not determined
Vapor Pressure	Not determined
Vapor Density	Not determined

Relative Density	1.00
Solubility	Soluble in water
Partition Coefficient: n-octanol/water	Not determined
Auto-Ignition Temperature	Not determined
Decomposition Temperature	Not determined
Viscosity	Not determined

SECTION 10: STABILITY AND REACTIVITY

Reactivity	No data available
Chemical Stability	Stable under ordinary conditions of use and storage
Possibility of Hazardous Reactions	No data available
Conditions to Avoid	Extremely high or low temperatures
Incompatible Materials	Strong oxidizers
Hazardous Decomposition Products	When heated to decomposition, can emit toxic gases, carbon dioxide, carbon monoxide, phosphorus oxides, and sodium oxide

SECTION 11: TOXICOLOGICAL INFORMATION

Acute Toxicity Not classified

Potassium Hydrogen Phthalate (877-24-7)	
LD50 dermal rabbit	4640 mg/kg
Water (7732-18-5)	
LD50 oral rat	≥90000 mg/kg

Skin Corrosion/Irritation	Not classified
Serious Eye Damage/Irritation	Not classified
Respiratory or Skin Sensitization	Not classified
Germ Cell Mutagenicity	Not classified
Carcinogenicity	Not classified
Reproductive Toxicity	Not classified
Specific Target Organ Toxicity (Single Exposure)	Not classified
Specific Target Organ Toxicity (Repeated Exposure)	Not classified
Aspiration Hazard	Not classified
Potential Adverse Human Health Effects and Symptoms	No data available
Other Information	Not available

SECTION 12: ECOLOGICAL INFORMATION

Toxicity	Not applicable
Persistence and Degradability	Not applicable
Bioaccumulative Potential	Not applicable
Mobility in Soil	Not applicable
Other Adverse Effects	Not applicable

SECTION 13: DISPOSAL CONSIDERATIONS

Methods of Disposal

Disposal Recommendations	Dispose of contents/containers in accordance with federal, state, and local regulations
Other Information	Avoid release to the surrounding environment

SECTION 14: TRANSPORT INFORMATION

UN Number	Not applicable
UN Shipping Name	Not applicable
Transport Hazard Class(es)	Not applicable
Packing Group	Not applicable
Environmental Hazards	Not applicable
Transport in Bulk	Not applicable
Other Precautions	Not applicable

SECTION 15: REGULATORY INFORMATION

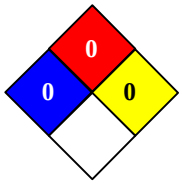
Potassium Hydrogen Phthalate (7778-77-0)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Water (7732-18-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

SECTION 16: OTHER INFORMATION

Revision Date: 12/10/2014

NFPA Hazards

Health Hazard	0: Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.
Fire Hazard	0: Materials that will not burn.
Instability/Reactivity	0: Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health	0: No significant risk to health.
Flammability	0: Materials that will not burn.
Physical Hazard	0: Materials that are normally stable.
Personal Protection	A

YSI 3821	
Health	0
Flammability	0
Physical Hazard	0
Personal Protection	A

The information contained herein is provided in good faith and is believed to be correct as of the date hereof. However, NCL of Wisconsin, Inc. makes no representation as to the comprehensiveness or accuracy of the information. It is expected that individuals receiving the information will exercise their independent judgment in determining its appropriateness for their conditions of use. Accordingly, NCL of Wisconsin, Inc. will not be responsible for damages of any kind resulting from the use of or reliance upon such information.

END OF SAFETY DATA SHEET

Safety Data Sheet
According to the (US) Hazard Communication Standard (29 CFR 1910.1200)

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name Buffer Solution pH 10.00

Catalog Number **YSI 3823**

Product Description Laboratory chemical, for use in calibrating pH probes

Supplier

YSI, a Xylem brand
Telephone: 937-767-7241
Emergency: CHEMTREC
US/Can: 800-424-9300
International: 001 703-572-3997

1725 Brannum Lane
Yellow Springs, OH 45387
MSDSinfo@ysi.com
YSI.com
Collect calls accepted

Manufacturer

NCL of Wisconsin, Inc.
Telephone: 1-800-648-7836
Email: nclabs@nclabs.com

PO Box 8, Birnamwood, WI 54414
Fax: 715-449-2454
Emergency Contact: 1-800-424-9300 (Chemtrec)

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification

Reproductive Toxicity — Category 1B



Signal Word Danger

Hazard Statements

H360 — May damage fertility or the unborn child

Precautionary Statements

P201	Obtain special instructions before use
P202	Do not handle until all safety precautions have been read and understood
P280	Wear protective gloves and eye protection
P308+P313	IF exposed or concerned: Get medical advice/attention
P405	Store locked up
P501	Dispose of contents/container to comply with local, state, and federal regulations

Other Hazards Not Contributing to the Classification None under normal conditions

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Identity Not applicable

Common Name Not applicable

Mixture

Name	CAS #	Approximate %
Water	7732-18-5	>96
Potassium Hydroxide	1310-58-3	<1
Disodium EDTA dihydrate	6381-92-6	<1
Potassium Carbonate	584-08-7	<1
Potassium Borate	1332-77-0	<1
Bromphenol Blue, Sodium Salt	62625-28-9	<0.01
Bromcresol Green, Sodium Salt	62625-32-5	<0.01

SECTION 4: FIRST AID MEASURES

Description of First Aid Measures

General First Aid Measures Never give anything by mouth to an unconscious person. Seek medical advice if you feel unwell.

If Inhaled Remove person to fresh air and keep comfortable for breathing. Allow victim to rest.

In Case of Skin Contact Remove contaminated clothing and wash exposed skin with mild soap and water. Rinse with warm water.

In Case of Eye Contact Immediately flush eyes with plenty of water. Remove contact lenses, if present and easy to do. Get medical attention if irritation develops.

If Swallowed Rinse mouth. Do NOT induce vomiting. Get medical attention if you feel unwell.

Most Important Symptoms/Effects Acute and Delayed

May damage fertility or the unborn child

Indication of Immediate Medical Attention and Special Treatment Needed

No additional information available.

SECTION 5: FIRE-FIGHTING MEASURES

Extinguishing Media

Suitable Extinguishing Media Foam. Dry powder. Sand. Carbon dioxide. Water spray.

Unsuitable Extinguishing Media Do not use high pressure water stream.

Special Hazards Arising from the Chemical No additional information available.

Special Protective Actions for Fire-Fighters Wear self-contained breathing apparatus and protective clothing. Keep exposed containers cool with water spray.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions Use personal protective equipment (see section 8). Evacuate area of non-essential personnel. Eliminate ignition sources.

Environmental Precautions Prevent entry to surface and ground waters.

Methods and Materials for Containment and Cleaning Up Clean up spills with inert solids. Collect spillage. Store away from other materials. Ensure compliance with federal, state, and local regulations.

SECTION 7: HANDLING AND STORAGE

Precautions for Safe Handling Avoid contact with eyes and skin. Avoid breathing vapors. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapor. Do not handle until all safety precautions have been read and understood. Obtain special instructions before use.

Conditions for Safe Storage Including any Incompatibilities Keep in a tightly closed container, stored in a cool, dry, ventilated area. Store away from heat sources, strong oxidizers and strong acids

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters

Potassium Hydroxide (1310-58-3)		
USA ACGIH	ACGIH Ceiling (mg/m^3)	2 mg/m^3

Appropriate Engineering Controls Provide adequate general ventilation. Maintain eye-wash fountain and quick-drench facilities in work area.

Individual Protection Measures Avoid all unnecessary exposure.

Eye/Face Protection Use chemical safety goggles and /or a full face shield where splashing is possible. Contact lenses should not be worn when working with this material. Maintain eye-wash fountain and quick-drench facilities in work area.

Skin Protection Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.

Respiratory Protection Wear appropriate mask.

Other Information Do not eat, drink, or smoke when using this product.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Physical State Liquid

Color Blue

Odor Odorless

Odor Threshold Not determined

pH 10

Melting Point/Freezing Point Not determined

Initial Boiling Point and Boiling Range	Not determined
Flash Point	Not determined
Evaporation Rate	Not determined
Flammability (Solid, Gas)	Not determined
Upper/Lower Flammability/Explosive Limits	Not determined
Vapor Pressure	Not determined
Vapor Density	Not determined
Relative Density	1.00
Solubility	Soluble in water
Partition Coefficient: n-octanol/water	Not determined
Auto-Ignition Temperature	Not determined
Decomposition Temperature	Not determined
Viscosity	Not determined

SECTION 10: STABILITY AND REACTIVITY

Reactivity	No data available
Chemical Stability	Stable under ordinary conditions of use and storage.
Possibility of Hazardous Reactions	No data available
Conditions to Avoid	Extremely high or low temperatures.
Incompatible Materials	Strong oxidizers and strong acids
Hazardous Decomposition Products	When heated to decomposition, can emit toxic gases, carbon dioxide, and carbon monoxide.

SECTION 11: TOXICOLOGICAL INFORMATION

Acute Toxicity Not classified

Potassium Hydroxide (1310-58-3)	
LD50 oral rat	333 mg/kg, Rat; experimental value
Water (7732-18-5)	
LD50 oral rat	≥90000 mg/kg

Skin Corrosion/Irritation	Not classified
Serious Eye Damage/Irritation	Not classified
Respiratory or Skin Sensitization	Not classified
Germ Cell Mutagenicity	Not classified
Carcinogenicity	Not classified
Reproductive Toxicity	May damage fertility or the unborn child
Specific Target Organ Toxicity (Single Exposure)	Not classified
Specific Target Organ Toxicity (Repeated Exposure)	Not classified
Aspiration Hazard	Not classified
Potential Adverse Human Health Effects and Symptoms	No data available
Other Information	Not available

SECTION 12: ECOLOGICAL INFORMATION

Toxicity	Not applicable
Persistence and Degradability	Not applicable
Bioaccumulative Potential	Not applicable
Mobility in Soil	Not applicable
Other Adverse Effects	Not applicable

SECTION 13: DISPOSAL CONSIDERATIONS

Methods of Disposal

Disposal Recommendations	Dispose of contents/containers in accordance with federal, state, and local regulations.
Other Information	Avoid release to the surrounding environment.

UN Number	Not applicable
UN Shipping Name	Not applicable
Transport Hazard Class(es)	Not applicable
Packing Group	Not applicable
Environmental Hazards	Not applicable
Transport in Bulk	Not applicable
Other Precautions	Not applicable

SECTION 15: REGULATORY INFORMATION

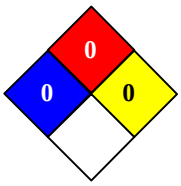
Potassium Hydroxide (1310-58-3)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Disodium EDTA Dihydrate (6381-92-6)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Water (7732-18-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Potassium Carbonate (584-08-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Potassium Borate (1332-77-0)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Bromphenol Blue, Sodium Salt (62625-28-9)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Bromcresol Green, Sodium Salt (62625-32-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

SECTION 16: OTHER INFORMATION

Revision Date: 12/10/2014

NFPA Hazards

Health Hazard	0: Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.
Fire Hazard	0: Materials that will not burn.
Instability/Reactivity	0: Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health	0: No significant risk to health.
Flammability	0: Materials that will not burn.
Physical Hazard	0: Materials that are normally stable.
Personal Protection	A

YSI 3821	
Health	0
Flammability	0
Physical Hazard	0
Personal Protection	A

The information contained herein is provided in good faith and is believed to be correct as of the date hereof. However, NCL of Wisconsin, Inc. makes no representation as to the comprehensiveness or accuracy of the information. It is expected that individuals receiving the information will exercise their independent judgment in determining its appropriateness for their conditions of use. Accordingly, NCL of Wisconsin, Inc. will not be responsible for damages of any kind resulting from the use of or reliance upon such information.

END OF SAFETY DATA SHEET

Conductivity Calibrator 1,000-100,000 micromho/cm

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Revision date: 09/11/2013 Supersedes: 04/04/2011 Version: 2.0

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY

Product Identifier

Product name: Conductivity Calibrator 1,000-100,000 micromho/cm

Product code: 3160**,** 3161, 3163, 3165, 3167, 3168, 3169

Intended Use Of The Product

Use of the substance/preparation: Calibration of YSI Analytical equipment

Name, Address, And Telephone Of The Responsible Party

YSI
1700/1725 Brannum Lane
Yellow Springs, OH 45387

T 937-767-7241

www.ysi.com
MSDSinfo@ysi.com

Emergency Telephone Number

Emergency number : Within USA and Canada: 1-800-424-9300 - Outside USA and Canada: +1 703-527-3887 (collect calls accepted) CHEMTREC

SECTION 2: HAZARDS IDENTIFICATION

Classification Of The Substance Or Mixture

Classification (GHS-US)

Not classified

Label Elements

GHS-US labeling No labeling applicable

Other Hazards Not available

Unknown acute toxicity (GHS US) Not available

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

Substances

Mixture

Name	Product identifier	% (w/w)	Classification (GHS-US)
Water	(CAS No.) 7732-18-5	93 - 100	Not classified
Potassium chloride	(CAS No.) 7447-40-7	0.1 - 7	Eye Irrit. 2B, H320

Full text of H-phrases: see section 16

SECTION 4: FIRST AID MEASURES

Description Of First Aid Measures

General: Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).

Inhalation: When symptoms occur: go into open air and ventilate suspected area.

Skin Contact: Remove contaminated clothing. Drench affected area with water for at least 15 minutes.

Eye Contact: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Ingestion: Rinse mouth.Do NOT induce vomiting

Most Important Symptoms And Effects Both Acute and Delayed

General: Not available

Inhalation: None expected under normal conditions of use..

Skin Contact: May cause mild skin irritation..

Eye Contact: May cause eye irritation..

Ingestion: If a large quantity has been ingested: Diarrhea. Abdominal pain..

Chronic symptoms: Not available

Indication Of Any Immediate Medical Attention And Special Treatment Needed

If exposed or concerned, get medical advice and attention.

SECTION 5: FIREFIGHTING MEASURES

Extinguishing Media

Suitable extinguishing media: Alcohol foam, polymer foam, dry chemical powder, carbon dioxide, water spray, fog.

Unsuitable extinguishing media: None known.

Special Hazards Arising From The Substance Or Mixture

Fire hazard: Not flammable.

Explosion hazard: Product is not explosive.

Reactivity: Hazardous reactions will not occur under normal conditions.

Advice For Firefighters

Precautionary measures fire: Not available

Firefighting instructions: Exercise caution when fighting any chemical fire.

Protection during firefighting: Do not enter fire area without proper protective equipment, including respiratory protection..

Hazardous Combustion Products: Upon heating, toxic fumes are formed. (chlorine). Potassium oxides.

Reference To Other Sections

Refer to section 9 for flammability properties.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment And Emergency Procedures

General measures: Handle in accordance with good industrial hygiene and safety practice.

For Non-Emergency Personnel

Protective equipment: Use appropriate personal protection equipment (PPE).

Emergency procedures: Evacuate unnecessary personnel.

For Emergency Personnel

Protective equipment: Equip cleanup crew with proper protection.

Emergency procedures: Ventilate area.

Environmental Precautions

Prevent entry to sewers and public waters.

Methods And Material For Containment And Cleaning Up

For containment: Absorb and/or contain spill with inert material, then place in suitable container.

Methods for cleaning up: Clear up spills immediately and dispose of waste safely.

Reference To Other Sections

See heading 8, Exposure Controls and Personal Protection.

SECTION 7: HANDLING AND STORAGE

Precautions For Safe Handling

Hygiene measures: Handle in accordance with good industrial hygiene and safety procedures. Wash hands and other exposed areas with mild soap and water before eating, drinking, or smoking and again when leaving work.

Conditions For Safe Storage, Including Any Incompatibilities

Storage conditions: Store in a dry, cool and well-ventilated place. Keep container closed when not in use.

Incompatible materials: Strong acids. Strong oxidizers.

Specific End Use(s)

Calibration of YSI Analytical equipment

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters

No Occupational Exposure Limits (OELs) have been established for this product or its chemical components.

Exposure Controls

Appropriate engineering controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Personal protective equipment: Safety glasses. Gloves.



Materials for protective clothing: Not available

Hand protection: Wear chemically resistant protective gloves.

Eye protection: Chemical goggles or safety glasses.

Skin and body protection: Not available

Respiratory protection: Use NIOSH-approved air-purifying or supplied-air respirator where airborne concentrations of vapor or mist are expected to exceed exposure limits.

Other information: When using, do not eat, drink or smoke.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Information On Basic Physical And Chemical Properties

Physical state	:	Liquid
Appearance	:	Clear
Odor	:	Not available
Odor threshold	:	Not available
pH	:	6.5 - 7.5
Relative evaporation rate (butyl acetate=1)	:	Not available
Melting point	:	Not available
Freezing point	:	Not available
Boiling point	:	100 °C (212 °F)
Flash point	:	Not available
Auto-ignition temperature	:	Not available
Decomposition Temperature	:	Not available
Flammability (solid, gas)	:	Not available
Lower flammable limit	:	Not available
Upper flammable limit	:	Not available
Vapor pressure	:	Not available
Relative vapor density at 20 °C	:	Not available
Relative density	:	Not available
Specific gravity density	:	1 g/ml
Solubility	:	Not available
Log Pow	:	Not available
Log Kow	:	Not available
Viscosity, kinematic	:	Not available
Viscosity, dynamic	:	Not available

Explosion data - sensitivity to mechanical impact : Not available

Explosion data - sensitivity to static discharge : Not available

SECTION 10: STABILITY AND REACTIVITY

Reactivity Hazardous reactions will not occur under normal conditions.

Chemical Stability Stable under normal conditions.

Possibility Of Hazardous Reactions Hazardous polymerization will not occur.

Conditions To Avoid Direct sunlight. Extremely high or low temperatures.

Incompatible Materials Strong acids. Strong oxidizers

Hazardous Decomposition Products Potassium oxides. Upon heating, toxic fumes are formed. (chlorine)

SECTION 11: TOXICOLOGICAL INFORMATION

Information On Toxicological Effects - Product

Acute toxicity : Not classified

LD50 and LC50 Data Not available

Skin corrosion/irritation: Not classified pH: 6.5 - 7.5

Serious eye damage/irritation: Not classified pH: 6.5 - 7.5

Respiratory or skin sensitization: Not classified

Germ cell mutagenicity: Not classified

Teratogenicity: Not available

Carcinogenicity: Not classified

Specific target organ toxicity (repeated exposure): Not classified

Reproductive toxicity: Not classified

Specific target organ toxicity (single exposure): Not classified

Aspiration hazard: Not classified

Symptoms/injuries after inhalation: None expected under normal conditions of use.

Symptoms/injuries after skin contact: May cause mild skin irritation.

Symptoms/injuries after eye contact: May cause eye irritation.

Symptoms/injuries after ingestion: If a large quantity has been ingested: Diarrhea. Abdominal pain.

Information On Toxicological Effects - Ingredient(s)

LD50 and LC50 Data

Potassium chloride (7447-40-7)	
LD50 oral rat	2600 mg/kg

SECTION 12: ECOLOGICAL INFORMATION

Toxicity

Potassium chloride (7447-40-7)	
LC50 fish 1	1060 mg/l (Exposure time: 96 h - Species: Lepomis macrochirus [static])
EC50 Daphnia 1	825 mg/l (Exposure time: 48 h - Species: Daphnia magna)
EC50 other aquatic organisms 1	2500 mg/l (Exposure time: 72 h - Species: Desmodesmus subspicatus)
LC50 fish 2	750 - 1020 mg/l (Exposure time: 96 h - Species: Pimephales promelas [static])
EC50 Daphnia 2	83 mg/l (Exposure time: 48 h - Species: Daphnia magna [Static])

Persistence And Degradability

Conductivity Calibrator 1,000-100,000 micromho/cm	
Persistence and degradability	Not established.

Bioaccumulative Potential

Conductivity Calibrator 1,000-100,000 micromho/cm	
Bioaccumulative potential	Not established.

Mobility In Soil Not available

Other Adverse Effects

Other information: Avoid release to the environment.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste disposal recommendations: Dispose of waste material in accordance with all local, regional, national, provincial, territorial and international regulations.

SECTION 14: TRANSPORT INFORMATION

In accordance with ICAO/IATA/DOT/TDG

UN Number Not regulated for transport

UN Proper Shipping Name Not regulated for transport

Additional information Not regulated for transport

Overland transport Not regulated for transport

Transport by sea Not regulated for transport

Air transport Not regulated for transport

SECTION 15: REGULATORY INFORMATION

US Federal regulations

Potassium chloride (7447-40-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Water (7732-18-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

US State regulations

Potassium chloride (7447-40-7)
U.S. - Texas - Effects Screening Levels - Long Term
U.S. - Texas - Effects Screening Levels - Short Term

Canadian regulations

Conductivity Calibrator 1,000-100,000 micromho/cm	
Uncontrolled product according to WHMIS classification criteria	
Potassium chloride (7447-40-7)	
Listed on the Canadian DSL (Domestic Substances List) inventory.	
WHMIS Classification	Class D Division 2 Subdivision B - Toxic material causing other toxic effects
Water (7732-18-5)	
Listed on the Canadian DSL (Domestic Substances List) inventory.	
WHMIS Classification	Uncontrolled product according to WHMIS classification criteria

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by CPR.

SECTION 16: OTHER INFORMATION

Indication of changes : 04/04/2013

Other information : This document has been prepared in accordance with the SDS requirements of the OSHA Hazard Communication Standard 29 CFR 1910.1200.

GHS Full Text Phrases:

Eye Irrit. 2B	Serious eye damage/eye irritation Category 2B

Party Responsible For The Preparation Of This Document:

YSI, EHS Manager
1700/1725 Brannum Lane
Dayton, OH 45387
937-767-7241 x433

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

North America GHS US 2012 & WHMIS

FLINN SCIENTIFIC, INC.
Safety Data Sheet (SDS)

SDS #: 246.00
Revision Date: June 5, 2014

SECTION 1 — CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Alconox® Cleaner

Flinn Scientific, Inc. P.O. Box 219, Batavia, IL 60510 (800) 452-1261
CHEMTREC Emergency Phone Number: (800) 424-9300

Signal Word **WARNING**

Pictograms



SECTION 2 — HAZARDS IDENTIFICATION

Hazard class: Skin and serious eye damage, corrosion or irritation (Category 2, 2A). Causes skin and serious eye irritation (H315+H319).

SECTION 3 — COMPOSITION, INFORMATION ON INGREDIENTS

Component Name	CAS Number	Formula	Formula Weight	Concentration
Proprietary mixture manufactured by Alconox, Inc.	None established	Proprietary	Proprietary	

SECTION 4 — FIRST AID MEASURES

Call a POISON CENTER or physician if you feel unwell.
If inhaled: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do so. Continue rinsing (P305+P351+P338). **If eye irritation persists:** Get medical advice or attention (P337+P313).
If on skin: Wash with plenty of water (P302+P352). **If skin irritation occurs:** Get medical advice or attention (P332+P313).
If swallowed: Rinse mouth. Call a POISON CENTER or physician if you feel unwell.

SECTION 5 — FIRE FIGHTING MEASURES

Nonflammable, noncombustible solid.
When heated to decomposition, may emit toxic fumes.
In case of fire: Use a tri-class dry chemical fire extinguisher.

NFPA CODE
None established

SECTION 6 — ACCIDENTAL RELEASE MEASURES

Sweep up the spill, place in a sealed bag or container, and dispose. Ventilate area and wash spill site after material pickup is complete. See Sections 8 and 13 for further information.

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SECTION 7 — HANDLING AND STORAGE

Flinn Suggested Chemical Storage Pattern: Inorganic Miscellaneous, or near washing area.

SECTION 8 — EXPOSURE CONTROLS, PERSONAL PROTECTION

Wear protective gloves, protective clothing, and eye protection (P280). Wash hands thoroughly after handling (P264).

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

White to cream-colored flakes or powder. Slight chlorine odor.
Alconox is a trade name. Anionic detergent. No other details available from the manufacturer.
Soluble: Water

SECTION 10 — STABILITY AND REACTIVITY

Avoid strong acids and oxidizing agents.
Shelf life: Indefinite if kept dry.

SECTION 11 — TOXICOLOGICAL INFORMATION

Acute effects: Irritant.
Chronic effects: N.A.
Target organs: N.A.

ORL-RAT LD_{50}: N.A.
IHL-RAT LC_{50}: N.A.
SKN-RBT LD_{50}: N.A.

N.A. = Not available, not all health aspects of this substance have been fully investigated.

SECTION 12 — ECOLOGICAL INFORMATION

Data not yet available.

SECTION 13 — DISPOSAL CONSIDERATIONS

Please review all federal, state and local regulations that may apply before proceeding.
Flinn Suggested Disposal Method #26b is one option.
Material is completely biodegradable.

SECTION 14 — TRANSPORT INFORMATION

Shipping name: Not regulated. Hazard class: N/A. UN number: N/A.

N/A = Not applicable

SECTION 15 — REGULATORY INFORMATION

Not listed.

SECTION 16 — OTHER INFORMATION

This Safety Data Sheet (SDS) is for guidance and is based upon information and tests believed to be reliable. Flinn Scientific, Inc. makes no guarantee of the accuracy or completeness of the data and shall not be liable for any damages relating thereto. The data is offered solely for your consideration, investigation, and verification. The data should not be confused with local, state, federal or insurance mandates, regulations, or requirements and CONSTITUTE NO WARRANTY. Any use of this data and information must be determined by the science instructor to be in accordance with applicable local, state or federal laws and regulations. The conditions or methods of handling, storage, use and disposal of the product(s) described are beyond the control of Flinn Scientific, Inc. and may be beyond our knowledge. FOR THIS AND OTHER REASONS, WE DO NOT ASSUME RESPONSIBILITY AND EXPRESSLY DISCLAIM LIABILITY FOR LOSS, DAMAGE OR EXPENSE ARISING OUT OF OR IN ANY WAY CONNECTED WITH THE HANDLING, STORAGE, USE OR DISPOSAL OF THIS PRODUCT(S).

Consult your copy of the *Flinn Science Catalog/Reference Manual* for additional information about laboratory chemicals.

Revision Date: June 5, 2014

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SAFETY DATA SHEET

Version 6.4
Revision Date 01/20/2020
Print Date 08/29/2020

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : *cis*-1,2-Dichloroethylene

Product Number : D62004
Brand : Aldrich
Index-No. : 602-026-00-3
CAS-No. : 156-59-2

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 Spruce Street
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone number

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Acute toxicity, Oral (Category 4), H302
Acute toxicity, Inhalation (Category 4), H332
Skin irritation (Category 2), H315
Short-term (acute) aquatic hazard (Category 3), H402
Long-term (chronic) aquatic hazard (Category 3), H412

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram



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operates as MilliporeSigma in the US and Canada

Signal word	Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H302 + H332	Harmful if swallowed or if inhaled.
H315	Causes skin irritation.
H412	Harmful to aquatic life with long lasting effects.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves/ eye protection/ face protection.
P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell. Rinse mouth.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P235	Store in a well-ventilated place. Keep cool.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms	:	cis-Acetylene dichloride
Formula	:	$C_2H_2Cl_2$
Molecular weight	:	96.94 g/mol
CAS-No.	:	156-59-2
EC-No.	:	205-859-7
Index-No.	:	602-026-00-3

Component	Classification	Concentration
cis-Dichloroethylene		
	Flam. Liq. 2; Acute Tox. 4; Skin Irrit. 2; Aquatic Acute 3; Aquatic Chronic 3;	<= 100 %

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	H225, H302, H332, H315, H402, H412	

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Dry powder Dry sand

Unsuitable extinguishing media
Do NOT use water jet.

5.2 Special hazards arising from the substance or mixture

Carbon oxides, Hydrogen chloride gas

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information

Use water spray to cool unopened containers.

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SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up

Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Handle and store under inert gas. Air and moisture sensitive. Light sensitive.
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
cis-Dichloroethylene	156-59-2	TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Central Nervous System impairment Eye irritation		

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8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: light yellow
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	Melting point/range: -80 °C (-112 °F) - lit.
f)	Initial boiling point and boiling range	60 °C 140 °F - lit.
g)	Flash point	6.0 °C (42.8 °F) - closed cup
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower	No data available

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	flammability or explosive limits	
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	1.284 g/cm3 at 25 °C (77 °F)
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information
No data available

SECTION 10: Stability and reactivity

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks.

10.5 Incompatible materials
Oxidizing agents

10.6 Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides, Hydrogen chloride gas
Other decomposition products - No data available
In the event of fire: see section 5

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operates as MilliporeSigma in the US and Canada

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - 770 mg/kg
LC50 Inhalation - Rat - 13700 ppm
Remarks: Behavioral:Somnolence (general depressed activity). Liver:Fatty liver degeneration.
Dermal: No data available
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: Moderate skin irritation - 24 h

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: KV9420000

narcosis, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

SECTION 12: Ecological information

12.1 Toxicity
No data available

The life science business of Merck KGaA, Darmstadt, Germany
operates as MilliporeSigma in the US and Canada

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Harmful to aquatic life with long lasting effects.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

SECTION 14: Transport information

DOT (US)
UN number: 1150 Class: 3 Packing group: II
Proper shipping name: 1,2-Dichloroethylene
Reportable Quantity (RQ):
Poison Inhalation Hazard: No

IMDG
UN number: 1150 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: 1,2-DICHLOROETHYLENE

IATA
UN number: 1150 Class: 3 Packing group: II
Proper shipping name: 1,2-Dichloroethylene

SECTION 15: Regulatory information

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

The life science business of Merck KGaA, Darmstadt, Germany
operates as MilliporeSigma in the US and Canada

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Fire Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

cis-Dichloroethylene	CAS-No. 156-59-2	Revision Date 1993-04-24

cis-Dichloroethylene	CAS-No. 156-59-2	Revision Date 1993-04-24

New Jersey Right To Know Components

cis-Dichloroethylene	CAS-No. 156-59-2	Revision Date 1993-04-24

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

SECTION 16: Other information

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

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Version: 6.4 Revision Date: 01/20/2020 Print Date: 08/29/2020

The life science business of Merck KGaA, Darmstadt, Germany
operates as MilliporeSigma in the US and Canada

Safety Data Sheet

Revision Date: 10/03/19
www.restek.com

2 Letter ISO country code/language code: US/EN

1. IDENTIFICATION

Catalog Number / Product Name:	**31064 / Diesel Range Organics Mix (EPA/WISC)**
Company:	Restek Corporation
Address:	110 Benner Circle Bellefonte, Pa. 16823
Phone#:	814-353-1300
Fax#:	814-353-1309
Emergency#:	800-424-9300 (CHEMTREC) 703-527-3887 (Outside the US)
Email:	www.restek.com
Revision Number:	9
Intended use:	For Laboratory use only

2. HAZARD(S)IDENTIFICATION

Emergency Overview:

GHS Hazard Symbols:



GHS Classification:	Carcinogenicity Category 2
GHS Signal Word:	Warning
GHS Hazard:	Suspected of causing cancer.
GHS Precautions:	
Safety Precautions:	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves/protective clothing/eye protection/face protection.
First Aid Measures:	IF exposed or concerned: Get medical advice/attention.
Storage:	Store locked up.
Disposal:	Dispose of contents/container according to section 13 of the SDS.
Single Exposure Target Organs:	No data available
Repeated Exposure Target Organs:	No data available

3. COMPOSITION / INFORMATION ON INGREDIENT

Chemical Name	CAS #	EINEC #	% Composition
Dichloromethane	75-09-2	200-838-9	98
Hexadecane	544-76-3	208-878-9	0.2
n-tetracosane	646-31-1	211-474-5	0.2

eicosane	112-95-8	204-018-1	0.2
n-hexacosane	630-01-3	211-124-1	0.2
n-Tetradecane	629-59-4	211-096-0	0.2
decane	124-18-5	204-686-4	0.2
docosane	629-97-0	211-121-5	0.2
n-Dodecane	112-40-3	203-967-9	0.2
octadecane	593-45-3	209-790-3	0.2
octacosane	630-02-4	211-125-7	0.2

4. FIRST-AID MEASURES

Inhalation: Remove to fresh air. If breathing is difficult, have a trained individual administer oxygen. If not breathing, give artificial respiration and have a trained individual administer oxygen. Get medical attention immediately

Eyes: Immediately flush eyes with plenty of water for at least 20 minutes retracting eyelids often. Tilt the head to prevent chemical from transferring to the uncontaminated eye. Get immediate medical attention and monitor the eye daily as advised by your physician. Serious harm (damage) may result if treatment is delayed. Continue to flush eyes while awaiting medical attention

Skin Contact: Wash with soap and water. Remove contaminated clothing, launder immediately, and discard contaminated leather goods. Get medical attention immediately.

Ingestion: Do not induce vomiting and seek medical attention immediately. Drink two glasses of water or milk to dilute. Provide medical care provider with this SDS. Never give anything by mouth to an unconscious person

5. FIRE- FIGHTING MEASURES

Extinguishing Media: Use alcohol resistant foam, carbon dioxide, or dry chemical when fighting fires. Water or foam may cause frothing if liquid is burning but it still may be a useful extinguishing agent if carefully applied to the surface of the fire. Do Not direct a stream of water into the hot burning liquid. Use methods suitable to fight surrounding fire.

Fire and/or Explosion Hazards: No data.

Fire Fighting Methods and Protection: Use methods for the surrounding fire.

Hazardous Combustion Products: Carbon dioxide, Carbon monoxide

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions and Equipment: Exposure to the spilled material may be severely irritating or toxic. Follow personal protective equipment recommendations found in Section 8 of this SDS. Personal protective equipment needs must be evaluated based on information provided on this sheet and the special circumstances created by the spill including; the material spilled, the quantity of the spill, the area in which the spill occurred, and the expertise of employees in the area responding to the spill. Never exceed any occupational exposure limits.

Methods for Clean-up: Prevent the spread of any spill to minimize harm to human health and the environment if safe to do so. Wear complete and proper personal protective equipment following the recommendation of Section 8 at a minimum. Dike with suitable absorbent material like granulated clay. Gather and store in a sealed container pending a waste disposal evaluation.

7. HANDLING AND STORAGE

Handling Technical Measures and Precautions: Toxic or severely irritating material. Avoid contacting and avoid breathing the material. Use only in a well ventilated area. As with all chemicals, good industrial hygiene practices should be followed when handling this material.

Storage Technical Measures and Conditions: Store in a cool dry place. Isolate from incompatible materials. Keep container closed when not in use

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

United States:

Chemical Name	CAS No.	IDLH	ACGIH STEL	ACGIH TLV-TWA	OSHA Exposure Limit

Dichloromethane	75-09-2	2300 ppm IDLH	None Known	50 ppm TWA	25 ppm TWA; 125 ppm STEL (15 min. TWA)

Personal Protection:

Engineering Measures: Local exhaust ventilation or other engineering controls are normally required when handling or using this product to avoid overexposure.

Respiratory Protection: Respiratory protection may be required to avoid overexposure when handling this product. General or local exhaust ventilation is the preferred means of protection. Use a respirator if general room ventilation is not available or sufficient to eliminate symptoms.

Eye Protection: Wear chemically resistant safety glasses with side shields when handling this product. Wear additional eye protection such as chemical splash goggles and/or face shield when the possibility exists for eye contact with splashing or spraying liquid, or airborne material. Do not wear contact lenses. Have an eye wash station available.

Skin Protection: Avoid skin contact by wearing chemically resistant gloves, an apron and other protective equipment depending upon conditions of use. Inspect gloves for chemical break-through and replace at regular intervals. Clean protective equipment regularly. Wash hands and other exposed areas with mild soap and water before eating, drinking, and when leaving work.

Medical Conditions Aggravated By Exposure: Eye disease Skin disease including eczema and sensitization Respiratory disease including asthma and bronchitis

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance, color:	Colorless
Odor:	Strong
Physical State:	No data available
pH:	Not applicable
Vapor Pressure:	No data available
Vapor Density:	2.93 (air = 1)
Boiling Point (°C):	No data available
Melting Point (°C):	-96.7 °C
Flash Point (°F):	No data available
Upper Flammable/Explosive Limit, % in air:	No data available
Lower Flammable/Explosive Limit, % in air:	No data available
Autoignition Temperature (°C):	556 deg C
Decomposition Temperature (°C):	No data available
Specific Gravity:	1.3254 - 1.3258 g/cm3 at 20 °C
Evaporation Rate:	No data available
Odor Threshold:	ND
Solubility:	Moderate; 50-99%
Partition Coefficient: n-octanol in water:	No data available
VOC % by weight:	98
Molecular Weight:	No data available

10. STABILITY AND REACTIVITY

Stability:	Stable under normal conditions.
Conditions to Avoid:	None known.Contamination High temperatures
Materials to Avoid / Chemical Incompatiability:	Strong oxidizing agents Caustics (bases)
Hazardous Decomposition Products:	Carbon dioxide Carbon monoxide

11. TOXICOLOGICAL INFORMATION

Routes of Entry:	Inhalation Absorption Ingestion Skin contact Eye contact
Target Organs Potentially Affected By Exposure:	Skin, Cardiovascular System, Eyes, Liver
Chemical Interactions That Change Toxicity:	None Known

Immediate (Acute) Health Effects by Route of Exposure:

Inhalation Irritation: Can cause moderate respiratory irritation, dizziness, weakness, fatigue, nausea and headache.

Inhalation Toxicity: Harmful! Can cause systemic damage (see "Target Organs)Inhalation may cause severe central nervous system depression (including unconsciousness).

Skin Contact: Contact causes severe skin irritation and possible burns.

Skin Absorption: Harmful if absorbed through the skin. May cause severe irritation and systemic damage.

Eye Contact:	Contact with the eyes may cause moderate to severe eye injury. Eye contact may result in tearing and reddening, but not likely to permanently injure eye tissue. Temporary vision impairment (cloudy or blurred vision) is possible.
Ingestion Irritation:	Irritating to mouth, throat, and stomach. Can cause abdominal discomfort, nausea, vomiting and diarrhea.
Ingestion Toxicity:	Harmful if swallowed. May cause systemic poisoning.

Long-Term (Chronic) Health Effects:

Carcinogenicity:	Contains a probable or known human carcinogen.
Reproductive and Developmental Toxicity:	No data available to indicate product or any components present at greater than 0.1% may cause birth defects.
Inhalation:	Upon prolonged and/or repeated exposure, can cause moderate respiratory irritation, dizziness, weakness, fatigue, nausea and headache.Harmful! Can cause systemic damage upon prolonged and/or repeated exposure (see "Target Organs)
Skin Absorption:	Upon prolonged or repeated exposure, harmful if absorbed through the skin. May cause severe irritation and systemic damage

Component Toxicological Data:
NIOSH:

Chemical Name	CAS No.	LD50/LC50
Methane, dichloro-	75-09-2	Inhalation LC50 Rat 53 mg/L 6 h

Component Carcinogenic Data:
OSHA:

Chemical Name	CAS No.	
Methylene chloride	75-09-2	25 ppm TWA (8 hr.); 125 ppm STEL (15 min.); 12.5 ppm Action Level (see 29 CFR 1910.1051); effective date for respiratory protection for certain employers to acheive the 8-hour TWA PEL is August 31, 1998; the start up date to install engineering controls is December 10, 1998.; {OSHA - 29 CFR 1910 Specifically Regulate

ACGIH:

Chemical Name	CAS No.	
Dichloromethane	75-09-2	A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans

NIOSH:

Chemical Name	CAS No.	
Methylene chloride	75-09-2	potential occupational carcinogen

NTP:

Chemical Name	CAS No.
No data available	

IARC:

Chemical Name	CAS No.	Group No.
Monograph 110 [in preparation]; Monograph 71 [1999]	75-09-2	Group 2A

12. ECOLOGICAL INFORMATION

Overview:	Moderate ecological hazard. This product may be dangerous to plants and/or wildlife. Keep out of waterways.
Mobility:	No data
Persistence:	No data
Bioaccumulation:	No data
Degradability:	No data
Ecological Toxicity Data:	No data available

13. DISPOSAL CONSIDERATIONS

Waste Description of Spent Product:	Spent or discarded material is a hazardous waste.Mixing

spent or discarded material with other materials may render the mixture hazardous. Perform a hazardous waste determination on mixtures.

Disposal Methods: Incinerate spent or discarded material a permitted hazardous waste facility.

Waste Disposal of Packaging: Comply with all Local, State, Federal, and Provincial Environmental Regulations.

14. TRANSPORTATION INFORMATION

United States:

DOT Proper Shipping Name: Toxic, liquids, organic, n.o.s. (Dichloromethane)
UN Number: UN2810
Hazard Class: 6.1
Packing Group: III

International:

IATA Proper Shipping Name: Toxic, liquids, organic, n.o.s. (Dichloromethane)
UN Number: UN2810
Hazard Class: 6.1
Packing Group: III

Marine Pollutant: No

Chemical Name	CAS#	Marine Pollutant	Severe Marine Pollutant
No data available			

15. REGULATORY INFORMATION

United States:

Chemical Name	CAS#	CERCLA	SARA 313	SARA EHS 313	TSCA
Dichloromethane	75-09-2	X	X	-	X

The following chemicals are listed on CA Prop 65:

Chemical Name	CAS #	Regulation
Dichloromethane Dichloromethane (Methylene chloride)	75-09-2	Prop 65 Cancer

State Right To Know Listing:

Chemical Name	CAS#	New Jersey	Massachusetts	Pennsylvania	California
Dichloromethane	75-09-2	X	X	X	X
Hexadecane	544-76-3	-	-	-	-
n-tetracosane	646-31-1	-	-	-	-
eicosane	112-95-8	-	-	-	-
n-hexacosane	630-01-3	-	-	-	-
n-Tetradecane	629-59-4	-	-	-	-
decane	124-18-5	X	-	X	-
docosane	629-97-0	-	-	-	-
n-Dodecane	112-40-3	-	-	-	-
octadecane	593-45-3	-	-	-	-
octacosane	630-02-4	-	-	-	-

16. OTHER INFORMATION

Prior Version Date: 09/18/18
Other Information: Any changes to the SDS compared to previous versions are marked by a vertical line in front of the concerned paragraph.
References: No data available
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Safety Data Sheet
acc. to OSHA HCS

Printing date 07/19/2017 Reviewed on 07/19/2017

1 Identification

· **Product identifier**

· **Product Name: GASOLINE RANGE ORGANICS (EPA)**

· **Part Number:** GRO-EPA
· **Application of the substance / the mixture** Certified Reference Material

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
SPEX CertiPrep, LLC.
203 Norcross Ave, Metuchen,
NJ 08840 USA

· **Information department:** product safety department
· **Emergency telephone number:**
Emergency Phone Number (24 hours)
CHEMTREC (800-424-9300)
Outside US: 703-527-3887

2 Hazard(s) identification

· **Classification of the substance or mixture**



GHS02 Flame

Flam. Liq. 2 H225 Highly flammable liquid and vapor.



GHS06 Skull and crossbones

Acute Tox. 3 H331 Toxic if inhaled.



GHS08 Health hazard

Repr. 2 H361 Suspected of damaging fertility or the unborn child.
STOT SE 1 H370 Causes damage to organs.

· **Label elements**
· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS06 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
methanol
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H331 Toxic if inhaled.
H361 Suspected of damaging fertility or the unborn child.
H370 Causes damage to organs.
· **Precautionary statements**
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
Do not breathe dust/fume/gas/mist/vapors/spray.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

(Contd. on page 2)

Safety Data Sheet
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Printing date 07/19/2017 Reviewed on 07/19/2017

Product Name: GASOLINE RANGE ORGANICS (EPA)

(Contd. of page 1)

· **Classification system:**
· **NFPA ratings (scale 0 - 4)**



Health = 3
Fire = 3
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = *3
Fire = 3
Reactivity = 0

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

3 Composition/information on ingredients

· **Chemical characterization: Mixtures**
· **Description:** Mixture of the substances listed below with nonhazardous additions.

· **Dangerous components:**		
67-56-1	methanol	98.95%
108-88-3	toluene	0.15%

· **Chemical identification of the substance/preparation**		
108-38-3	m-xylene	0.15%
95-63-6	1,2,4-trimethylbenzene	0.15%
540-84-1	2,2,4-trimethylpentane	0.15%
107-83-5	2-methylpentane	0.15%
95-47-6	o-xylene	0.15%
71-43-2	benzene	0.05%
100-41-4	ethylbenzene	0.05%
142-82-5	heptane	0.05%

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Immediately remove any clothing soiled by the product.
Remove breathing apparatus only after contaminated clothing have been completely removed.
In case of irregular breathing or respiratory arrest provide artificial respiration.
· **After inhalation:**
Supply fresh air or oxygen; call for doctor.
In case of unconsciousness place patient stably in side position for transportation.
· **After skin contact:** Immediately wash with water and soap and rinse thoroughly.
· **After eye contact:** Rinse opened eye for several minutes under running water. Then consult a doctor.
· **After swallowing:** Do not induce vomiting; immediately call for medical help.
· **Information for Doctor:**
· **Most important symptoms and effects, both acute and delayed** No further relevant information available.
· **Indication of any immediate medical attention and special treatment needed** No further relevant information available.

5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:** CO2, sand, extinguishing powder. Do not use water.
· **For safety reasons unsuitable extinguishing agents:** Water with full jet
· **Special hazards arising from the substance or mixture** No further relevant information available.
· **Advice for firefighters**
· **Protective equipment:** Mouth respiratory protective device.

(Contd. on page 3)

Safety Data Sheet
acc. to OSHA HCS

Product Name: GASOLINE RANGE ORGANICS (EPA)

(Contd. of page 2)

6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures** Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:**
Do not allow product to reach sewage system or any water course.
Inform respective authorities in case of seepage into water course or sewage system.
Do not allow to enter sewers/ surface or ground water.
· **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
Do not flush with water or aqueous cleansing agents
· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.
· **Protective Action Criteria for Chemicals**

· **PAC-1:**		
67-56-1	methanol	530 ppm
108-38-3	m-xylene	130 ppm
95-63-6	1,2,4-trimethylbenzene	140 ppm
540-84-1	2,2,4-trimethylpentane	230 ppm
107-83-5	2-methylpentane	1,000 ppm
108-88-3	toluene	67 ppm
71-43-2	benzene	52 ppm
100-41-4	ethylbenzene	33 ppm
142-82-5	heptane	500 ppm

· **PAC-2:**		
67-56-1	methanol	2,100 ppm
108-38-3	m-xylene	920 ppm
95-63-6	1,2,4-trimethylbenzene	360 ppm
540-84-1	2,2,4-trimethylpentane	830 ppm
107-83-5	2-methylpentane	11000** ppm
108-88-3	toluene	560 ppm
71-43-2	benzene	800 ppm
100-41-4	ethylbenzene	1100* ppm
142-82-5	heptane	830 ppm

· **PAC-3:**		
67-56-1	methanol	7200* ppm
108-38-3	m-xylene	2500* ppm
95-63-6	1,2,4-trimethylbenzene	480 ppm
540-84-1	2,2,4-trimethylpentane	5000* ppm
107-83-5	2-methylpentane	66000*** ppm
108-88-3	toluene	3700* ppm
71-43-2	benzene	4000* ppm
100-41-4	ethylbenzene	1800* ppm
142-82-5	heptane	5000* ppm

7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Ensure good ventilation/exhaustion at the workplace.
Open and handle receptacle with care.
Prevent formation of aerosols.
· **Information about protection against explosions and fires:**
Keep ignition sources away - Do not smoke.
Protect against electrostatic charges.
Keep respiratory protective device available.

(Contd. on page 4)

Safety Data Sheet
acc. to OSHA HCS

Product Name: GASOLINE RANGE ORGANICS (EPA)

(Contd. of page 3)

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** Store in a cool location.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:**
Keep receptacle tightly sealed.
Store in cool, dry conditions in well sealed receptacles.
· **Specific end use(s)** No further relevant information available.

8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**

· **Components with limit values that require monitoring at the workplace:**	
67-56-1 methanol	
PEL	Long-term value: 260 mg/m³, 200 ppm
REL	Short-term value: 325 mg/m³, 250 ppm Long-term value: 260 mg/m³, 200 ppm Skin
TLV	Short-term value: 328 mg/m³, 250 ppm Long-term value: 262 mg/m³, 200 ppm Skin; BEI
108-88-3 toluene	
PEL	Long-term value: 200 ppm Ceiling limit value: 300; 500* ppm *10-min peak per 8-hr shift
REL	Short-term value: 560 mg/m³, 150 ppm Long-term value: 375 mg/m³, 100 ppm
TLV	Long-term value: 75 mg/m³, 20 ppm BEI

· **Ingredients with biological limit values:**	
67-56-1 methanol	
BEI	15 mg/L Medium: urine Time: end of shift Parameter: Methanol (background, nonspecific)
108-88-3 toluene	
BEI	0.02 mg/L Medium: blood Time: prior to last shift of workweek Parameter: Toluene 0.03 mg/L Medium: urine Time: end of shift Parameter: Toluene 0.3 mg/g creatinine Medium: urine Time: end of shift Parameter: o-Cresol with hydrolysis (background)

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Store protective clothing separately.
Avoid contact with the eyes and skin.
· **Breathing equipment:**
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.

(Contd. on page 5)

Safety Data Sheet
acc. to OSHA HCS

Printing date 07/19/2017 *Reviewed on 07/19/2017*

Product Name: GASOLINE RANGE ORGANICS (EPA)

(Contd. of page 4)

· **Protection of hands:**



Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation

· **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.

· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

· **Eye protection:**



Tightly sealed goggles

9 Physical and chemical properties

· **Information on basic physical and chemical properties**	
· **General Information**	
· **Appearance:**	
Form:	Liquid
Color:	According to product specification
· **Odor:**	Characteristic
· **Odour Threshold:**	Not applicable.
· **pH-value:**	Not applicable.
· **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	64.7 °C (148 °F)
· **Flash point:**	11 °C (52 °F)
· **Flammability (solid, gaseous):**	Not applicable.
· **Ignition temperature:**	455 °C (851 °F)
· **Decomposition temperature:**	Not applicable.
· **Auto igniting:**	Product is not selfigniting.
· **Danger of explosion:**	Product is not explosive. However, formation of explosive air/vapor mixtures are possible.
· **Explosion limits:**	
Lower:	5.5 Vol %
Upper:	44.0 Vol %
· **Vapor pressure at 20 °C (68 °F):**	128 hPa (96 mm Hg)
· **Density**	Not applicable.
· **Relative density**	Not applicable.
· **Vapor density**	Not applicable.
· **Evaporation rate**	Not applicable.
· **Solubility in / Miscibility with**	
Water:	Not miscible or difficult to mix.
· **Partition coefficient (n-octanol/water):**	Not applicable.
· **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
· **Solvent content:**	
Organic solvents:	99.8 %
VOC content:	100.0 %
Solids content:	0.2 %

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Product Name: GASOLINE RANGE ORGANICS (EPA)

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· **Other information** No further relevant information available.

10 Stability and reactivity

· **Reactivity** No further relevant information available.
· **Chemical stability**
· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.
· **Conditions to avoid** No further relevant information available.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· **LD/LC50 values that are relevant for classification:**		
67-56-1 methanol		
Oral	LD50	5628 mg/kg (rat)
Dermal	LD50	15800 mg/kg (rabbit)
71-43-2 benzene		
Oral	LD50	4894 mg/kg (rat)
Dermal	LD50	48 mg/kg (mouse)
Inhalative	LC50/4 h	9980 mg/l (mouse)

· **Primary irritant effect:**
· **on the skin:** No irritant effect.
· **on the eye:** No irritating effect.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Toxic

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**		
108-38-3	m-xylene	3
95-47-6	o-xylene	3
108-88-3	toluene	3
71-43-2	benzene	1
100-41-4	ethylbenzene	2B

· **NTP (National Toxicology Program)**		
71-43-2	benzene	K

· **OSHA-Ca (Occupational Safety & Health Administration)**	
71-43-2	benzene

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Additional ecological information:**
· **General notes:**
Water hazard class 1 (Self-assessment): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

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Product Name: GASOLINE RANGE ORGANICS (EPA)

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· **Other adverse effects** No further relevant information available.

13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:** Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

· **UN-Number**	
· **DOT, ADR, IMDG, IATA**	UN1230
· **UN proper shipping name**	
· **DOT**	Methanol
· **ADR**	1230 Methanol
· **IMDG, IATA**	METHANOL
· **Transport hazard class(es)**	
· **DOT**	
· **Class**	3 Flammable liquids
· **Label**	3, 6.1
· **ADR**	
· **Class**	3 Flammable liquids
· **Label**	3+6.1
· **IMDG**	
· **Class**	3 Flammable liquids
· **Label**	3/6.1
· **IATA**	
· **Class**	3 Flammable liquids
· **Label**	3 (6.1)
· **Packing group**	
· **DOT, ADR, IMDG, IATA**	II
· **Environmental hazards:**	Not applicable.
· **Special precautions for user**	Warning: Flammable liquids
· **Danger code (Kemler):**	336
· **EMS Number:**	F-E,S-D
· **Stowage Category**	B
· **Stowage Code**	SW2 Clear of living quarters.

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· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **Transport/Additional information:**	
· **ADR**	
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **IMDG**	
· **Limited quantities (LQ)**	1L
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **UN "Model Regulation":**	UN 1230 METHANOL, 3 (6.1), II

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**
· **Sara**

· **Section 355 (extremely hazardous substances):**
None of the ingredients is listed.

· **Section 313 (Specific toxic chemical listings):**

67-56-1	methanol
108-38-3	m-xylene
95-63-6	1,2,4-trimethylbenzene
95-47-6	o-xylene
108-88-3	toluene
71-43-2	benzene
100-41-4	ethylbenzene

· **TSCA (Toxic Substances Control Act):**
All ingredients are listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**

71-43-2	benzene
100-41-4	ethylbenzene

· **Chemicals known to cause reproductive toxicity for females:**
None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for males:**

71-43-2	benzene

· **Chemicals known to cause developmental toxicity:**

67-56-1	methanol
108-88-3	toluene
71-43-2	benzene

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**

108-38-3	m-xylene	I
95-63-6	1,2,4-trimethylbenzene	II
540-84-1	2,2,4-trimethylpentane	II
95-47-6	o-xylene	I
108-88-3	toluene	II
71-43-2	benzene	A, K/L
100-41-4	ethylbenzene	D
142-82-5	heptane	D

· **TLV (Threshold Limit Value established by ACGIH)**

108-38-3	m-xylene	A4
95-47-6	o-xylene	A4

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108-88-3	toluene	A4
71-43-2	benzene	A1
100-41-4	ethylbenzene	A3

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**

71-43-2	benzene

· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS06 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
methanol
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H331 Toxic if inhaled.
H361 Suspected of damaging fertility or the unborn child.
H370 Causes damage to organs.
· **Precautionary statements**
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
Do not breathe dust/fume/gas/mist/vapors/spray.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.
· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing SDS:** product safety department
· **Contact:**
SPEX CertiPrep, LLC.
1-732-549-7144
· **Date of preparation / last revision** 07/19/2017 / -
· **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
PBT: Persistent, Bioaccumulative and Toxic
vPvB: very Persistent and very Bioaccumulative
NIOSH: National Institute for Occupational Safety
OSHA: Occupational Safety & Health
TLV: Threshold Limit Value
PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
BEI: Biological Exposure Limit
Flam. Liq. 2: Flammable liquids – Category 2
Acute Tox. 3: Acute toxicity – Category 3
Repr. 2: Reproductive toxicity – Category 2
STOT SE 1: Specific target organ toxicity (single exposure) – Category 1

Isopropyl Alcohol (2-Propanol)

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 11/14/2013 Revision date: 01/23/2020 Supersedes: 01/26/2018 Version: 1.3

SECTION 1: Identification

1.1. Identification

Product form	:	Substance
Substance name	:	Isopropyl Alcohol (2-Propanol)
CAS-No.	:	67-63-0
Product code	:	LC15750
Formula	:	C3H8O
Synonyms	:	1-methylethanol / 1-methylethyl alcohol / 2-hydroxypropane / dimethyl carbinol / ethyl carbinol / hydroxypropane / IPA / i-propanol / isoethylcarbinol / propan-2-ol / sec-propanol

1.2. Recommended use and restrictions on use

Use of the substance/mixture	:	Disinfectant Solvent
Recommended use	:	Laboratory chemicals
Restrictions on use	:	Not for food, drug or household use

1.3. Supplier

LabChem, Inc.
Jackson's Pointe Commerce Park Building 1000, 1010 Jackson's Pointe Court
Zelienople, PA 16063 - USA
T 412-826-5230 - F 724-473-0647
info@labchem.com - www.labchem.com

1.4. Emergency telephone number

Emergency number	:	CHEMTREC: 1-800-424-9300 or +1-703-741-5970

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS US classification

Flammable liquids Category 2	H225 Highly flammable liquid and vapour
Serious eye damage/eye irritation Category 2A	H319 Causes serious eye irritation
Specific target organ toxicity (single exposure) Category 3	H335 May cause respiratory irritation

Full text of H statements : see section 16

2.2. GHS Label elements, including precautionary statements

GHS US labeling

Hazard pictograms (GHS US) :



Signal word (GHS US) : Danger

Hazard statements (GHS US) :
H225 - Highly flammable liquid and vapour
H319 - Causes serious eye irritation
H335 - May cause respiratory irritation

Precautionary statements (GHS US) :
P210 - Keep away from heat, hot surfaces, open flames, sparks. - No smoking.
P233 - Keep container tightly closed.
P240 - Ground/bond container and receiving equipment.
P241 - Use explosion-proof electrical, lighting, ventilating equipment.
P242 - Use only non-sparking tools.
P243 - Take precautionary measures against static discharge.
P261 - Avoid breathing mist, vapors, spray.
P264 - Wash exposed skin thoroughly after handling.
P271 - Use only outdoors or in a well-ventilated area.
P280 - Wear eye protection, face protection, protective clothing, protective gloves.
P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P312 - Call a POISON CENTER or doctor/physician if you feel unwell.
P337+P313 - If eye irritation persists: Get medical advice/attention.
P370+P378 - In case of fire: Use dry chemical powder, alcohol-resistant foam, carbon dioxide (CO2) to extinguish
P403+P233 - Store in a well-ventilated place. Keep container tightly closed.
P403+P235 - Store in a well-ventilated place. Keep cool.
P405 - Store locked up.
P501 - Dispose of contents/container to comply with local, state and federal regulations.

2.3. Other hazards which do not result in classification

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substances

Substance type : Mono-constituent

Name	Product identifier	%	GHS US classification
Isopropyl Alcohol (2-Propanol) (Main constituent)	(CAS-No.) 67-63-0	100	Flam. Liq. 2, H225 Eye Irrit. 2A, H319 STOT SE 3, H335

Full text of hazard classes and H-statements : see section 16

3.2. Mixtures

Not applicable

SECTION 4: First-aid measures

4.1. Description of first aid measures

First-aid measures general : Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with labored breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Depending on the victim's condition: doctor/hospital. Never give alcohol to drink.

First-aid measures after inhalation : Remove the victim into fresh air. Respiratory problems: consult a doctor/medical service.

First-aid measures after skin contact : Rinse with water. Do not apply (chemical) neutralizing agents without medical advice. Soap may be used. Take victim to a doctor if irritation persists.

First-aid measures after eye contact : Rinse immediately with plenty of water. Remove contact lenses, if present and easy to do. Continue rinsing. Do not apply (chemical) neutralizing agents without medical advice. Take victim to an ophthalmologist if irritation persists.

First-aid measures after ingestion : Rinse mouth with water. Do not apply (chemical) neutralizing agents without medical advice. Immediately after ingestion: give lots of water to drink. Do not induce vomiting. Call Poison Information Centre (www.big.be/antigif.htm). Consult a doctor/medical service if you feel unwell. Ingestion of large quantities: immediately to hospital. Take the container/vomit to the doctor/hospital.

4.2. Most important symptoms and effects (acute and delayed)

Potential Adverse human health effects and symptoms : Non-toxic if swallowed (LD50 oral, rat > 5000 mg/kg). Not irritant to skin. Non-toxic in contact with skin (LD50 skin> 5000 mg/kg). May cause drowsiness or dizziness. Causes serious eye irritation.

Symptoms/effects after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Dry/sore throat. Central nervous system depression. Dizziness. Headache. Narcosis.

Symptoms/effects after skin contact : Dry skin.

Symptoms/effects after eye contact : Irritation of the eye tissue. Redness of the eye tissue.

Symptoms/effects after ingestion : AFTER ABSORPTION OF LARGE QUANTITIES: Central nervous system depression. Headache. Dilation of the blood vessels. Low arterial pressure. Nausea. Vomiting. Abdominal pain. Disturbed motor response. Disturbances of consciousness. FOLLOWING SYMPTOMS MAY APPEAR LATER: Body temperature fall. Slowing respiration.

Chronic symptoms : Red skin. Dry skin. Itching. Cracking of the skin. Skin rash/inflammation. Impaired memory.

4.3. Immediate medical attention and special treatment, if necessary

No additional information available

SECTION 5: Fire-fighting measures

5.1. Suitable (and unsuitable) extinguishing media

Suitable extinguishing media : Quick-acting ABC powder extinguisher. Quick-acting BC powder extinguisher. Quick-acting class B foam extinguisher. Quick-acting CO2 extinguisher. Class B foam (alcohol-resistant). Water spray if puddle cannot expand.

Unsuitable extinguishing media : Water (quick-acting extinguisher, reel); risk of puddle expansion. Water; risk of puddle expansion.

5.2. Specific hazards arising from the chemical

Fire hazard : DIRECT FIRE HAZARD. Highly flammable liquid and vapour. Gas/vapor flammable with air within explosion limits. INDIRECT FIRE HAZARD. May be ignited by sparks. Gas/vapor spreads at floor level: ignition hazard.

Explosion hazard : DIRECT EXPLOSION HAZARD. Gas/vapour explosive with air within explosion limits. INDIRECT EXPLOSION HAZARD. may be ignited by sparks. Reactions with explosion hazards: see "Reactivity Hazard".

5.3. Special protective equipment and precautions for fire-fighters

Firefighting instructions : Cool tanks/drums with water spray/remove them into safety. Do not move the load if exposed to heat.

Protection during firefighting : Heat/fire exposure: compressed air/oxygen apparatus.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Clean up any spills as soon as possible, using an absorbent material to collect it.

6.1.1. For non-emergency personnel

Protective equipment : Gloves. Protective goggles. Protective clothing. Large spills/in enclosed spaces: compressed air apparatus.

Emergency procedures : Keep upwind. Mark the danger area. Consider evacuation. Seal off low-lying areas. Close doors and windows of adjacent premises. Stop engines and no smoking. No naked flames or sparks. Spark- and explosion-proof appliances and lighting equipment. Keep containers closed. Wash contaminated clothes.

6.1.2. For emergency responders

Protective equipment : Equip cleanup crew with proper protection. Do not breathe gas, fumes, vapor or spray.

Emergency procedures : Stop leak if safe to do so. Ventilate area. If a major spill occurs, all personnel should be immediately evacuated and the area ventilated.

6.2. Environmental precautions

Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment : Contain released substance, pump into suitable containers. Plug the leak, cut off the supply. Dam up the liquid spill. Try to reduce evaporation. Measure the concentration of the explosive gas-air mixture. Dilute/disperse combustible gas/vapour with water curtain. Provide equipment/receptacles with earthing. Do not use compressed air for pumping over spills.

Methods for cleaning up : Take up liquid spill into absorbent material, e.g.: dry sand/earth/vermiculite or powdered limestone. Scoop absorbed substance into closing containers. Damaged/cooled tanks must be emptied. Do not use compressed air for pumping over spills. Carefully collect the spill/leftovers. Clean contaminated surfaces with an excess of water. Take collected spill to manufacturer/competent authority. Wash clothing and equipment after handling.

6.4. Reference to other sections

For further information refer to section 8: "Exposure controls/personal protection".

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Additional hazards when processed : May form explosive peroxides.

Precautions for safe handling : Use spark-/explosionproof appliances and lighting system. Take precautions against electrostatic charges. Keep away from naked flames/heat. Keep away from ignition sources/sparks. Measure the concentration in the air regularly. Work under local exhaust/ventilation. Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Handle uncleaned empty containers as full ones. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Do not use compressed air for pumping over. Keep container tightly closed.

Hygiene measures	:	Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse.

7.2. Conditions for safe storage, including any incompatibilities

Incompatible products	:	Ammonia. Strong acids. Strong oxidizers.
Incompatible materials	:	Direct sunlight. Heat sources. Sources of ignition.
Heat-ignition	:	KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.
Prohibitions on mixed storage	:	KEEP SUBSTANCE AWAY FROM: oxidizing agents. strong acids. (strong) bases. amines. halogens.
Storage area	:	Store in a cool area. Store in a dry area. Ventilation at floor level. Fireproof storeroom. Provide for an automatic sprinkler system. Provide for a tub to collect spills. Provide the tank with earthing. May be stored under nitrogen. Meet the legal requirements.
Special rules on packaging	:	SPECIAL REQUIREMENTS: closing. with pressure relief valve. dry. clean. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.
Packaging materials	:	SUITABLE MATERIAL: stainless steel. monel steel. carbon steel. copper. nickel. bronze. glass. Teflon. polyethylene. polypropylene. zinc. MATERIAL TO AVOID: steel with rubber inner lining. aluminium.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Isopropyl Alcohol (2-Propanol) (67-63-0)		
ACGIH	ACGIH TWA (ppm)	200 ppm
ACGIH	ACGIH STEL (ppm)	400 ppm
NIOSH	NIOSH REL (TWA) (mg/m³)	980 mg/m³
NIOSH	NIOSH REL (TWA) (ppm)	400 ppm
NIOSH	NIOSH REL (STEL) (mg/m³)	1225 mg/m³
NIOSH	NIOSH REL (STEL) (ppm)	500 ppm

8.2. Appropriate engineering controls

Appropriate engineering controls	:	Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Provide adequate general and local exhaust ventilation.

8.3. Individual protection measures/Personal protective equipment

Personal protective equipment:

Safety glasses. Gloves. Protective clothing. Face shield. High gas/vapor concentration: gas mask with filter type A.

Materials for protective clothing:

GIVE EXCELLENT RESISTANCE: butyl rubber. nitrile rubber. viton. polyethylene/ethylenevinylalcohol. GIVE GOOD RESISTANCE: neoprene. chloroprene rubber. GIVE LESS RESISTANCE: PVC. neoprene/natural rubber. GIVE POOR RESISTANCE: natural rubber. polyethylene. PVA

Hand protection:

Protective gloves against chemicals (EN 374)

Eye protection:

Safety glasses

Skin and body protection:

Protective clothing

Respiratory protection:

Full face mask with filter type A at conc. in air > exposure limit

Personal protective equipment symbol(s):



SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Liquid
Appearance	:	Liquid.
Color	:	Colourless
Odor	:	Alcohol odour Stuffy odour Mild odour
Odor threshold	:	No data available
pH	:	Not applicable
Melting point	:	-89 °C
Freezing point	:	No data available
Boiling point	:	82 °C (1013 hPa)
Critical temperature	:	235 °C
Critical pressure	:	47600 hPa
Flash point	:	12 °C
Relative evaporation rate (butyl acetate=1)	:	2.3
Relative evaporation rate (ether=1)	:	21
Flammability (solid, gas)	:	No data available
Vapor pressure	:	44 hPa (20 °C)
Vapor pressure at 50 °C	:	229 hPa
Relative vapor density at 20 °C	:	2.1
Relative density	:	0.8 (20 °C)
Relative density of saturated gas/air mixture	:	1.05
Specific gravity / density	:	785 kg/m³
Molecular mass	:	60.1 g/mol
Solubility	:	Miscible with water. Soluble in ethanol. Soluble in ether. Soluble in acetone. Soluble in oils/fats. Soluble in chloroform. Water: miscible Ethanol: complete Ether: complete Acetone: soluble
Log Pow	:	0.05 (Weight of evidence approach, 25 °C)
Auto-ignition temperature	:	399 °C
Decomposition temperature	:	No data available
Viscosity, kinematic	:	2.532 mm²/s (25 °C)
Viscosity, dynamic	:	2.1 mPa·s (25 °C)
Explosion limits	:	2 – 13 vol % Lower explosive limit (LEL): 2 vol % Upper explosive limit (UEL): 13 vol %
Explosive properties	:	No data available
Oxidizing properties	:	No data available

9.2. Other information

Minimum ignition energy	:	0.65 mJ
Specific conductivity	:	350000000 pS/m (25 °C)
Saturation concentration	:	106 g/m³
VOC content	:	100 %
Other properties	:	Gas/vapour heavier than air at 20°C. Clear. Volatile.

SECTION 10: Stability and reactivity

10.1. Reactivity

Violent to explosive reaction with (strong) oxidizers. Prolonged storage/in large quantities: may form peroxides.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

May react violently with oxidants.

10.4. Conditions to avoid

Direct sunlight. High temperature. Incompatible materials. Open flame. Sparks.

10.5. Incompatible materials

Ammonia. Strong acids. Strong oxidizers.

10.6. Hazardous decomposition products

Carbon dioxide. Carbon monoxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity (oral) : Not classified

Acute toxicity (dermal) : Not classified

Acute toxicity (inhalation) : Not classified

Isopropyl Alcohol (2-Propanol) (67-63-0)	
LD50 oral rat	5840 mg/kg body weight (Equivalent or similar to OECD 401, Rat, Experimental value, Oral, 14 day(s))
LD50 dermal rabbit	16400 mg/kg body weight (Equivalent or similar to OECD 402, 24 h, Rabbit, Experimental value, Dermal, 14 day(s))
LC50 inhalation rat (ppm)	> 10000 ppm (Equivalent or similar to OECD 403, 6 h, Rat, Male / female, Experimental value, Inhalation (vapours), 14 day(s))
ATE US (oral)	5840 mg/kg body weight
ATE US (dermal)	16400 mg/kg body weight

Skin corrosion/irritation : Not classified
pH: Not applicable

Serious eye damage/irritation : Causes serious eye irritation.
pH: Not applicable

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

STOT-single exposure : May cause respiratory irritation.

STOT-repeated exposure : Not classified

Aspiration hazard : Not classified

Viscosity, kinematic : 2.532 mm²/s (25 °C)

Likely routes of exposure : Inhalation. Skin and eye contact.

Potential Adverse human health effects and symptoms : Non-toxic if swallowed (LD50 oral, rat > 5000 mg/kg). Not irritant to skin. Non-toxic in contact with skin (LD50 skin> 5000 mg/kg). May cause drowsiness or dizziness. Causes serious eye irritation.

Symptoms/effects after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Dry/sore throat. Central nervous system depression. Dizziness. Headache. Narcosis.

Symptoms/effects after skin contact : Dry skin.

Symptoms/effects after eye contact : Irritation of the eye tissue. Redness of the eye tissue.

Symptoms/effects after ingestion : AFTER ABSORPTION OF LARGE QUANTITIES: Central nervous system depression. Headache. Dilation of the blood vessels. Low arterial pressure. Nausea. Vomiting. Abdominal pain. Disturbed motor response. Disturbances of consciousness. FOLLOWING SYMPTOMS MAY APPEAR LATER: Body temperature fall. Slowing respiration.

Chronic symptoms : Red skin. Dry skin. Itching. Cracking of the skin. Skin rash/inflammation. Impaired memory.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Not classified as dangerous for the environment according to the criteria of Regulation (EC) No 1272/2008.

Ecology - air : Not included in the list of substances which may contribute to the greenhouse effect (IPCC). Not included in the list of fluorinated greenhouse gases (Regulation (EU) No 517/2014). Photooxidation in the air. Not classified as dangerous for the ozone layer (Regulation (EC) No 1005/2009).

Ecology - water : Not harmful to crustacea. Not harmful to fishes. Groundwater pollutant. Inhibition of activated sludge. Not harmful to algae. Not harmful to bacteria.

Isopropyl Alcohol (2-Propanol) (67-63-0)	
LC50 fish 1	9640 – 10000 mg/l (Equivalent or similar to OECD 203, 96 h, Pimephales promelas, Flow-through system, Fresh water, Experimental value, Lethal)

12.2. Persistence and degradability

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Persistence and degradability	Biodegradable in the soil. Biodegradable in the soil under anaerobic conditions. Readily biodegradable in water.
Biochemical oxygen demand (BOD)	1.19 g O_2/g substance
Chemical oxygen demand (COD)	2.23 g O_2/g substance
ThOD	2.4 g O_2/g substance

12.3. Bioaccumulative potential

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Log Pow	0.05 (Weight of evidence approach, 25 °C)
Bioaccumulative potential	Low potential for bioaccumulation (Log Kow < 4).

12.4. Mobility in soil

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Surface tension	0.021 N/m (25 °C)
Log Koc	0.185 – 0.541 (log Koc, SRC PCKOCWIN v2.0, Calculated value)
Ecology - soil	Highly mobile in soil.

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Disposal methods

Waste disposal recommendations : Do not discharge into drains or the environment. Remove waste in accordance with local and/or national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Recycle by distillation. Incinerate under surveillance with energy recovery. Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.

Additional information : Hazardous waste according to Directive 2008/98/EC, as amended by Regulation (EU) No 1357/2014 and Regulation (EU) No 2017/997.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Transport document description : UN1219 Isopropyl alcohol, 3, II

UN-No.(DOT) : UN1219

Proper Shipping Name (DOT) : Isopropyl alcohol

Transport hazard class(es) (DOT) : 3 - Class 3 - Flammable and combustible liquid 49 CFR 173.120

Packing group (DOT) : II - Medium Danger

Hazard labels (DOT)	:	3 - Flammable liquid



DOT Packaging Non Bulk (49 CFR 173.xxx)	:	202
DOT Packaging Bulk (49 CFR 173.xxx)	:	242
DOT Special Provisions (49 CFR 172.102)	:	IB2 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized. T4 - 2.65 178.274(d)(2) Normal..... 178.275(d)(3) TP1 - The maximum degree of filling must not exceed the degree of filling determined by the following: Degree of filling = 97 / 1 + a (tr - tf) Where: tr is the maximum mean bulk temperature during transport, and tf is the temperature in degrees celsius of the liquid during filling.
DOT Packaging Exceptions (49 CFR 173.xxx)	:	4b;150
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	5 L
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	60 L
DOT Vessel Stowage Location	:	B - (i) The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3 m of overall vessel length; and (ii) ‘‘On deck only’’ on passenger vessels in which the number of passengers specified in paragraph (k)(2)(i) of this section is exceeded.
Other information	:	No supplementary information available.

Transportation of Dangerous Goods

Transport document description	:	UN1219 ISOPROPANOL, 3, II
UN-No. (TDG)	:	UN1219
Proper Shipping Name (Transportation of Dangerous Goods)	:	ISOPROPANOL
TDG Primary Hazard Classes	:	3 - Class 3 - Flammable Liquids
Packing group	:	II - Medium Danger
Explosive Limit and Limited Quantity Index	:	1 L
Passenger Carrying Road Vehicle or Passenger Carrying Railway Vehicle Index	:	5 L

Transport by sea

Transport document description (IMDG)	:	UN 1219 Isopropyl alcohol, 3, II
UN-No. (IMDG)	:	1219
Proper Shipping Name (IMDG)	:	Isopropyl alcohol
Class (IMDG)	:	3 - Flammable liquids
Packing group (IMDG)	:	II - substances presenting medium danger
EmS-No. (1)	:	F-E
EmS-No. (2)	:	S-D

Air transport

Transport document description (IATA)	:	UN 1219 Isopropyl alcohol, 3, II
UN-No. (IATA)	:	1219
Proper Shipping Name (IATA)	:	Isopropyl alcohol
Class (IATA)	:	3 - Flammable Liquids
Packing group (IATA)	:	II - Medium Danger

SECTION 15: Regulatory information

15.1. US Federal regulations

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Subject to reporting requirements of United States SARA Section 313	
SARA Section 311/312 Hazard Classes	Physical hazard - Flammable (gases, aerosols, liquids, or solids) Health hazard - Serious eye damage or eye irritation Health hazard - Specific target organ toxicity (single or repeated exposure)

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory

Chemical(s) subject to the reporting requirements of Section 313 or Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Isopropyl Alcohol (2-Propanol)	CAS-No. 67-63-0	100%

15.2. International regulations

CANADA
No additional information available

EU-Regulations
No additional information available

National regulations
No additional information available

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

SECTION 16: Other information

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Revision date : 01/23/2020

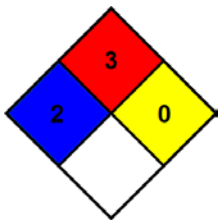
Full text of H-phrases: see section 16:

H225	Highly flammable liquid and vapour
H319	Causes serious eye irritation
H335	May cause respiratory irritation

NFPA health hazard : 2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.

NFPA fire hazard : 3 - Liquids and solids (including finely divided suspended solids) that can be ignited under almost all ambient temperature conditions.

NFPA reactivity : 0 - Material that in themselves are normally stable, even under fire conditions.



Hazard Rating		
Health	:	1 Slight Hazard - Irritation or minor reversible injury possible
Flammability	:	3 Serious Hazard - Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points below 73 F and boiling points above 100 F. as well as liquids with flash points between 73 F and 100 F. (Classes IB & IC)
Physical	:	0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.
Personal protection	:	H H - Splash goggles, Gloves, Synthetic apron, Vapor respirator

SDS US LabChem

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

Safety Data Sheet
acc. to OSHA HCS

Printing date 03/18/2019 *Reviewed on 03/18/2019*

1 Identification

· **Product identifier**

· **Product Name: PAH Combination Mix**

· **Part Number:** 8310-A
· **Application of the substance / the mixture** Certified Reference Material

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
SPEX CertiPrep, LLC.
203 Norcross Ave, Metuchen,
NJ 08840 USA

· **Information department:** product safety department
· **Emergency telephone number:**
Emergency Phone Number (24 hours)
CHEMTREC (800-424-9300)
Outside US: 703-527-3887

2 Hazard(s) identification

· **Classification of the substance or mixture**



GHS02 Flame

Flam. Liq. 2 H225 Highly flammable liquid and vapor.



GHS08 Health hazard

Carc. 1B H350 May cause cancer.



GHS07

Acute Tox. 4 H312 Harmful in contact with skin.
Acute Tox. 4 H332 Harmful if inhaled.
Eye Irrit. 2A H319 Causes serious eye irritation.

· **Label elements**
· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS07 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
acetonitrile
benzo[a]pyrene
dibenz[a,h]anthracene
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H312+H332 Harmful in contact with skin or if inhaled.
H319 Causes serious eye irritation.
H350 May cause cancer.
· **Precautionary statements**
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

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Product Name: PAH Combination Mix

(Contd. of page 1)

· **Classification system:**
· **NFPA ratings (scale 0 - 4)**



Health = 2
Fire = 3
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = *2
Fire = 3
Reactivity = 0

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

3 Composition/information on ingredients

· **Chemical characterization: Mixtures**
· **Description:** Mixture of the substances listed below with nonhazardous additions.

· **Dangerous components:**		
75-05-8	acetonitrile	99.2%
50-32-8	benzo[a]pyrene	0.05%
53-70-3	dibenz[a,h]anthracene	0.05%

· **Chemical identification of the substance/preparation**		
86-73-7	fluorene	0.05%
193-39-5	indeno[1,2,3-cd]pyrene	0.05%
83-32-9	acenaphthene	0.05%
208-96-8	acenaphthylene	0.05%
120-12-7	anthracene	0.05%
191-24-2	Benzo(g,h,i)perylene	0.05%
207-08-9	benzo[k]fluoranthene	0.05%
205-99-2	benz[e]acephenanthrylene	0.05%
56-55-3	benz[a]anthracene	0.05%
91-20-3	naphthalene	0.05%
218-01-9	chrysene	0.05%
85-01-8	phenanthrene, pure	0.05%
129-00-0	pyrene	0.05%
206-44-0	fluoranthene	0.05%

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Immediately remove any clothing soiled by the product.
Symptoms of poisoning may even occur after several hours; therefore medical observation for at least 48 hours after the accident.
· **After inhalation:**
Supply fresh air. If required, provide artificial respiration. Keep patient warm. Consult doctor if symptoms persist.
In case of unconsciousness place patient stably in side position for transportation.
· **After skin contact:** Immediately rinse with water.
· **After eye contact:** Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor.
· **After swallowing:** Do not give anything to eat or drink - Do not induce vomitting
· **Information for Doctor:**
· **Most important symptoms and effects, both acute and delayed** No further relevant information available.
· **Indication of any immediate medical attention and special treatment needed** No further relevant information available.

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Product Name: PAH Combination Mix

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5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:** CO2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· **Special hazards arising from the substance or mixture** No further relevant information available.
· **Advice for firefighters**
· **Protective equipment:** Mouth respiratory protective device.

6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures** Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:**
Dilute with plenty of water.
Do not allow to enter sewers/ surface or ground water.
· **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.
· **Protective Action Criteria for Chemicals**

· **PAC-1:**		
75-05-8	acetonitrile	13 ppm
86-73-7	fluorene	6.6 mg/m³
193-39-5	indeno[1,2,3-cd]pyrene	1.2 mg/m³
83-32-9	acenaphthene	3.6 mg/m³
208-96-8	acenaphthylene	10 mg/m³
120-12-7	anthracene	48 mg/m³
191-24-2	Benzo(g,h,i)perylene	30 mg/m³
50-32-8	benzo[a]pyrene	0.6 mg/m³
205-99-2	benz[e]acephenanthrylene	0.12 mg/m³
56-55-3	benz[a]anthracene	0.6 mg/m³
91-20-3	naphthalene	15 ppm
218-01-9	chrysene	0.6 mg/m³
85-01-8	phenanthrene, pure	5.4 mg/m³
129-00-0	pyrene	0.15 mg/m³
53-70-3	dibenz[a,h]anthracene	0.093 mg/m³
206-44-0	fluoranthene	8.2 mg/m³

· **PAC-2:**		
75-05-8	acetonitrile	50 ppm
86-73-7	fluorene	72 mg/m³
193-39-5	indeno[1,2,3-cd]pyrene	13 mg/m³
83-32-9	acenaphthene	40 mg/m³
208-96-8	acenaphthylene	110 mg/m³
120-12-7	anthracene	530 mg/m³
191-24-2	Benzo(g,h,i)perylene	330 mg/m³
50-32-8	benzo[a]pyrene	120 mg/m³
205-99-2	benz[e]acephenanthrylene	1.3 mg/m³
56-55-3	benz[a]anthracene	120 mg/m³
91-20-3	naphthalene	83 ppm
218-01-9	chrysene	12 mg/m³
85-01-8	phenanthrene, pure	59 mg/m³
129-00-0	pyrene	1.7 mg/m³
53-70-3	dibenz[a,h]anthracene	1 mg/m³
206-44-0	fluoranthene	90 mg/m³

· **PAC-3:**		
75-05-8	acetonitrile	150 ppm

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86-73-7	fluorene	430 mg/m³
193-39-5	indeno[1,2,3-cd]pyrene	79 mg/m³
83-32-9	acenaphthene	240 mg/m³
208-96-8	acenaphthylene	660 mg/m³
120-12-7	anthracene	3,200 mg/m³
191-24-2	Benzo(g,h,i)perylene	2,000 mg/m³
50-32-8	benzo[a]pyrene	700 mg/m³
205-99-2	benz[e]acephenanthrylene	7.9 mg/m³
56-55-3	benz[a]anthracene	700 mg/m³
91-20-3	naphthalene	500 ppm
218-01-9	chrysene	69 mg/m³
85-01-8	phenanthrene, pure	360 mg/m³
129-00-0	pyrene	110 mg/m³
53-70-3	dibenz[a,h]anthracene	2.9 mg/m³
206-44-0	fluoranthene	400 mg/m³

7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Ensure good ventilation/exhaustion at the workplace.
Open and handle receptacle with care.
Prevent formation of aerosols.
· **Information about protection against explosions and fires:**
Keep ignition sources away - Do not smoke.
Protect against electrostatic charges.
Keep respiratory protective device available.

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** Store in a cool location.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:**
Keep receptacle tightly sealed.
Store in cool, dry conditions in well sealed receptacles.
· **Specific end use(s)** No further relevant information available.

8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**
· **Components with limit values that require monitoring at the workplace:**
The following constituents are the only constituents of the product which have a PEL, TLV or other recommended exposure limit.
At this time, the remaining constituent has no known exposure limits.

75-05-8 acetonitrile	
PEL	Long-term value: 70 mg/m³, 40 ppm
REL	Long-term value: 34 mg/m³, 20 ppm
TLV	Long-term value: 34 mg/m³, 20 ppm Skin
50-32-8 benzo[a]pyrene	
PEL	Long-term value: 0.2 mg/m³ see Coal tar pitch volatiles
REL	Long-term value: 0.1 mg/m³ Coal tar pitch volatile; Pocket Guide Apps. A+C
TLV	L; BEIp

· **Ingredients with biological limit values:**	
50-32-8 benzo[a]pyrene	
BEI	- Medium: urine Time: end of shift at end of workweek Parameter: 1-Hydroxypyrene with hydrolysis (nonquantitative)

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· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Store protective clothing separately.
Avoid contact with the eyes.
Avoid contact with the eyes and skin.
· **Respiratory protection:**
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.
· **Protection of hands:**



Protective gloves

The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation
· **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· **Eye protection:**



Tightly sealed goggles

9 Physical and chemical properties

· **Information on basic physical and chemical properties**	
· **General Information**	
· **Appearance:**	
Form:	Liquid
Color:	According to product specification
· **Odor:**	Characteristic
· **Odour Threshold:**	Not applicable.
· **pH-value:**	Not applicable.
· **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	81 °C (177.8 °F)
· **Flash point:**	< 23 °C (<73.4 °F)
· **Flammability (solid, gaseous):**	Not applicable.
· **Ignition temperature:**	525 °C (977 °F)
· **Decomposition temperature:**	Not applicable.
· **Auto igniting:**	Product is not selfigniting.
· **Danger of explosion:**	Product is not explosive. However, formation of explosive air/vapor mixtures are possible.
· **Explosion limits:**	
Lower:	4.4 Vol %
Upper:	16 Vol %
· **Vapor pressure at 20 °C (68 °F):**	97 hPa (72.8 mm Hg)
· **Density**	Not applicable.
· **Relative density**	Not applicable.
· **Vapor density**	Not applicable.

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Product Name: PAH Combination Mix

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· **Evaporation rate**	Not applicable.
· **Solubility in / Miscibility with**	
Water:	Fully miscible.
· **Partition coefficient (n-octanol/water):**	Not applicable.
· **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
· **Solvent content:**	
VOC content:	0.00 %
Solids content:	0.7 %
· **Other information**	No further relevant information available.

10 Stability and reactivity

· **Reactivity** No further relevant information available.
· **Chemical stability**
· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.
· **Conditions to avoid** No further relevant information available.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· **LD/LC50 values that are relevant for classification:**		
75-05-8 acetonitrile		
Oral	LD50	2,730 mg/kg (rat)
Dermal	LD50	1,250 mg/kg (rabbit)

· **Primary irritant effect:**
· **on the eye:** Irritating effect.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Harmful
Irritant

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**		
86-73-7	fluorene	3
193-39-5	indeno[1,2,3-cd]pyrene	2B
83-32-9	acenaphthene	3
120-12-7	anthracene	3
191-24-2	Benzo(g,h,i)perylene	3
207-08-9	benzo[k]fluoranthene	2B
50-32-8	benzo[a]pyrene	1
205-99-2	benz[e]acephenanthrylene	2B
56-55-3	benz[a]anthracene	2B
91-20-3	naphthalene	2B
218-01-9	chrysene	2B
85-01-8	phenanthrene, pure	3
129-00-0	pyrene	3
53-70-3	dibenz[a,h]anthracene	2A
206-44-0	fluoranthene	3

· **NTP (National Toxicology Program)**		
86-73-7	fluorene	R
193-39-5	indeno[1,2,3-cd]pyrene	R

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Product Name: PAH Combination Mix

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120-12-7	anthracene	R
207-08-9	benzo[k]fluoranthene	R
50-32-8	benzo[a]pyrene	R
205-99-2	benz[e]acephenanthrylene	R
56-55-3	benz[a]anthracene	R
91-20-3	naphthalene	R
218-01-9	chrysene	R
85-01-8	phenanthrene, pure	R
129-00-0	pyrene	R
53-70-3	dibenz[a,h]anthracene	R
206-44-0	fluoranthene	R

· **OSHA-Ca (Occupational Safety & Health Administration)**

None of the ingredients is listed.

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Additional ecological information:**
· **General notes:**
Water hazard class 3 (Self-assessment): extremely hazardous for water
Do not allow product to reach ground water, water course or sewage system, even in small quantities.
Danger to drinking water if even extremely small quantities leak into the ground.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.
· **Other adverse effects** No further relevant information available.

13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:** Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to official regulations.
· **Recommended cleansing agent:** Water, if necessary with cleansing agents.

14 Transport information

· **UN-Number**
· **DOT, ADR, IMDG, IATA** UN1648

· **UN proper shipping name**
· **DOT** Acetonitrile
· **ADR** 1648 ACETONITRILE, ENVIRONMENTALLY HAZARDOUS
· **IMDG** ACETONITRILE, MARINE POLLUTANT
· **IATA** ACETONITRILE

· **Transport hazard class(es)**

· **DOT, IATA**



· **Class** 3 Flammable liquids

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Product Name: PAH Combination Mix

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· **Label**	3
· **ADR, IMDG**	
	
· **Class**	3 Flammable liquids
· **Label**	3
· **Packing group**	
· **DOT, ADR, IMDG, IATA**	II
· **Environmental hazards:**	Product contains environmentally hazardous substances: benzo[a]pyrene
· **Marine pollutant:**	Symbol (fish and tree)
· **Special marking (ADR):**	Symbol (fish and tree)
· **Special precautions for user**	Warning: Flammable liquids
· **Danger code (Kemler):**	33
· **EMS Number:**	F-E,S-D
· **Stowage Category**	B
· **Stowage Code**	SW2 Clear of living quarters.
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **Transport/Additional information:**	
· **ADR**	
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **IMDG**	
· **Limited quantities (LQ)**	1L
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **UN "Model Regulation":**	UN 1648 ACETONITRILE, 3, II, ENVIRONMENTALLY HAZARDOUS

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**
· **Sara**

· **Section 313 (Specific toxic chemical listings):**	
75-05-8	acetonitrile
193-39-5	indeno[1,2,3-cd]pyrene
120-12-7	anthracene
191-24-2	Benzo(g,h,i)perylene
207-08-9	benzo[k]fluoranthene
50-32-8	benzo[a]pyrene
205-99-2	benz[e]acephenanthrylene
56-55-3	benz[a]anthracene
91-20-3	naphthalene
218-01-9	chrysene
85-01-8	phenanthrene, pure
53-70-3	dibenz[a,h]anthracene
206-44-0	fluoranthene

· **TSCA (Toxic Substances Control Act):**	
75-05-8	acetonitrile
86-73-7	fluorene
193-39-5	indeno[1,2,3-cd]pyrene
83-32-9	acenaphthene
208-96-8	acenaphthylene

(Contd. on page 9)

Safety Data Sheet
acc. to OSHA HCS

Product Name: PAH Combination Mix

(Contd. of page 8)

120-12-7	anthracene
50-32-8	benzo[a]pyrene
56-55-3	benz[a]anthracene
91-20-3	naphthalene
218-01-9	chrysene
85-01-8	phenanthrene, pure
129-00-0	pyrene
53-70-3	dibenz[a,h]anthracene
206-44-0	fluoranthene

· **TSCA new (21st Century Act): (Substances not listed)**

53-70-3	dibenz[a,h]anthracene

· **Proposition 65**

· **Chemicals known to cause cancer:**

193-39-5	indeno[1,2,3-cd]pyrene
207-08-9	benzo[k]fluoranthene
50-32-8	benzo[a]pyrene
205-99-2	benz[e]acephenanthrylene
56-55-3	benz[a]anthracene
91-20-3	naphthalene
218-01-9	chrysene
53-70-3	dibenz[a,h]anthracene

· **Chemicals known to cause reproductive toxicity for females:**

None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for males:**

None of the ingredients is listed.

· **Chemicals known to cause developmental toxicity:**

None of the ingredients is listed.

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**

75-05-8	acetonitrile	CBD, D
86-73-7	fluorene	D
193-39-5	indeno[1,2,3-cd]pyrene	B2
83-32-9	acenaphthene	A (oral)
208-96-8	acenaphthylene	D
120-12-7	anthracene	D
191-24-2	Benzo(g,h,i)perylene	D
207-08-9	benzo[k]fluoranthene	B2
50-32-8	benzo[a]pyrene	CaH
205-99-2	benz[e]acephenanthrylene	B2
56-55-3	benz[a]anthracene	B2
91-20-3	naphthalene	C, CBD
218-01-9	chrysene	B2
85-01-8	phenanthrene, pure	D
129-00-0	pyrene	D
53-70-3	dibenz[a,h]anthracene	B2
206-44-0	fluoranthene	D

· **TLV (Threshold Limit Value established by ACGIH)**

75-05-8	acetonitrile	A4
50-32-8	benzo[a]pyrene	A2
205-99-2	benz[e]acephenanthrylene	A2
56-55-3	benz[a]anthracene	A2
91-20-3	naphthalene	A4
218-01-9	chrysene	A3

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**

50-32-8	benzo[a]pyrene

(Contd. on page 10)

Safety Data Sheet
acc. to OSHA HCS

Product Name: PAH Combination Mix

(Contd. of page 9)

218-01-9	chrysene

· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS07 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
acetonitrile
benzo[a]pyrene
dibenz[a,h]anthracene
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H312+H332 Harmful in contact with skin or if inhaled.
H319 Causes serious eye irritation.
H350 May cause cancer.
· **Precautionary statements**
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

· **National regulations:**

· **Information about limitation of use:**
Workers are not allowed to be exposed to the hazardous carcinogenic materials contained in this preparation. Exceptions can be made by the authorities in certain cases.
· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing SDS:** product safety department
· **Contact:**
SPEX CertiPrep, LLC.
1-732-549-7144
· **Date of preparation / last revision** 03/18/2019 / -
· **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
PBT: Persistent, Bioaccumulative and Toxic
vPvB: very Persistent and very Bioaccumulative
NIOSH: National Institute for Occupational Safety
OSHA: Occupational Safety & Health
TLV: Threshold Limit Value
PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
BEI: Biological Exposure Limit
Flam. Liq. 2: Flammable liquids – Category 2
Acute Tox. 4: Acute toxicity – Category 4
Eye Irrit. 2A: Serious eye damage/eye irritation – Category 2A
Carc. 1B: Carcinogenicity – Category 1B

Safety Data Sheet
Perchloroethylene (All Grades)

Version 1.1 Revision Date: 12/11/2014

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Perchloroethylene (All Grades)
Product Use Description : Industrial chemical

Manufacturer or supplier's details

Company : Nexeo Solutions LLC
Address 3 Waterway Square Place Suite 1000
Woodlands, Tx. 77380
United States of America

Emergency telephone number:
Health North America: 1-855-NEXEO4U (1-855-639-3648)
Health International: 1-855-NEXEO4U (1-855-639-3648)
Transport North America: CHEMTREC 800.424.9300

Additional Information: : Responsible Party: Product Safety Group
E-Mail: msds@nexeosolutions.com
SDS Requests: 1-855-429-2661
SDS Requests Fax: 1-281-500-2370
Website: www.nexeosolutions.com

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Carcinogenicity : Category 2

GHS Label element

Hazard pictograms :



Signal word : Danger

Hazard statements : H351 Suspected of causing cancer.

Precautionary statements : **Prevention:**
P202 Do not handle until all safety precautions have been read and understood.
P281 Use personal protective equipment as required.
Response:
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
Storage:
P405 Store locked up.

Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Potential Health Effects

Aggravated Medical Condition : None known.

Symptoms of Overexposure : Nausea
Headache
Dizziness
Fatigue
Unconsciousness
Dermatitis
Vomiting
Lack of coordination

Carcinogenicity:

IARC Group 2A: Probably carcinogenic to humans

127-18-4 Tetrachloroethylene

Group 2B: Possibly carcinogenic to humans

56-23-5 Carbon tetrachloride

ACGIH Suspected human carcinogen

56-23-5 Carbon tetrachloride

OSHA No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

NTP Reasonably anticipated to be a human carcinogen

127-18-4 Tetrachloroethylene

56-23-5 Carbon tetrachloride

Emergency Overview

Appearance	liquid
Colour	clear, colourless
Odour	mild, sweet, ether-like
Hazard Summary	No information available.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Substance

Hazardous components

CAS-No.	Chemical Name	Concentration (%)
127-18-4	Tetrachloroethylene	90 - 100
56-23-5	Carbon tetrachloride	0.1 - 1

Molecular formula : C2-Cl4

Synonyms : TETRACHLOROETHENE, TETRACHLOROETHYLENE, PERCHLOROETHENE, PERCHLOROETHYLENE INDUSTRIAL, PERCHLOROETHYLENE ISO GRADE,

SECTION 4. FIRST AID MEASURES

General advice : Show this safety data sheet to the doctor in attendance.
Do not leave the victim unattended.

If inhaled : If unconscious place in recovery position and seek medical advice.
If symptoms persist, call a physician.

In case of eye contact : Flush eyes with water as a precaution.
Keep eye wide open while rinsing.
If eye irritation persists, consult a specialist.

If swallowed : Induce vomiting immediately and call a physician.
Keep respiratory tract clear.
Do not give milk or alcoholic beverages.
Never give anything by mouth to an unconscious person.
If symptoms persist, call a physician.
Take victim immediately to hospital.

Most important symptoms and effects, both acute and delayed : Nausea
Headache
Dizziness
Fatigue
Unconsciousness
Dermatitis
Vomiting
Lack of coordination

Notes to physician	:	Do not give adrenaline or similar drugs.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media	:	Use an extinguishing media appropriate for surrounding fire.
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during firefighting	:	Do not allow run-off from fire fighting to enter drains or water courses.
Specific extinguishing methods	:	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
Further information	:	Collect contaminated fire extinguishing water separately. This must not be discharged into drains.
Special protective equipment for firefighters	:	In the event of fire, wear self-contained breathing apparatus. Wear a positive-pressure supplied-air respirator with full facepiece. Exposure to decomposition products may be a hazard to health.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Use personal protective equipment.
Environmental precautions	:	Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform respective authorities.
Methods and materials for containment and cleaning up	:	Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Keep in suitable, closed containers for disposal.

SECTION 7. HANDLING AND STORAGE

Advice on safe handling	:	Do not breathe vapours/dust.

Avoid exposure - obtain special instructions before use.
Avoid contact with skin and eyes.
For personal protection see section 8.
Smoking, eating and drinking should be prohibited in the application area.
Dispose of rinse water in accordance with local and national regulations.

Conditions for safe storage : Keep container tightly closed in a dry and well-ventilated place.
Containers which are opened must be carefully re-sealed and kept upright to prevent leakage.
Observe label precautions.
Electrical installations / working materials must comply with the technological safety standards.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

CAS-No.	Components	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
127-18-4	Tetrachloroethylene	TWA	25 ppm	ACGIH
		STEL	100 ppm	ACGIH
		TWA	100 ppm	OSHA Z-2
		CEIL	200 ppm	OSHA Z-2
		Peak	300 ppm	OSHA Z-2
		TWA	25 ppm 170 mg/m3	OSHA P0
56-23-5	Carbon tetrachloride	TWA	5 ppm	ACGIH
		STEL	10 ppm	ACGIH
		ST	2 ppm 12.6 mg/m3	NIOSH REL
		TWA	10 ppm	OSHA Z-2
		CEIL	25 ppm	OSHA Z-2
		Peak	200 ppm	OSHA Z-2
		TWA	2 ppm 12.6 mg/m3	OSHA P0

Biological occupational exposure limits

Components	CAS-No.	Control parameters	Biological specimen	Sampling time	Permissible concentration	Basis
Tetrachloroethylene	127-18-4	Tetrachloroethylene	In end-exhaled	Prior to shift	3 parts per million	ACGIH BEI

			air	(16 hours after expo-sure ceases)		
		Tetrachlo-roethylene	In blood	Prior to shift (16 hours after expo-sure ceases)	0.5 mg/l	ACGIH BEI

Personal protective equipment

Respiratory protection : In the case of vapour formation use a respirator with an approved filter.
Wear a positive-pressure supplied-air respirator with full facepiece.

Hand protection
Remarks : The suitability for a specific workplace should be discussed with the producers of the protective gloves.

Eye protection : Eye wash bottle with pure water
Tightly fitting safety goggles

Skin and body protection : impervious clothing
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures : When using do not eat or drink.
When using do not smoke.
Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance : liquid

Colour : clear, colourless

Odour : mild, sweet, ether-like

Odour Threshold : 55 ppm

pH	:	No data available
Freezing Point (Freezing Point)	:	-19 °C (-2 °F)
Boiling Point (Boiling point/boiling range)	:	121 °C (250 °F)
Flash point	:	not applicable
Evaporation rate	:	0.1 - 0.33
Flammability (solid, gas)	:	No data available
Burning rate	:	No data available
Upper explosion limit	:	No data available
Lower explosion limit	:	No data available
Vapour pressure	:	13 - 18 mmHg @ 20 - 25 °C (68 - 77 °F)
Relative vapour density	:	5.8
Relative density	:	1.62 @ 25 °C (77 °F) Reference substance: (water = 1)
Density	:	1.619 g/cm3 @ 77 °F (77 °F)
Bulk density	:	1.8 kg/m3
Solubility(ies)		
Water solubility	:	negligible
Solubility in other solvents	:	No data available
Partition coefficient: n-octanol/water	:	Pow: 2.88
Auto-ignition temperature	:	not applicable
Thermal decomposition	:	No data available
Viscosity		
Viscosity, dynamic	:	1 mPa.s

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Hazardous polymerisation does not occur. Stable under recommended storage conditions.
Conditions to avoid	:	Keep away from heat, flame, sparks and other ignition sources. elevated temperatures Exposure to moisture.
Incompatible materials	:	Acids Bases Strong oxidizing agents Oxygen Peroxides reactive metals such as aluminum and magnesium Alkali metals Nitric acid Zinc Barium lithium Iron
Hazardous decomposition products	:	Chlorine Phosgene Carbon oxides hydrogen chloride Trichloroacetic acid decomposes above 200 °C forming HCl, CO and Phosgene. Thermal decomposition can lead to release of irritating gases and vapours.

SECTION 11. TOXICOLOGICAL INFORMATION

Acute toxicity

Product:

Acute oral toxicity	:	Acute toxicity estimate : 2,647 mg/kg Method: Calculation method
Acute inhalation toxicity	:	Acute toxicity estimate : > 40 mg/l

Exposure time: 4 h
Test atmosphere: vapour
Method: Calculation method

Acute dermal toxicity : Acute toxicity estimate : > 5,000 mg/kg
Method: Calculation method

Components:

127-18-4:

Acute oral toxicity : LD50 (rat, male): 3,835 mg/kg
Method: OECD Test Guideline 401

Acute inhalation toxicity : LC50 (mouse, male and female): 35 mg/l
Exposure time: 4 h
Test atmosphere: vapour
Method: OECD Test Guideline 403

Acute dermal toxicity : LD50 (rabbit): 10,000 mg/kg

56-23-5:

Acute oral toxicity : LD50 (rat): 50 mg/kg
Assessment: The component/mixture is toxic after single ingestion.

Acute inhalation toxicity : (rat): 8 mg/l
Assessment: The component/mixture is toxic after short term inhalation.

Acute dermal toxicity : Assessment: The component/mixture is toxic after single contact with skin.

Skin corrosion/irritation

Components:

127-18-4:
Species: rabbit
Exposure time: 4 h
Method: OECD Test Guideline 404
Result: Irritating to skin.

56-23-5:
Species: rabbit
Result: Irritating to skin.

Serious eye damage/eye irritation

Components:

127-18-4:
Species: rabbit

Result: Irritating to eyes.

56-23-5:
Species: rabbit
Result: Irritating to eyes.

Respiratory or skin sensitisation

Components:

127-18-4:
Test Type: lymph node assay
Species: mouse
Assessment: May cause sensitization by skin contact.
Method: OECD Test Guideline 429
Result: Weak sensitizer

Germ cell mutagenicity

Components:

127-18-4:

Genotoxicity in vitro : Test Type: Chromosome aberration test in vitro
Test species: Chinese hamster ovary (CHO)
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 473
Result: negative

: Test Type: Ames test
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative

: Test Type: Mammalian cell gene mutation assay
Test species: Mouse lymphoma cells
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 476
Result: negative

Genotoxicity in vivo : Test Type: Chromosome aberration assay in vivo
Test species: rat (male and female)
Cell type: Bone marrow
Application Route: Inhalation
Exposure time: 1- 5 d, 7 h/d
Dose: 0, 100, 500 ppm
Result: Ambiguous

Test Type: In vivo micronucleus test
Test species: mouse (male)

Cell type: Peripheral blood reticulocytes
Application Route: Intraperitoneal
Exposure time: Single
Dose: o, 500, 1000, 2000 mg/kg bw
Method: OECD Test Guideline 474
Result: negative

Test Type: DNA damage and/or repair
Test species: rat (male)
Cell type: Kidney cells
Application Route: Oral
Exposure time: 7 d
Dose: 0, 1000 mg/kg
Result: negative

Test Type: Chromosome aberration assay in vivo
Test species: rat (male and female)
Cell type: Bone marrow
Application Route: inhalation (vapour)
Exposure time: 52 wks, 6 h/d
Dose: 0, 300, 600 ppm
Result: negative

Germ cell mutagenicity-Assessment : Did not show mutagenic effects in animal experiments.

56-23-5:

Genotoxicity in vitro : Test Type: Ames test
Test species: Salmonella typhimurium
Method: OECD Test Guideline 471
Result: negative

Genotoxicity in vivo : Test Type: In vivo micronucleus test
Test species: mouse
Method: OECD Test Guideline 474
Result: negative

Germ cell mutagenicity-Assessment : Tests on bacterial or mammalian cell cultures did not show mutagenic effects.

Carcinogenicity

Components:

127-18-4:
Species: mouse, (male and female)
Application Route: inhalation (vapour)
Exposure time: 103 wks
Dose: 0, 100, 200 ppm
Frequency of Treatment: 6 h/d, 5 d/wk
LOAEL: 100 ppm

Method: OECD Test Guideline 451
Result: evidence of carcinogenic activity
Symptoms: increase incidence of hepatocellular carcinomas

Species: rat, (male and female)
Application Route: inhalation (vapour)
Exposure time: 103 wks
Dose: 0, 200, 400 ppm
Frequency of Treatment: 6 h/d, 5 d/wk
LOAEL: 200 ppm

Result: evidence of carcinogenic activity
Symptoms: Increased incidence of renal tubular cell carcinomas

Carcinogenicity - Assessment : Suspected human carcinogens

56-23-5:
Species: mouse
NOAEL: 9.9 mg/kg bw/day

Carcinogenicity - Assessment : Suspected human carcinogens

Reproductive toxicity

Components:
127-18-4:

Effects on fertility : Test Type: Two-generation study
Species: rat, male and female
Application Route: inhalation (vapour)
Dose: 0, 100, 300, 1000 ppm
General Toxicity - Parent: NOAEC: 100 ppm
General Toxicity F1: NOAEC: 100 ppm
Fertility: NOAEC: 1,000 ppm
Symptoms: Maternal effects. Clinical signs Reduced offspring weight gain.
Method: EPA OTS 798.4700
Result: Animal testing did not show any effects on fertility.
GLP: yes

Effects on foetal development : Species: rat
Application Route: inhalation (vapour)
Dose: 0, 75, 250, 600 ppm
Duration of Single Treatment: 14 d
Frequency of Treatment: 6 hr/day
General Toxicity Maternal: NOAEC: 250 ppm

Developmental Toxicity: NOAEC: 250 ppm
Symptoms: Reduced body weight
Method: OECD Test Guideline 414
Result: No teratogenic effects.
GLP: yes

Reproductive toxicity - Assessment : Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.

56-23-5:

Effects on foetal development : Species: rat
Embryo-foetal toxicity.: Lowest observed adverse effect level: 112.5 mg/kg body weight
Method: OECD Test Guideline 414

Reproductive toxicity - Assessment : teratogenicity classification is not possible

STOT - single exposure

Product: No data available

Components:

127-18-4:

Exposure routes:	Target Organs:	Assessment:	Remarks:
Inhalation	Central nervous system	May cause drowsiness or dizziness., The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with narcotic effects.	

56-23-5:

Exposure routes:	Target Organs:	Assessment:	Remarks:
Inhalation	Central nervous system	May cause drowsiness or dizziness., The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with narcotic effects.	

STOT - repeated exposure

Product: No data available

Components:

127-18-4: No data available

56-23-5:

Exposure routes:	Target Organs:	Assessment:	Remarks:
Inhalation	Kidney, Liver	Causes damage to organs through prolonged or repeated exposure., The substance or mixture is classified as specific target organ toxicant, repeated exposure, category 1.	

Repeated dose toxicity

Components:

127-18-4:
Species: mouse, male
LOAEL: 540 mg/kg
Application Route: Oral
Exposure time: 78 wks
Number of exposures: 5 d/wk
Dose: 0, 540, 1070 mg/kg bw/day
Symptoms: Kidney disorders

Species: mouse, female
LOAEL: 330 mg/kg
Application Route: Oral
Exposure time: 78 wks
Number of exposures: 5 d/wk
Dose: 0, 390, 770 mg/kg bw/day
Symptoms: Kidney disorders

Species: rat, male and female
LOAEL: 200
Application Route: inhalation (vapour)
Exposure time: 103 wks
Number of exposures: 6 h/d, 5 d/wk
Dose: 0, 200, 400 ppm
Symptoms: Kidney disorders

Species: mouse, male and female
LOAEL: 100
Application Route: inhalation (vapour)
Exposure time: 103 wks
Number of exposures: 6 h/d, 5 d/wk
Dose: 0, 100, 200 ppm
Symptoms: Liver effects, Kidney disorders, lung effects

Repeated dose toxicity - Assessment : Causes skin irritation., Causes eye irritation.

Aspiration toxicity

Components:
127-18-4:
No aspiration toxicity classification

Further information

Product:
Remarks: No data available

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:
127-18-4:

Toxicity to fish	:	LC50 (Limanda limanda (Marlin)): 5 mg/l Exposure time: 96 h Test Type: flow-through test
Toxicity to daphnia and other aquatic inverte-brates	:	EC50 (Daphnia magna (Water flea)): 8.5 mg/l Exposure time: 48 h Test Type: static test
Toxicity to algae	:	EC50 (Chlamydomonas reinhardtii): 3.64 mg/l End point: Growth rate Exposure time: 72 h Test Type: Closed system

Ecotoxicology Assessment
Acute aquatic toxicity : Toxic to aquatic life.

Chronic aquatic toxicity : Toxic to aquatic life with long lasting effects.

56-23-5:

Toxicity to fish	:	LC50 (Danio rerio (zebra fish)): 24.3 mg/l Exposure time: 4 d Test Type: flow-through test Method: OECD Test Guideline 203
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): > 770 mg/l Exposure time: 24 h Test Type: static test
Toxicity to algae	:	EC50 (Pseudokirchneriella subcapitata (green algae)): 20 mg/l Exposure time: 72 h Test Type: static test Method: OECD Test Guideline 201
Ecotoxicology Assessment Chronic aquatic toxicity	:	Harmful to aquatic life with long lasting effects.

Persistence and degradability

Components:

127-18-4:

Biodegradability	:	Inoculum: activated sludge Concentration: 100 mg/l Biodegradation: 11 % Exposure time: 28 d Remarks: Not readily biodegradable.

56-23-5:

Biodegradability	:	anaerobic Result: Readily biodegradable. Remarks: Readily biodegradable

Bioaccumulative potential

Components:

127-18-4:

Partition coefficient: n-octanol/water	:	Pow: 3.40

56-23-5:

Partition coefficient: n-octanol/water	:	log Pow: 2.83 (25 °C) pH: 7

Mobility in soil

No data available

Other adverse effects

No data available

Product:

Regulation	40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances
Remarks	Warning: Manufactured with /$/, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

Additional ecological information : An environmental hazard cannot be excluded in the event of unprofessional handling or disposal., Toxic to aquatic life with long lasting effects.

Components:

56-23-5:

Ozone-Depletion Potential	1.1
Regulation	UNEP - Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer (Update: 2009-10-01)
Group	Annex B - Group II: Carbon tetrachloride
Ozone-Depletion Potential	1.1
Regulation	40 CFR Protection of Environment; Part 82 Protection of Stratospheric Ozone - CAA Section 602 Class I Substances (Update: 2007-07-01)
Group	Group IV

Additional ecological information : Dangerous for the ozone layer.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of in accordance with all applicable local, state and federal regulations.
For assistance with your waste management needs - including disposal, recycling and waste stream reduction, contact NEXEO's Environmental Services Group at 800-637-7922.

Contaminated packaging : Empty remaining contents.
Dispose of as unused product.
Do not re-use empty containers.

SECTION 14. TRANSPORT INFORMATION

IATA (International Air Transport Association): UN1897, TETRACHLOROETHYLENE, 6.1, III
IMDG (International Maritime Dangerous Goods): UN1897, TETRACHLOROETHYLENE, 6.1, III

DOT (Department of Transportation): UN1897, TETRACHLOROETHYLENE, 6.1, III

SECTION 15. REGULATORY INFORMATION

OSHA Hazards : Carcinogen

WHMIS Classification : D2A: Very Toxic Material Causing Other Toxic Effects

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
Tetrachloroethylene	127-18-4	100	100

SARA 304 Extremely Hazardous Substances Reportable Quantity
This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Chronic Health Hazard

SARA 302 : SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:

127-18-4	Tetrachloroethylene	100 %
56-23-5	Carbon tetrachloride	0.45 %

Clean Air Act

Ozone-Depletion Potential	:	carbon tetrachloride	56-23-5
		Carbon Tetrachloride	56-23-5

The following chemical(s) are listed as HAP under the U.S. Clean Air Act, Section 12 (40 CFR 61):

127-18-4	Tetrachloroethylene	100 %
56-23-5	Carbon tetrachloride	0.45 %

This product does not contain any chemicals listed under the U.S. Clean Air Act Section 112(r) for Accidental Release Prevention (40 CFR 68.130, Subpart F).
The following chemical(s) are listed under the U.S. Clean Air Act Section 111 SOCMI Intermediate or Final VOC's (40 CFR 60.489):

127-18-4	Tetrachloroethylene	100 %
56-23-5	Carbon tetrachloride	0.45 %

Clean Water Act

The following Hazardous Substances are listed under the U.S. CleanWater Act, Section 311, Table 116.4A:

56-23-5	Carbon tetrachloride	0.45 %

The following Hazardous Chemicals are listed under the U.S. CleanWater Act, Section 311, Table 117.3:

56-23-5	Carbon tetrachloride	0.45 %

This product does not contain any toxic pollutants listed under the U.S. Clean Water Act Section 307

US State Regulations

Massachusetts Right To Know

127-18-4	Tetrachloroethylene	90 - 100 %
56-23-5	Carbon tetrachloride	0.1 - 1 %

Pennsylvania Right To Know

127-18-4	Tetrachloroethylene	90 - 100 %
56-23-5	Carbon tetrachloride	0.1 - 1 %

New Jersey Right To Know

127-18-4	Tetrachloroethylene	90 - 100 %
56-23-5	Carbon tetrachloride	0.1 - 1 %

California Prop 65 WARNING! This product contains a chemical known to the State of California to cause cancer.

127-18-4	Tetrachloroethylene
56-23-5	Carbon tetrachloride

The components of this product are reported in the following inventories:

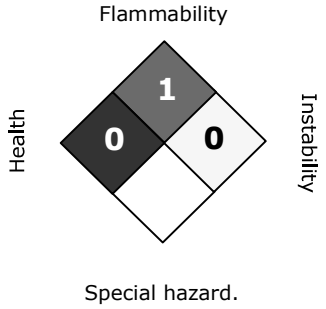
1907/2006 (EU)	:	n (Negative listing) (Not in compliance with the inventory)
Switzerland. New notified substances and declared preparations	:	y (positive listing) (The formulation contains substances listed on the Swiss Inventory)

United States TSCA Inventory	:	y (positive listing) (On TSCA Inventory)
Canadian Domestic Substances List (DSL)	:	y (positive listing) (All components of this product are on the Canadian DSL.)
Australia Inventory of Chemical Substances (AICS)	:	y (positive listing) (On the inventory, or in compliance with the inventory)
New Zealand. Inventory of Chemical Substances	:	n (Negative listing) (On the inventory, or in compliance with the inventory)
Japan. ENCS - Existing and New Chemical Substances Inventory	:	y (positive listing) (On the inventory, or in compliance with the inventory)
Japan. ISHL - Inventory of Chemical Substances (METI)	:	y (positive listing) (On the inventory, or in compliance with the inventory)
Korea. Korean Existing Chemicals Inventory (KECI)	:	y (positive listing) (On the inventory, or in compliance with the inventory)
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	:	y (positive listing) (On the inventory, or in compliance with the inventory)
China. Inventory of Existing Chemical Substances in China (IECSC)	:	y (positive listing) (On the inventory, or in compliance with the inventory)

SECTION 16. OTHER INFORMATION

Further information

NFPA:



HMIS III:

HEALTH	**0***
FLAMMABILITY	**1**
PHYSICAL HAZARD	**0**

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 =Extreme, * = Chronic

The information accumulated is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made become available subsequently to the date hereof, we do not assume any responsibility for the results of its use. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances. This MSDS has been prepared by NEXEO™ Solutions EHS Product Safety Department (1-855-429-2661) MSDS@nexeosolutions.com.

Legecy MSDS: R0001042

Material number:
16056599, 16062193, 16056596, 16056598, 16056597, 16009752, 637625, 604780, 554102, 554349, 547485, 54914, 72995, 104807, 87675, 104196, 56039, 71265, 505397, 503744, 503743, 501951, 501344, 20233, 20232, 20231

Key or legend to abbreviations and acronyms used in the safety data sheet			
ACGIH	American Conference of Government Industrial Hygienists	LD50	Lethal Dose 50%
AICS	Australia, Inventory of Chemical Substances	LOAEL	Lowest Observed Adverse Effect Level
DSL	Canada, Domestic Substances List	NFPA	National Fire Protection Agency
NDSL	Canada, Non-Domestic Substances List	NIOSH	National Institute for Occupational Safety & Health
CNS	Central Nervous System	NTP	National Toxicology Program
CAS	Chemical Abstract Service	NZIoC	New Zealand Inventory of Chemicals
EC50	Effective Concentration	NOAEL	No Observable Adverse Effect Level

EC50	Effective Concentration 50%	NOEC	No Observed Effect Concentration
EGEST	EOSCA Generic Exposure Scenario Tool	OSHA	Occupational Safety & Health Administration
EOSCA	European Oilfield Specialty Chemicals Association	PEL	Permissible Exposure Limit
EINECS	European Inventory of Existing Chemical Substances	PICCS	Philipines Inventory of Commercial Chemical Substances
MAK	Germany Maximum Concentration Values	PRNT	Presumed Not Toxic
GHS	Globally Harmonized System	RCRA	Resource Conservation Recovery Act
>=	Greater Than or Equal To	STEL	Short-term Exposure Limit
IC50	Inhibition Concentration 50%	SARA	Superfund Amendments and Reauthorization Act.
IARC	International Agency for Research on Cancer	TLV	Threshold Limit Value
IECSC	Inventory of Existing Chemical Substances in China	TWA	Time Weighted Average
ENCS	Japan, Inventory of Existing and New Chemical Substances	TSCA	Toxic Substance Control Act
KECI	Korea, Existing Chemical Inventory	UVCB	Unknown or Variable Compositon, Complex Reaction Products, and Biological Materials
<=	Less Than or Equal To	WHMIS	Workplace Hazardous Materials Information System
LC50		Lethal Concentration 50%	

Safety Data Sheet
acc. to OSHA HCS

Printing date 03/23/2019 Version Number 2 Reviewed on 03/23/2019

*
1 Identification

· **Product identifier**

· **Trade name: Perfluorooctanoic Acid (PFOA)**

· **Part number:** N-1588
· **CAS Number:**
335-67-1
· **EC number:**
206-397-9
· **Index number:**
607-704-00-2
· **Application of the substance / the mixture** Reagents and Standards for Analytical Chemical Laboratory Use

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
Agilent Technologies, Inc.
5301 Stevens Creek Blvd.
Santa Clara, CA 95051 USA

· **Information department:**
Telephone: 800-227-9770
e-mail: pdl-msds_author@agilent.com
· **Emergency telephone number:** CHEMTREC®: 1-800-424-9300

*
2 Hazard(s) identification

· **Classification of the substance or mixture**


GHS08 Health hazard

Carc. 2 H351 Suspected of causing cancer.
Repr. 1B H360 May damage fertility or the unborn child.
STOT RE 1 H372 Causes damage to the liver through prolonged or repeated exposure.


GHS05 Corrosion

Eye Dam. 1 H318 Causes serious eye damage.


GHS07

Acute Tox. 4 H302 Harmful if swallowed.
Acute Tox. 4 H332 Harmful if inhaled.

· **Label elements**
· **GHS label elements** The substance is classified and labeled according to the Globally Harmonized System (GHS).

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Trade name: Perfluorooctanoic Acid (PFOA)

(Contd. of page 1)

· **Hazard pictograms**



GHS05 GHS07 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
perfluorooctanoic acid (PFOA)
· **Hazard statements**
Harmful if swallowed or if inhaled.
Causes serious eye damage.
Suspected of causing cancer.
May damage fertility or the unborn child.
Causes damage to the liver through prolonged or repeated exposure.
· **Precautionary statements**
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe dust/fume/gas/mist/vapors/spray.
Wash thoroughly after handling.
Do not eat, drink or smoke when using this product.
Use only outdoors or in a well-ventilated area.
Wear protective gloves/protective clothing/eye protection/face protection.
If swallowed: Call a poison center/doctor if you feel unwell.
Rinse mouth.
IF INHALED: Remove person to fresh air and keep comfortable for breathing.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do.
Continue rinsing.
Immediately call a poison center/doctor.
IF exposed or concerned: Get medical advice/attention.
Get medical advice/attention if you feel unwell.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.
· **Classification system:**
· **NFPA ratings (scale 0 - 4)**



Health = 3
Fire = 0
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = *3
Fire = 0
Reactivity = 0

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.

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Safety Data Sheet
acc. to OSHA HCS

Trade name: Perfluorooctanoic Acid (PFOA)

(Contd. of page 2)

· **vPvB:** Not applicable.

3 Composition/information on ingredients

· **Chemical characterization: Substances**
· **CAS No. Description**
335-67-1 perfluorooctanoic acid (PFOA)
· **Identification number(s)**
· **EC number:** 206-397-9
· **Index number:** 607-704-00-2

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Symptoms of poisoning may even occur after several hours; therefore medical observation for at least 48 hours after the accident.
· **After inhalation:**
Supply fresh air. If required, provide artificial respiration. Keep patient warm. Consult doctor if symptoms persist.
In case of unconsciousness place patient stably in side position for transportation.
· **After skin contact:** Generally the product does not irritate the skin.
· **After eye contact:** Rinse opened eye for several minutes under running water. Then consult a doctor.
· **After swallowing:** Immediately call a doctor.
· **Information for doctor:**
· **Most important symptoms and effects, both acute and delayed** No further relevant information available.
· **Indication of any immediate medical attention and special treatment needed**
No further relevant information available.

5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:** Use fire fighting measures that suit the environment.
· **Special hazards arising from the substance or mixture**
During heating or in case of fire poisonous gases are produced.
· **Advice for firefighters**
· **Protective equipment:** Mouth respiratory protective device.

6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures**
Mount respiratory protective device.
Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:** Do not allow to enter sewers/ surface or ground water.
· **Methods and material for containment and cleaning up:**
Use neutralizing agent.
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.

(Contd. on page 4)

(Contd. of page 3)

· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.
· **Protective Action Criteria for Chemicals**

· **PAC-1:**
1.1 mg/m³

· **PAC-2:**
12 mg/m³

· **PAC-3:**
75 mg/m³

7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Thorough dedusting.
Ensure good ventilation/exhaustion at the workplace.
Open and handle receptacle with care.
· **Information about protection against explosions and fires:** Keep respiratory protective device available.

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** No special requirements.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:** Keep receptacle tightly sealed.
· **Specific end use(s)** No further relevant information available.

*

8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**
· **Components with limit values that require monitoring at the workplace:** Not required.
· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Store protective clothing separately.
Avoid contact with the eyes.
Avoid contact with the eyes and skin.
· **Breathing equipment:**
When used as intended with Agilent instruments, the use of the product under normal laboratory conditions and with standard practices does not result in significant airborne exposures and therefore respiratory protection is not needed.
Under an emergency condition where a respirator is deemed necessary, use a NIOSH or equivalent approved device/equipment with appropriate organic or acid gas cartridge.

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· **Protection of hands:**
Although not recommended for constant contact with the chemicals or for clean-up, nitrile gloves 11-13 mil thickness are recommended for normal use. The breakthrough time is 1 hr. For cleaning a spill where there is direct contact of the chemical, butyl rubber gloves are recommended 12-15 mil thickness with breakthrough times exceeding 4 hrs. Supplier recommendations should be followed.
· **Material of gloves**
For normal use: nitrile rubber, 11-13 mil thickness
For direct contact with the chemical: butyl rubber, 12-15 mil thickness
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.
· **Penetration time of glove material**
For normal use: nitrile rubber: 1 hour
For direct contact with the chemical: butyl rubber: >4 hours
· **Eye protection:**



Tightly sealed goggles

9 Physical and chemical properties

· **Information on basic physical and chemical properties**	
· **General Information**	
· **Appearance:**	
Form:	Solid
Color:	Not determined.
· **Odor:**	Characteristic
· **Odor threshold:**	Not determined.
· **pH-value:**	Not applicable.
· **Change in condition**	
Melting point/Melting range:	55-56 °C (131-132.8 °F)
Boiling point/Boiling range:	190 °C (374 °F)
· **Flash point:**	Not applicable.
· **Flammability (solid, gaseous):**	Product is not flammable.
· **Decomposition temperature:**	Not determined.
· **Auto igniting:**	Not determined.
· **Danger of explosion:**	Product does not present an explosion hazard.
· **Explosion limits:**	
Lower:	Not determined.
Upper:	Not determined.
· **Vapor pressure at 20 °C (68 °F):**	0.69 hPa (0.5 mm Hg)
· **Density at 20 °C (68 °F):**	0.9 g/cm³ (7.5105 lbs/gal)
· **Relative density**	Not determined.
· **Vapor density**	Not applicable.

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· **Evaporation rate**	Not applicable.
· **Solubility in / Miscibility with Water at 20 °C (68 °F):**	3.4 g/l
· **Partition coefficient (n-octanol/water):**	Not determined.
· **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
VOC content:	0.00 % 0.0 g/l / 0.00 lb/gal
Solids content:	100.0 %
· **Other information**	No further relevant information available.

10 Stability and reactivity

· **Reactivity** No further relevant information available.
· **Chemical stability**
· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.
· **Conditions to avoid** No further relevant information available.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· **LD/LC50 values that are relevant for classification:**

ATE (Acute Toxicity Estimate)

Oral	LD50	500 mg/kg
Inhalative	LC50/4 h	1.5 mg/L

· **Primary irritant effect:**
· **on the skin:** No irritant effect.
· **on the eye:** Strong irritant with the danger of severe eye injury.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**

2B

· **NTP (National Toxicology Program)**

Substance is not listed.

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acc. to OSHA HCS

(Contd. of page 6)

· **OSHA-Ca (Occupational Safety & Health Administration)**

Substance is not listed.

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Additional ecological information:**
· **General notes:**
Water hazard class 2 (Assessment by list): hazardous for water
Do not allow product to reach ground water, water course or sewage system.
Must not reach bodies of water or drainage ditch undiluted or unneutralized.
Danger to drinking water if even small quantities leak into the ground.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.
· **Other adverse effects** No further relevant information available.

13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:**
Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

· **UN-Number**	
· **DOT, IMDG, IATA**	UN3261
· **UN proper shipping name**	
· **DOT**	Corrosive solid, acidic, organic, n.o.s. (perfluorooctanoic acid (PFOA))
· **IMDG, IATA**	CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (perfluorooctanoic acid (PFOA))

(Contd. on page 8)

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· **Transport hazard class(es)**

· **IATA**



· **Class**	8 Corrosive substances
· **Label**	8
· **Environmental hazards:**	Not applicable.
· **Special precautions for user**	Warning: Corrosive substances
· **Danger code (Kemler):**	80
· **EMS Number:**	F-A,S-B
· **Segregation groups**	Acids
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **Transport/Additional information:**	
· **DOT**	
· **Quantity limitations**	On passenger aircraft/rail: 25 kg On cargo aircraft only: 100 kg
· **IMDG**	
· **Limited quantities (LQ)**	5 kg
· **Excepted quantities (EQ)**	Code: E1 Maximum net quantity per inner packaging: 30 g Maximum net quantity per outer packaging: 1000 g
· **UN "Model Regulation":**	UN 3261 CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (PERFLUOROOCTANOIC ACID (PFOA)), 8, III

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**

· **Sara**

· **Section 355 (extremely hazardous substances):**

Substance is not listed.

· **Section 313 (Specific toxic chemical listings):**

Substance is not listed.

· **TSCA (Toxic Substances Control Act):**

Substance is listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**

Substance is not listed.

· **Chemicals known to cause reproductive toxicity for females:**

Substance is not listed.

(Contd. on page 9)

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acc. to OSHA HCS

Trade name: Perfluorooctanoic Acid (PFOA)

(Contd. of page 8)

· **Chemicals known to cause reproductive toxicity for males:**
Substance is not listed.

· **Chemicals known to cause developmental toxicity:**
Substance is listed.

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**
Substance is not listed.

· **TLV (Threshold Limit Value established by ACGIH)**
Substance is not listed.

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**
Substance is not listed.

· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

*
16 Other information

The information contained in this document is based on Agilent's state of knowledge at the time of preparation. No warranty as to its accurateness, completeness or suitability for a particular purpose is expressed or implied.

· **Date of preparation / last revision** 03/23/2019 / 1

· **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
PBT: Persistent, Bioaccumulative and Toxic
vPvB: very Persistent and very Bioaccumulative
NIOSH: National Institute for Occupational Safety
OSHA: Occupational Safety & Health
TLV: Threshold Limit Value
PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
Acute Tox. 4: Acute toxicity – Category 4
Eye Dam. 1: Serious eye damage/eye irritation – Category 1
Carc. 2: Carcinogenicity – Category 2
Repr. 1B: Reproductive toxicity – Category 1B
STOT RE 1: Specific target organ toxicity (repeated exposure) – Category 1

· *** Data compared to the previous version altered.**

Safety Data Sheet
acc. to OSHA HCS

Printing date 12/13/2016 *Reviewed on 12/13/2016*

1 Identification

· **Product identifier**

· **Product Name: Perfluoro-n-octane Sulfonate (PFOS)**

· **Part Number:** LCS-4951
· **Application of the substance / the mixture** Certified Reference Material

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
SPEX CertiPrep, LLC.
203 Norcross Ave, Metuchen,
NJ 08840 USA

· **Information department:** product safety department
· **Emergency telephone number:**
Emergency Phone Number (24 hours)
CHEMTREC (800-424-9300)
Outside US: 703-527-3887

2 Hazard(s) identification

· **Classification of the substance or mixture**



GHS02 Flame

Flam. Liq. 2 H225 Highly flammable liquid and vapor.



GHS06 Skull and crossbones

Acute Tox. 3 H331 Toxic if inhaled.



GHS08 Health hazard

Carc. 2 H351 Suspected of causing cancer.
Repr. 1 H360-H362 May damage fertility or the unborn child. May cause harm to breast-fed children.
STOT SE 1 H370 Causes damage to organs.

· **Label elements**
· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS06 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
methanol
perfluorooctane sulfonic acid
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H331 Toxic if inhaled.
H351 Suspected of causing cancer.
H360-H362 May damage fertility or the unborn child. May cause harm to breast-fed children.
H370 Causes damage to organs.
· **Precautionary statements**
Avoid contact during pregnancy/while nursing.
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

(Contd. on page 2)

Safety Data Sheet
acc. to OSHA HCS

Printing date 12/13/2016 Reviewed on 12/13/2016

Product Name: Perfluoro-n-octane Sulfonate (PFOS)

(Contd. of page 1)

· **Classification system:**
· **NFPA ratings (scale 0 - 4)**



Health = 3
Fire = 3
Reactivity = 0

· **HMIS-ratings (scale 0 - 4)**



Health = *3
Fire = 3
Reactivity = 0

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

3 Composition/information on ingredients

· **Chemical characterization: Mixtures**
· **Description:** Mixture of the substances listed below with nonhazardous additions.

· **Dangerous components:**		
67-56-1	methanol	99.9%
1763-23-1	perfluorooctane sulfonic acid	0.1%

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Immediately remove any clothing soiled by the product.
Remove breathing apparatus only after contaminated clothing have been completely removed.
In case of irregular breathing or respiratory arrest provide artificial respiration.
· **After inhalation:**
Supply fresh air or oxygen; call for doctor.
In case of unconsciousness place patient stably in side position for transportation.
· **After skin contact:** Immediately wash with water and soap and rinse thoroughly.
· **After eye contact:** Rinse opened eye for several minutes under running water. Then consult a doctor.
· **After swallowing:** Do not induce vomiting; immediately call for medical help.
· **Information for Doctor:**
· **Most important symptoms and effects, both acute and delayed** No further relevant information available.
· **Indication of any immediate medical attention and special treatment needed** No further relevant information available.

5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:** CO2, sand, extinguishing powder. Do not use water.
· **For safety reasons unsuitable extinguishing agents:** Water with full jet
· **Special hazards arising from the substance or mixture** No further relevant information available.
· **Advice for firefighters**
· **Protective equipment:** Mouth respiratory protective device.

6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures** Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:**
Do not allow product to reach sewage system or any water course.
Inform respective authorities in case of seepage into water course or sewage system.
Do not allow to enter sewers/ surface or ground water.
· **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
Do not flush with water or aqueous cleansing agents

(Contd. on page 3)

Safety Data Sheet
acc. to OSHA HCS

Product Name: Perfluoro-n-octane Sulfonate (PFOS)

(Contd. of page 2)

· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Ensure good ventilation/exhaustion at the workplace.
Open and handle receptacle with care.
Prevent formation of aerosols.
· **Information about protection against explosions and fires:**
Keep ignition sources away - Do not smoke.
Protect against electrostatic charges.
Keep respiratory protective device available.

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:** Store in a cool location.
· **Information about storage in one common storage facility:** Not required.
· **Further information about storage conditions:**
Keep receptacle tightly sealed.
Store in cool, dry conditions in well sealed receptacles.
· **Specific end use(s)** No further relevant information available.

8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**
· **Components with limit values that require monitoring at the workplace:**
The following constituent is the only constituent of the product which has a PEL, TLV or other recommended exposure limit.
At this time, the remaining constituent has no known exposure limits.

67-56-1 methanol	
PEL	Long-term value: 260 mg/m³, 200 ppm
REL	Short-term value: 325 mg/m³, 250 ppm Long-term value: 260 mg/m³, 200 ppm Skin
TLV	Short-term value: 328 mg/m³, 250 ppm Long-term value: 262 mg/m³, 200 ppm Skin; BEI

· **Ingredients with biological limit values:**	
67-56-1 methanol	
BEI	15 mg/L Medium: urine Time: end of shift Parameter: Methanol (background, nonspecific)

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
Keep away from foodstuffs, beverages and feed.
Immediately remove all soiled and contaminated clothing.
Wash hands before breaks and at the end of work.
Store protective clothing separately.
Avoid contact with the eyes and skin.
· **Breathing equipment:**
In case of brief exposure or low pollution use respiratory filter device. In case of intensive or longer exposure use respiratory protective device that is independent of circulating air.
· **Protection of hands:**



Protective gloves

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The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
Due to missing tests no recommendation to the glove material can be given for the product/ the preparation/ the chemical mixture.
Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation

· **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.

· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

· **Eye protection:**



Tightly sealed goggles

9 Physical and chemical properties

· **Information on basic physical and chemical properties**	
· **General Information**	
· **Appearance:**	
Form:	Liquid
Color:	According to product specification
· **Odor:**	Characteristic
· **Odour Threshold:**	Not applicable.
· **pH-value:**	Not applicable.
· **Change in condition**	
Melting point/Melting range:	Undetermined.
Boiling point/Boiling range:	64 °C (147 °F)
· **Flash point:**	11 °C (52 °F)
· **Flammability (solid, gaseous):**	Not applicable.
· **Ignition temperature:**	455 °C (851 °F)
· **Decomposition temperature:**	Not applicable.
· **Auto igniting:**	Product is not selfigniting.
· **Danger of explosion:**	Product is not explosive. However, formation of explosive air/vapor mixtures are possible.
· **Explosion limits:**	
Lower:	5.5 Vol %
Upper:	44.0 Vol %
· **Vapor pressure at 20 °C (68 °F):**	128 hPa (96 mm Hg)
· **Density at 20 °C (68 °F)**	0.79 g/cm³ (6.593 lbs/gal)
· **Relative density**	Not applicable.
· **Vapor density**	Not applicable.
· **Evaporation rate**	Not applicable.
· **Solubility in / Miscibility with**	
Water:	Not miscible or difficult to mix.
· **Partition coefficient (n-octanol/water):**	Not applicable.
· **Viscosity:**	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
· **Solvent content:**	
Organic solvents:	99.9 %
VOC content:	99.9 %
Solids content:	0.1 %
· **Other information**	No further relevant information available.

10 Stability and reactivity

· **Reactivity** No further relevant information available.

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· **Chemical stability**
· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.
· **Conditions to avoid** No further relevant information available.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· **LD/LC50 values that are relevant for classification:**		
67-56-1 methanol		
Oral	LD50	5628 mg/kg (rat)
Dermal	LD50	15800 mg/kg (rabbit)

· **Primary irritant effect:**
· **on the skin:** No irritant effect.
· **on the eye:** No irritating effect.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Toxic

· **Carcinogenic categories**

· **IARC (International Agency for Research on Cancer)**
None of the ingredients is listed.

· **NTP (National Toxicology Program)**
None of the ingredients is listed.

· **OSHA-Ca (Occupational Safety & Health Administration)**
None of the ingredients is listed.

12 Ecological information

· **Toxicity**
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Additional ecological information:**
· **General notes:**
Water hazard class 1 (Self-assessment): slightly hazardous for water
Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.
· **Other adverse effects** No further relevant information available.

13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:** Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to official regulations.

14 Transport information

· **UN-Number**	
· **DOT, ADR, IMDG, IATA**	UN1230
· **UN proper shipping name**	
· **DOT**	Methanol

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· **ADR**	1230 Methanol
· **IMDG, IATA**	METHANOL
· **Transport hazard class(es)**	
· **DOT**	
	
· **Class**	3 Flammable liquids
· **Label**	3, 6.1
· **ADR**	
	
· **Class**	3 Flammable liquids
· **Label**	3+6.1
· **IMDG**	
	
· **Class**	3 Flammable liquids
· **Label**	3/6.1
· **IATA**	
	
· **Class**	3 Flammable liquids
· **Label**	3 (6.1)
· **Packing group**	
· **DOT, ADR, IMDG, IATA**	II
· **Environmental hazards:**	Not applicable.
· **Special precautions for user**	Warning: Flammable liquids
· **Danger code (Kemler):**	336
· **EMS Number:**	F-E,S-D
· **Stowage Category**	B
· **Stowage Code**	SW2 Clear of living quarters.
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable.
· **Transport/Additional information:**	
· **ADR**	
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **IMDG**	
· **Limited quantities (LQ)**	1L
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **UN "Model Regulation":**	UN 1230 METHANOL, 3 (6.1), II

US

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15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**
· **Sara**

· **Section 355 (extremely hazardous substances):**
None of the ingredients is listed.

· **Section 313 (Specific toxic chemical listings):**

67-56-1	methanol

· **TSCA (Toxic Substances Control Act):**
All ingredients are listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**
None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for females:**
None of the ingredients is listed.

· **Chemicals known to cause reproductive toxicity for males:**
None of the ingredients is listed.

· **Chemicals known to cause developmental toxicity:**

67-56-1	methanol

· **Carcinogenic categories**

· **EPA (Environmental Protection Agency)**
None of the ingredients is listed.

· **TLV (Threshold Limit Value established by ACGIH)**
None of the ingredients is listed.

· **NIOSH-Ca (National Institute for Occupational Safety and Health)**
None of the ingredients is listed.

· **Protective Action Criteria for Chemicals**

· **PAC-1:**

67-56-1	methanol	530 ppm

· **PAC-2:**

67-56-1	methanol	2,100 ppm

· **PAC-3:**

67-56-1	methanol	7200* ppm

· **GHS label elements** The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**



GHS02 GHS06 GHS08

· **Signal word** Danger

· **Hazard-determining components of labeling:**
methanol
perfluorooctane sulfonic acid
· **Hazard statements**
H225 Highly flammable liquid and vapor.
H331 Toxic if inhaled.
H351 Suspected of causing cancer.
H360-H362 May damage fertility or the unborn child. May cause harm to breast-fed children.
H370 Causes damage to organs.
· **Precautionary statements**
Avoid contact during pregnancy/while nursing.
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Use explosion-proof electrical/ventilating/lighting/equipment.
If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
Store locked up.
Dispose of contents/container in accordance with local/regional/national/international regulations.

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· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing SDS:** product safety department
· **Contact:**
SPEX CertiPrep, LLC.
1-732-549-7144
· **Date of preparation / last revision** 12/13/2016 / -
· **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
PBT: Persistent, Bioaccumulative and Toxic
vPvB: very Persistent and very Bioaccumulative
NIOSH: National Institute for Occupational Safety
OSHA: Occupational Safety & Health
TLV: Threshold Limit Value
PEL: Permissible Exposure Limit
REL: Recommended Exposure Limit
BEI: Biological Exposure Limit
Flam. Liq. 2: Flammable liquids – Category 2
Acute Tox. 3: Acute toxicity – Category 3
Carc. 2: Carcinogenicity – Category 2
Repr. 1: Reproductive toxicity – Category 1
STOT SE 1: Specific target organ toxicity (single exposure) – Category 1

PURELL® Advanced Instant Hand Sanitizer

Version	Revision Date:	MSDS Number:	Date of last issue: 12/12/2014
1.1	02/10/2015	36762-00002	Date of first issue: 12/12/2014

SECTION 1. IDENTIFICATION

Product name : PURELL® Advanced Instant Hand Sanitizer

Manufacturer or supplier's details

Company name of supplier : GOJO Industries, Inc.

Address : One GOJO Plaza, Suite 500
Akron OH 44311

Telephone : 1 (330) 255-6000

Emergency telephone : 1-800-424-9300 CHEMTREC

Recommended use of the chemical and restrictions on use

Recommended use : Hand Sanitizer

Restrictions on use : This is a personal care or cosmetic product that is safe for consumers and other users under normal and reasonably foreseeable use. Cosmetics and consumer products, specifically defined by regulations around the world, are exempt from the requirement of an SDS for the consumer. While this material is not considered hazardous, this SDS contains valuable information critical to the safe handling and proper use of the product for industrial workplace conditions as well as unusual and unintended exposures such as large spills. This SDS should be retained and available for employees and other users of this product. For specific intended-use guidance, please refer to the information provided on the package or instruction sheet.

SECTION 2. HAZARDS IDENTIFICATION

GHS Classification

Flammable liquids : Category 3

Eye irritation : Category 2A

GHS Label element

Hazard pictograms :



Signal Word : Warning

Hazard Statements : H226 Flammable liquid and vapor.
H319 Causes serious eye irritation.

Precautionary Statements : **Prevention:**
P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233 Keep container tightly closed.
P241 Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242 Use only non-sparking tools.
P243 Take precautionary measures against static discharge.
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/ eye protection/ face protection.
Response:
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313 If eye irritation persists: Get medical advice/ attention.
Storage:
P403 + P235 Store in a well-ventilated place. Keep cool.
Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

Vapors may form explosive mixture with air.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Hazardous ingredients

Chemical Name	CAS-No.	Concentration (%)
Ethanol	64-17-5	>= 50 - < 70
Propan-2-ol	67-63-0	>= 1 - < 5

SECTION 4. FIRST AID MEASURES

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.

If inhaled : If inhaled, remove to fresh air.
Get medical attention if symptoms occur.

In case of skin contact : Wash with water and soap as a precaution.
Get medical attention if symptoms occur.

In case of eye contact : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.
If easy to do, remove contact lens, if worn.

Get medical attention.

If swallowed	:	If swallowed, DO NOT induce vomiting. Get medical attention if symptoms occur. Rinse mouth thoroughly with water.
Most important symptoms and effects, both acute and delayed	:	Causes serious eye irritation.
Protection of first-aiders	:	First Aid responders should pay attention to self-protection, and use the recommended personal protective equipment when the potential for exposure exists.
Notes to physician	:	Treat symptomatically and supportively.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Water spray Alcohol-resistant foam Dry chemical Carbon dioxide (CO2)
Unsuitable extinguishing media	:	High volume water jet
Specific hazards during fire fighting	:	Do not use a solid water stream as it may scatter and spread fire. Flash back possible over considerable distance. Vapors may form explosive mixtures with air. Exposure to combustion products may be a hazard to health.
Hazardous combustion products	:	Carbon oxides
Specific extinguishing methods	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Use water spray to cool unopened containers. Remove undamaged containers from fire area if it is safe to do so. Evacuate area.
Special protective equipment for fire-fighters	:	In the event of fire, wear self-contained breathing apparatus. Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Remove all sources of ignition. Use personal protective equipment. Follow safe handling advice and personal protective equipment recommendations.
Environmental precautions	:	Discharge into the environment must be avoided.

Prevent further leakage or spillage if safe to do so.
Prevent spreading over a wide area (e.g. by containment or oil barriers).
Retain and dispose of contaminated wash water.
Local authorities should be advised if significant spillages cannot be contained.

Methods and materials for containment and cleaning up : Non-sparking tools should be used.
Soak up with inert absorbent material.
Suppress (knock down) gases/vapors/mists with a water spray jet.
For large spills, provide diking or other appropriate containment to keep material from spreading. If diked material can be pumped, store recovered material in appropriate container.
Clean up remaining materials from spill with suitable absorbent.
Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable.
Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

SECTION 7. HANDLING AND STORAGE

Technical measures : See Engineering measures under EXPOSURE CONTROLS/PERSONAL PROTECTION section.

Local/Total ventilation : Use with local exhaust ventilation.
Use only in an area equipped with explosion proof exhaust ventilation.

Advice on safe handling : Do not breathe vapors or spray mist.
Do not swallow.
Do not get in eyes.
Avoid prolonged or repeated contact with skin.
Handle in accordance with good industrial hygiene and safety practice.
Non-sparking tools should be used.
Keep container tightly closed.
Keep away from heat and sources of ignition.
Take precautionary measures against static discharges.
Take care to prevent spills, waste and minimize release to the environment.

Conditions for safe storage : Keep in properly labeled containers.
Keep tightly closed.
Keep in a cool, well-ventilated place.
Store in accordance with the particular national regulations.
Keep away from heat and sources of ignition.

Materials to avoid : Do not store with the following product types:
Strong oxidizing agents

Organic peroxides
Flammable solids
Pyrophoric liquids
Pyrophoric solids
Self-heating substances and mixtures
Substances and mixtures which in contact with water emit flammable gases
Explosives
Gases

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

Ingredients	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Ethanol	64-17-5	TWA	1,000 ppm 1,900 mg/m3	NIOSH REL
		TWA	1,000 ppm 1,900 mg/m3	OSHA Z-1
		STEL	1,000 ppm	ACGIH
Propan-2-ol	67-63-0	TWA	200 ppm	ACGIH
		STEL	400 ppm	ACGIH
		TWA	400 ppm 980 mg/m3	NIOSH REL
		ST	500 ppm 1,225 mg/m3	NIOSH REL
		TWA	400 ppm 980 mg/m3	OSHA Z-1

Biological occupational exposure limits

Ingredients	CAS-No.	Control parameters	Biological specimen	Sam-pling time	Permissible concentration	Basis
Propan-2-ol	67-63-0	Acetone	Urine	End of shift at end of work-week	40 mg/l	ACGIH BEI

Engineering measures : Minimize workplace exposure concentrations.
Use only in an area equipped with explosion proof exhaust ventilation.
Use with local exhaust ventilation.

Personal protective equipment

Respiratory protection : General and local exhaust ventilation is recommended to maintain vapor exposures below recommended limits. Where concentrations are above recommended limits or are unknown, appropriate respiratory protection should be worn. Follow OSHA respirator regulations (29 CFR 1910.134) and

use NIOSH/MSHA approved respirators. Protection provided by air purifying respirators against exposure to any hazardous chemical is limited. Use a positive pressure air supplied respirator if there is any potential for uncontrolled release, exposure levels are unknown, or any other circumstance where air purifying respirators may not provide adequate protection.

Hand protection

Material	:	Impervious gloves
Material	:	Flame retardant gloves
Remarks	:	Choose gloves to protect hands against chemicals depending on the concentration specific to place of work. Breakthrough time is not determined for the product. Change gloves often! For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday.
Eye protection	:	Wear the following personal protective equipment: Safety goggles
Skin and body protection	:	Select appropriate protective clothing based on chemical resistance data and an assessment of the local exposure potential. Wear the following personal protective equipment: Flame retardant antistatic protective clothing. Skin contact must be avoided by using impervious protective clothing (gloves, aprons, boots, etc).
Hygiene measures	:	Ensure that eye flushing systems and safety showers are located close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	gel
Color	:	clear, light blue
Odor	:	fruity
Odor Threshold	:	No data available
pH	:	6.5 - 8.5
Melting point/freezing point	:	No data available
Initial boiling point and boiling range	:	73 °C

Flash point	:	25 °C
Evaporation rate	:	No data available
Flammability (solid, gas)	:	Not applicable
Upper explosion limit	:	No data available
Lower explosion limit	:	No data available
Vapor pressure	:	No data available
Relative vapor density	:	No data available
Density	:	0.881 g/cm3
Solubility(ies)		
Water solubility	:	soluble
Partition coefficient: n-octanol/water	:	Not applicable
Autoignition temperature	:	No data available
Decomposition temperature	:	The substance or mixture is not classified self-reactive.
Viscosity		
Viscosity, kinematic	:	1,000 - 17,000 mm2/s (20 °C)
Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Not classified as a reactivity hazard.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Flammable liquid and vapor. Vapors may form explosive mixture with air. Can react with strong oxidizing agents.
Conditions to avoid	:	Heat, flames and sparks.
Incompatible materials	:	Oxidizing agents
Hazardous decomposition products	:	No hazardous decomposition products are known.

SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure
Inhalation
Skin contact
Ingestion
Eye contact

Acute toxicity

Not classified based on available information.

Product:

Acute oral toxicity	:	Acute toxicity estimate: > 5,000 mg/kg Method: Calculation method

Ingredients:

Ethanol:

Acute oral toxicity	:	LD50 (Rat): > 5,000 mg/kg
Acute inhalation toxicity	:	LC50 (Rat): 124.7 mg/l Exposure time: 4 h Test atmosphere: vapor

Propan-2-ol:

Acute oral toxicity	:	LD50 (Rat): > 5,000 mg/kg
Acute inhalation toxicity	:	LC50 (Rat): 72.6 mg/l Exposure time: 4 h Test atmosphere: vapor
Acute dermal toxicity	:	LD50 (Rat): > 5,000 mg/kg

Skin corrosion/irritation

Not classified based on available information.

Product:

Result: No skin irritation

Ingredients:

Ethanol:
Species: Rabbit
Method: OECD Test Guideline 404
Result: No skin irritation

Propan-2-ol:
Species: Rabbit
Result: No skin irritation

Serious eye damage/eye irritation

Causes serious eye irritation.

Ingredients:

Ethanol:
Species: Rabbit
Result: Irritation to eyes, reversing within 21 days
Method: OECD Test Guideline 405

Propan-2-ol:
Species: Rabbit
Result: Irritation to eyes, reversing within 21 days

Respiratory or skin sensitization

Skin sensitization: Not classified based on available information.
Respiratory sensitization: Not classified based on available information.

Product:

Assessment: Does not cause skin sensitization.

Ingredients:

Ethanol:
Test Type: Local lymph node assay (LLNA)
Routes of exposure: Skin contact
Species: Mouse
Result: negative

Propan-2-ol:
Test Type: Buehler Test
Routes of exposure: Skin contact
Species: Guinea pig
Method: OECD Test Guideline 406
Result: negative

Germ cell mutagenicity

Not classified based on available information.

Ingredients:

Ethanol:

Genotoxicity in vitro	:	Test Type: In vitro mammalian cell gene mutation test Result: negative
Genotoxicity in vivo	:	Test Type: Rodent dominant lethal test (germ cell) (in vivo) Species: Mouse Application Route: Ingestion Result: negative

Propan-2-ol:

Genotoxicity in vitro	:	Test Type: Bacterial reverse mutation assay (AMES) Result: negative
Genotoxicity in vivo	:	Test Type: Mammalian erythrocyte micronucleus test (in vivo cytogenetic assay) Species: Mouse Application Route: Intraperitoneal injection Result: negative

Carcinogenicity

Not classified based on available information.

Ingredients:

Propan-2-ol:
Species: Rat
Application Route: inhalation (vapor)
Exposure time: 104 weeks
Method: OECD Test Guideline 451
Result: negative

IARC	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
OSHA	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
NTP	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

Reproductive toxicity

Not classified based on available information.

Ingredients:

Ethanol:

Effects on fertility	:	Test Type: Two-generation reproduction toxicity study Species: Mouse Application Route: Ingestion Method: OECD Test Guideline 416 Result: negative

Propan-2-ol:

Effects on fertility	:	Test Type: Two-generation reproduction toxicity study Species: Rat Application Route: Ingestion Result: negative
Effects on fetal development	:	Test Type: Embryo-fetal development Species: Rat Application Route: Ingestion Result: negative

STOT-single exposure

Not classified based on available information.

Ingredients:

Propan-2-ol:
Assessment: May cause drowsiness or dizziness.

STOT-repeated exposure

Not classified based on available information.

Repeated dose toxicity

Ingredients:

Ethanol:
Species: Rat
NOAEL: 2,400 mg/kg
Application Route: Ingestion
Exposure time: 2 y

Propan-2-ol:
Species: Rat
NOAEL: 5000 ppm
Application Route: inhalation (vapor)
Exposure time: 104 w
Method: OECD Test Guideline 413

Aspiration toxicity

Not classified based on available information.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Ingredients:

Ethanol:

Toxicity to fish	:	LC50 (Pimephales promelas (fathead minnow)): > 1,000 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): > 1,000 mg/l Exposure time: 48 h
Toxicity to algae	:	EC50 (Chlorella vulgaris (Fresh water algae)): 275 mg/l Exposure time: 72 h Method: OECD Test Guideline 201
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 9.6 mg/l Exposure time: 9 d
Toxicity to bacteria	:	EC50 (Photobacterium phosphoreum): 32.1 mg/l Exposure time: 0.25 h

Propan-2-ol:

Toxicity to fish	:	LC50 (Pimephales promelas (fathead minnow)): 10,000 mg/l Exposure time: 96 h
Toxicity to daphnia and other aquatic invertebrates	:	EC50 (Daphnia magna (Water flea)): > 10,000 mg/l Exposure time: 24 h
Toxicity to algae	:	ErC50 (Scenedesmus quadricauda (Green algae)): > 1,800 mg/l

Exposure time: 8 d

Toxicity to bacteria : EC50 (Pseudomonas putida): > 1,050 mg/l
Exposure time: 16 h

Persistence and degradability

Ingredients:

Ethanol:
Biodegradability : Result: Readily biodegradable.
Biodegradation: 84 %
Exposure time: 20 d

Propan-2-ol:
Biodegradability : Result: rapidly degradable

Bioaccumulative potential

Ingredients:

Ethanol:
Partition coefficient: n-octanol/water : log Pow: -0.35

Propan-2-ol:
Partition coefficient: n-octanol/water : log Pow: 0.05

Mobility in soil

No data available

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of in accordance with local regulations.

Contaminated packaging : Dispose of as unused product.
Empty containers should be taken to an approved waste handling site for recycling or disposal.
Do not burn, or use a cutting torch on, the empty drum.

SECTION 14. TRANSPORT INFORMATION

International Regulation

UNRTDG
UN number : UN 1987
Proper shipping name : ALCOHOLS, N.O.S.

(Ethanol, Propan-2-ol)

Class	:	3
Packing group	:	III
Labels	:	3

IATA-DGR

UN/ID No.	:	UN 1987
Proper shipping name	:	Alcohols, n.o.s. (Ethanol, Propan-2-ol)
Class	:	3
Packing group	:	III
Labels	:	Flammable Liquids
Packing instruction (cargo aircraft)	:	366
Packing instruction (passenger aircraft)	:	355

IMDG-Code

UN number	:	UN 1987
Proper shipping name	:	ALCOHOLS, N.O.S. (Ethanol, Propan-2-ol)
Class	:	3
Packing group	:	III
Labels	:	3
EmS Code	:	F-E, S-D
Marine pollutant	:	no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

49 CFR

UN/ID/NA number	:	UN 1987
Proper shipping name	:	ALCOHOLS, N.O.S.
Class	:	3
Packing group	:	III
Labels	:	FLAMMABLE LIQUID
ERG Code	:	127
Marine pollutant	:	no

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know

CERCLA Reportable Quantity

This material does not contain any components with a CERCLA RQ.

SARA 304 Extremely Hazardous Substances Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Fire Hazard

Acute Health Hazard

SARA 302 : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : The following components are subject to reporting levels established by SARA Title III, Section 313:

Propan-2-ol	67-63-0	3.4086 %

US State Regulations

Pennsylvania Right To Know

Ethanol	64-17-5	50 - 70 %
Water	7732-18-5	30 - 50 %
Propan-2-ol	67-63-0	1 - 5 %

New Jersey Right To Know

Ethanol	64-17-5	50 - 70 %
Water	7732-18-5	30 - 50 %
Propan-2-ol	67-63-0	1 - 5 %

California Prop 65 This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

The ingredients of this product are reported in the following inventories:

REACH : All ingredients (pre-)registered or exempt.

TSCA : All chemical substances in this material are included on or exempted from listing on the TSCA Inventory of Chemical Substances.

DSL : All chemical substances in this product comply with the CEPA 1999 and NSNR and are on or exempt from listing on the Canadian Domestic Substances List (DSL).

AICS : All ingredients listed or exempt.

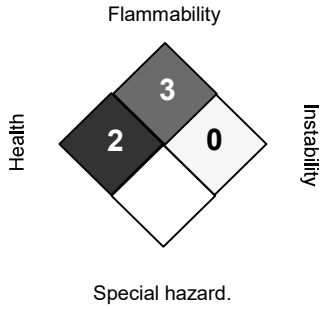
Inventories

AICS (Australia), DSL (Canada), IECSC (China), REACH (European Union), ENCS (Japan), ISHL (Japan), KECI (Korea), NZIoC (New Zealand), PICCS (Philippines), NECSI (Taiwan), TSCA (USA)

SECTION 16. OTHER INFORMATION

Further information

NFPA:



HMIS III:

HEALTH	2
FLAMMABILITY	3
PHYSICAL HAZARD	0

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

Full text of other abbreviations

ACGIH	:	USA. ACGIH Threshold Limit Values (TLV)
ACGIH BEI	:	ACGIH - Biological Exposure Indices (BEI)
NIOSH REL	:	USA. NIOSH Recommended Exposure Limits
OSHA Z-1	:	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
ACGIH / TWA	:	8-hour, time-weighted average
ACGIH / STEL	:	Short-term exposure limit
NIOSH REL / TWA	:	Time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek
NIOSH REL / ST	:	STEL - 15-minute TWA exposure that should not be exceeded at any time during a workday
OSHA Z-1 / TWA	:	8-hour time weighted average
Sources of key data used to compile the Material Safety Data Sheet	:	Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, http://echa.europa.eu/
Revision Date	:	02/10/2015

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

US / Z8

Section 1 - Product and Company Identification

Product Identifiers:

Product name:	**Repel Insect Repellent Sportsmen Max Formula 40% DEET**
EPA reg. number:	305-46
Recommended product use:	Insect Repellent - Aerosol

Details of the Supplier of the Safety Data Sheet:

Manufacturer/Supplier:	Chemsico Div. of United Industries Corp. P.O. Box 142642 St. Louis, MO 63114
For product information:	1-800-880-1181
For medical emergencies:	1-800-633-2873

Section 2 - Hazards Identification

Conforms to Hazard Communication Standard 29 CFR 1910.1200.

GHS Classification of Substance or Mixture:

Physical Hazards GHS Classification	Flammable aerosol - Category 2 Gases under pressure – Compressed Gas
Health Hazards GHS Classification	Primary Eye Irritant – Category 2A

GHS Label Elements:

Hazard pictogram(s):



Signal word: WARNING

Hazard statements:

- Flammable aerosol
- Compressed gas – contents under pressure; may burst if heated
- Causes eye irritation

Precautionary Statements:

- Contents under pressure.
- Do not use or store near heat or open flame.
- Do not puncture or incinerate container.
- Exposure to temperatures above 130°F may cause bursting.
- If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Section 3 - Composition / Information on Ingredients

Chemical Name	CAS#	Weight Percent
DEET (N,N-Diethyl-m-toluamide)	134-62-3	40.0%
Ethanol	64-17-5	20.0%
Isobutane	75-28-5	10.0%

Note: Ingredients not identified are proprietary or non-hazardous. Values are not product specifications.

Section 4 - First Aid Measures

Eye contact: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice.

Skin contact: After returning indoors, wash treated skin with soap and water. Discontinue use if irritation or rash occurs.

Inhalation: No special requirements

Ingestion: Call a poison control center or doctor immediately for treatment advice. Have person sip if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Note to Physician: None

General advice: If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Keep out of reach of children.

Section 5 - Fire Fighting Measures

Flammable properties: Pressurized aerosol container

NFPA classification: NFPA level 1 aerosol

Suitable extinguishing media: Water fog, foam, CO_2, dry chemical

Unsuitable extinguishing media: Not available

Specific hazards arising from the chemical: Contents under pressure – container may burst in heat of fire.

Protective equipment for firefighters: Firefighters should wear full protective clothing including self-contained breathing apparatus.

Hazardous combustion products: None known

Explosion data: Not available

Sensitivity to static discharge: Not available

Personal precautions: Keep unnecessary personnel away. Do not touch or walk through spilled material.

Section 6 - Accidental Release Measures

Personnel precautions: Remove all sources of ignition. Wear personnel protective equipment as recommended in Section 8. Wash thoroughly after handling.

For emergency responders: If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials.

Environmental precautions: Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Methods for containment and cleaning up: Stop leak if without risk. Move containers from spill area. Before attempting clean up, refer to hazard data given above. Small spills may be absorbed with earth, sand or absorbent material swept up and placed in suitable, covered, and labeled containers. Prevent large spills from entering sewers or waterways. Contact emergency services and supplier for advice. Never return spills in original containers for re-use.

Section 7 - Handling and Storage

Precautions for safe handling: Put on appropriate personal protective equipment as recommended in Section 8. Pressurized container: protect from sunlight and do not expose to temperatures exceeding 50°C (122°F). Do not pierce or burn, even after use. Do not ingest. Avoid contact with skin, eyes and clothing. Avoid breathing vapor or mist. Use only with adequate ventilation. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous.

Storage: Store in a cool, dry area away from open flame. Do not store above 50°C (122°F).

Section 8 - Exposure Controls / Personal Protection

Exposure guidelines:

Components with Occupational Exposure Limits							
		Exposure Limits					
		OSHA PEL		ACGIH TLV		SupplierOEL	
Chemical name		**ppm**	**mg/m³**	**ppm**	**mg/m³**	**ppm**	**mg/m³**
DEET	TWA	None		None		None	
Ethanol	TWA	1000	1900	1000	------	1000	1900
Isobutane	TWA	Not established		1000	------	Not established	

Engineering controls: General ventilation normally adequate.

Personal protective equipment:

Eye/Face protection: During application, prevent entry into eyes. Wear safety glasses with side shields if using in large applications.

Skin and body protection:	After returning indoors, wash treated skin with soap and water.
Respiratory protection:	Where exposure guideline levels may be exceeded, use an approved NIOSH respirator.
General hygiene considerations:	Handle in accordance with good industrial hygiene and safety practices. When using, do not eat or drink. Wash hands before breaks and immediately after handling the product.

Section 9 - Physical & Chemical Properties

Appearance:	Clear
Color:	Colorless to pale yellow
Physical state:	Pressurized liquid
Odor:	Ethanol & DEET
Odor threshold:	No data available
pH:	8.3 (liquid portion)
Melting point:	No data available
Freezing point:	No data available
Boiling point:	No data available
Flash point:	85°F (liquid portion)
Flame Extension	18” (level 1 aerosol)
Flammability limits in air, lower, % by volume:	No data available
Flammability limits in air, upper, % by volume:	No data available
Vapor pressure:	No data available
Vapor density:	No data available
Relative density @ 20°C:	0.922 (liquid portion)
Octanol/water coefficient:	No data available
Auto-ignition temperature:	No data available
Decomposition temperature:	No data available
Solubility:	Miscible in water
Evaporation rate:	No data available
% Volatile organic compounds:	30.2

Section 10 - Chemical Stability & Reactivity Information

Reactivity

Conditions to avoid:	Do not mix with other chemicals.
Incompatible materials:	Avoid strong oxidizers.

Chemical stability

Product stability:	Stable under recommended storage conditions.

Other

Hazardous decomposition products: None known

Possibility of hazardous reactions: Hazardous polymerization does not occur.

Section 11 - Toxicological Information

Primary eye irritation: Causes substantial but temporary eye injury (EPA tox. category II)

Primary skin irritation: Non-irritating (EPA tox. category IV)

Acute dermal: LD_{50} > 5000 mg/kg (EPA tox. category IV)

Acute inhalation: LC_{50} > 2 mg/L (EPA tox. category IV)

Acute oral: LD_{50} > 2000 mg/kg (EPA tox. category III)

Sensitization: Not a skin sensitizer.

Chronic effects/ Carcinogenicity: No data available

Mutagenicity: No data available

Reproductive effects: No data available

Teratogenicity: No data available

Ecotoxicity: No data available

Section 12 - Ecological Information

Environmental effects: No data available

Aquatic toxicity: None

Persistence / degradability: No data available

Bioaccumulation / accumulation: No data available

Partition coefficient: No data available

Mobility in environmental media: No data available

Chemical fate information: No data available

Section 13 - Disposal Considerations

Waste codes: Not available

Disposal instructions: Dispose in accordance with all applicable regulations.

Waste from residues / unused products: Not available

Contaminated packaging: Not available

Section 14 - Transportation Information

U.S. Department of Transportation (DOT): UN-1950, Aerosols, Flammable, 2.1, Limited Quantity

IATA: UN-1950, Aerosols, 2.1

IMDG: UN-1950, Aerosols, Flammable, Limited Quantity

Section 15 - Regulatory Information

29 CFR 1910.1200 hazardous chemical Occupational Safety and Health Administration (OSHA): No

CERCLA (Superfund) reportable quantity: Not available

Hazard categories

Superfund Amendments and Reauthorization Act of 1986 (SARA):

Immediate Hazard	No
Delayed Hazard	No
Fire Hazard	No
Pressure Hazard	No
Reactivity Hazard	No

Section 302 extremely hazardous Substance: No

Section 311 hazardous chemical: No

Clean Air Act (CAA): Not available

Clean Water Act (CWA): Not available

State regulations:

FIFRA labeling: This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

Signal word: CAUTION

Precautionary statements: Causes substantial but temporary eye injury. Do not get in eyes. Harmful if swallowed. Use of this product may cause skin reactions in rare cases. Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

FLAMMABLE. Contents under pressure. Keep away from heat, sparks and open flame. Do not puncture or incinerate container. Exposure to temperatures above 130°F may cause bursting. Do not apply to synthetic fabrics such as acetate, rayon or spandex. Will not damage cotton, wool or nylon. May damage furniture finishes, leather, plastics and painted and varnished surfaces, including watch crystals, guns, bows and automobiles.

Notification status: All ingredients of this product are listed or are excluded from listing on the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

California Prop. 65: This product does not contain any chemicals known to the state of California to cause cancer, birth defects or any other reproductive harm.

Disclaimer: Information contained herein was obtained from sources considered technically accurate and reliable. While every effort has been made to ensure full disclosure of product hazards, in some cases data is not available and is so stated. Since conditions of actual product use are beyond control of the supplier, it is assumed that users of this material have been fully trained according to the requirements of all applicable legislation and regulatory instruments. No warranty, expressed or implied, is made and supplier will not be liable for any losses, injuries or

consequential damages which may result from the use of or reliance on any information contained in this document.

Section 16 - Other Information

HMIS ratings:	Health Hazard 1 Flammability 3 Physical Hazard 0
Item numbers:	HG-33801; HG-73801; HG-83801; HG-94102; HG-94201
Issue date:	2/22/2016
Prepared by:	WPC Brands, Inc. P.O. Box 4406 Bridgeton, MO 63044-0406 (800) 242-1166

SAFETY DATA SHEET

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name **Residual Fuel Oil (Flashpoint > 100°C) - Blended**

Other means of identification

Fuel Oil (FO)
Heavy Fuel Oil (HFO)
Marine Bunker Fuel
High Sulphur Fuel Oil (HSFO)
Low Sulphur Fuel Oil (LSFO)
Vacuum Residue (VACRES)
Intermediate Fuel Oil (IFO)
Intermediate Fuel Oil 180 (IFO 180)
Intermediate Fuel Oil 380 (IFO 380)

RMA 10, RMA 10LS, RMA 10XX, RMA 10LSXX
RMA 30, RMA 30LS, RMA 30XX, RMA 30LSXX
RMB 30, RMB 30LS, RMB 30XX, RMB 30LSXX
RMD 80, RMD 80LS, RMD 80XX, RMD 80LSXX
RME 180, RME 180LS, RME 180XX, RME 180LSXX
RMF 180, RMF 180LS, RMF 180XX, RMF 180LSXX
RMG 180, RMG 180LS, RMG 180XX, RMG 180LSXX
RMG 380, RMG 380LS, RMG 380XX, RMG 380LSXX
RMG 500, RMG 500XX
RMG 700, RMG 700XX
RMH 380, RMH 380LS, RMH 380XX, RMH 380LSXX
RMH 700, RMH 700XX
RMK 380, RMK 380LS, RMK 380XX, RMK 380LSXX
RMK 500, RMK 500XX
RMK 700, RMK 700XX

Proper shipping name MARPOL Annex 1 rules apply for bulk shipments by sea.

SDS no. SBX2296

Product type Liquid.

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses
Use as a fuel - Industrial
Use as a fuel - Professional
Formulation and (re)packing of substances and mixtures

Use of the substance/ mixture Fuel.
For specific application advice see appropriate Technical Data Sheet or consult our company representative.

1.3 Details of the supplier of the safety data sheet

Supplier

BP Europa S.E. – BP Nederland
Rivium Boulevard 301
2909 LK Capelle a/d Ijssel
Rotterdam
NETHERLANDS

Tel: 010 249 1000

E-mail address MSDSadvice@bp.com

1.4 Emergency telephone number

EMERGENCY TELEPHONE NUMBER

+31 10 249 1000 (24 hour)
Netherlands: NVIC 030 274 8888 (Only to inform medical personnel (physicians, veterinarians, pharmacists) about symptoms and treatment of acute intoxications.)

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Product definition Mixture

Classification according to Directive 1999/45/EC [DPD]

The product is classified as dangerous according to Directive 1999/45/EC and its amendments.

Classification
Carc. Cat. 2; R45
Repr. Cat. 3; R63
Xn; R20, R48/21
Xi; R38
N; R50/53

Human health hazards May cause cancer. Possible risk of harm to the unborn child. Also harmful by inhalation. Also harmful: danger of serious damage to health by prolonged exposure in contact with skin. Irritating to skin.

Environmental hazards Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

See Section 16 for the full text of the R phrases or H statements declared above.

See sections 11 and 12 for more detailed information on health effects and symptoms and environmental hazards.

2.2 Label elements

Hazard symbol or symbols





Indication of danger

Dangerous for the environment

Risk phrases
R45- May cause cancer.
R63- Possible risk of harm to the unborn child.
R20- Also harmful by inhalation.
R48/21- Also harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R38- Irritating to skin.
R50/53- Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety phrases
S53- Avoid exposure - obtain special instructions before use.
S36/37- Wear suitable protective clothing and gloves.
S61- Avoid release to the environment. Refer to special instructions/safety data sheet.

Hazardous ingredients
Fuel oil, residual
Residues (petroleum), atmospheric
residues (petroleum),thermal cracked
Residues (petroleum), hydrocracked
residues (petroleum), catalytic cracking
Gas oils (petroleum), heavy vacuum
Distillates (petroleum), light catalytic cracked
Distillates (petroleum), light thermal cracked

Supplemental label elements Not applicable.

Special packaging requirements

Containers to be fitted with child-resistant fastenings Not applicable.

Tactile warning of danger Not applicable.

2.3 Other hazards

Other hazards which do not result in classification
Will cause burns if hot material contacts eyes.
Will cause burns if hot material contacts skin.
This material can contain hydrogen sulphide (H_2S), a very toxic and extremely flammable gas.
This material may contain significant quantities of polycyclic aromatic hydrocarbons (PCAs), some of which have been shown by experimental studies to induce skin cancer.
Note: High Pressure Applications
Injections through the skin resulting from contact with the product at high pressure constitute a major medical emergency.
See 'Notes to physician' under First-Aid Measures, Section 4 of this Safety Data Sheet.

SECTION 3: Composition/information on ingredients

Substance/mixture Mixture

Product/ingredient name	Identifiers	%	Classification 67/548/EEC	Classification Regulation (EC) No. 1272/2008 [CLP]	Type
Fuel oil, residual	REACH #: 01-2119474894-22 EC: 270-675-6 CAS: 68476-33-5 Index: 649-024-00-9	0 - 100	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1]
Residues (petroleum), atmospheric	REACH #: 01-2119485969-10 EC: 269-777-3 CAS: 68333-22-2	0 - 95	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1]
residues (petroleum), thermal cracked	REACH #: 01-2119484869-13 EC: 265-081-9 CAS: 64741-80-6	0 - 75	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1]
residues (petroleum), hydrocracked	REACH #: 01-2119489964-16 EC: 265-076-1 CAS: 64741-75-9 Index: 649-012-00-3	0 - 25	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1]
residues (petroleum), catalytic cracking	REACH #: 01-2119486485-25 EC: 295-511-0 CAS: 92061-97-7	0 - 25	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1]
Gas oils (petroleum), heavy vacuum	REACH #: 01-2119487294-29 EC: 265-058-3 CAS: 64741-57-7	0 - 15	Carc. Cat. 2; R45 Repr. Cat. 3; R63 Xn; R20, R48/21 R66 N; R50/53	Acute Tox. 4, H332 Carc. 1B, H350 Repr. 2, H361d STOT RE 2, H373 Aquatic Chronic 1, H410	[1] [2]
Distillates (petroleum), light catalytic cracked	REACH #: 01-2119489734-23 EC: 265-060-4 CAS: 64741-59-9 Index: 649-435-00-3	0 - 15	Carc. Cat. 2; R45 Xn; R20, R48/21, R65 Xi; R38 N; R50/53	Flam. Liq. 3, H226 Acute Tox. 4, H332 Skin Irrit. 2, H315 Carc. 1B, H350 STOT RE 2, H373 Asp. Tox. 1, H304 Aquatic Chronic 1, H410	[1]
Distillates (petroleum), light thermal cracked	REACH #: 01-2119472307-37 EC: 265-084-5 CAS: 64741-82-8	0 - 15	Carc. Cat. 2; R45 Xn; R20, R48/21, R65 Xi; R38 N; R50/53	Acute Tox. 4, H332 Skin Irrit. 2, H315 Carc. 1B, H350 STOT RE 2, H373 Asp. Tox. 1, H304 Aquatic Chronic 1, H410	[1]

See Section 16 for the full text of the R-phrases declared above.

See Section 16 for the full text of the H statements declared above.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact

Hot product - Flood with water to dissipate heat. In the event of any product remaining, do not try to remove it other than by continued irrigation with water. Obtain medical attention immediately.
Cold product - Wash eye thoroughly with copious quantities of water, ensuring eyelids are held open. Obtain medical advice if any pain or redness develops or persists.

SECTION 4: First aid measures

Skin contact

Hot Product - Flood skin with cold water to dissipate heat, cover with clean cotton or gauze, obtain medical advice immediately.
Cold Product - Wash contaminated skin with soap and water. Remove contaminated clothing and wash underlying skin as soon as reasonably practicable.
Never use gasoline, kerosene or other solvents to remove product from skin or clothing.

Inhalation

Get medical attention immediately. If inhaled, remove to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel.

EXPOSURE TO HYDROGEN SULPHIDE:
Casualties suffering ill effects as a result of exposure to hydrogen sulphide should be immediately removed to fresh air and medical assistance obtained without delay. Unconscious casualties must be placed in the recovery position. Monitor breathing and pulse rate and if breathing has failed, or is deemed inadequate, respiration must be assisted, preferably by the mouth to mouth method. Administer external cardiac massage if necessary. Seek medical attention immediately.

Ingestion

Get medical attention immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately.

Protection of first-aiders

No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician

Treatment should in general be symptomatic and directed to relieving any effects.
Inhalation of hydrogen sulphide may cause central respiratory depression leading to coma and death. It is irritant to the respiratory tract causing chemical pneumonitis and pulmonary oedema. The onset of pulmonary oedema may be delayed for 24 to 48 hours. Treat with oxygen and ventilate as appropriate. Administer broncho-dilators if indicated and consider administration of corticosteroids. Keep casualty under surveillance for 48 hours in case pulmonary oedema develops.
Note: High Pressure Applications
Injections through the skin resulting from contact with the product at high pressure constitute a major medical emergency. Injuries may not appear serious at first but within a few hours tissue becomes swollen, discoloured and extremely painful with extensive subcutaneous necrosis. Surgical exploration should be undertaken without delay. Thorough and extensive debridement of the wound and underlying tissue is necessary to minimise tissue loss and prevent or limit permanent damage. Note that high pressure may force the product considerable distances along tissue planes.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media

In case of fire, use water fog, foam, dry chemical or carbon dioxide extinguisher or spray.
This substance will float and can be reignited on surface water.

Unsuitable extinguishing media

Do not use water jet.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture

Avoid spraying directly into storage containers because of the danger of boil-over. In a fire or if heated, a pressure increase will occur and the container may burst. Vapours can form explosive mixtures with air. Vapours are heavier than air and can spread along the ground or float on water surfaces to remote ignition sources. Vapours may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. Boil-over is the rapid increase in volume caused by the presence of water in hot product and the subsequent overflow from a tank.

Hazardous combustion products

Combustion products may include the following:
carbon oxides (CO, CO_2) (carbon monoxide, carbon dioxide)
sulphur oxides (SO, SO_2, etc.)
Hydrogen Sulphide (H2S)
unidentified organic and inorganic compounds

SECTION 5: Firefighting measures

5.3 Advice for firefighters

Special precautions for fire-fighters

Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain. First move people out of line-of-sight of the scene and away from windows. This material is very toxic to aquatic organisms. No action shall be taken involving any personal risk or without suitable training. Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters

Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel

Immediately contact emergency personnel. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Floors may be slippery; use care to avoid falling. Do not breathe vapour or mist. Ensure good ventilation. Put on appropriate personal protective equipment.

This material can contain hydrogen sulphide (H_2S), a very toxic and extremely flammable gas. Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained positive pressure breathing apparatus (SCBA).

For emergency responders

Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit. Chemical resistant boots. See also the information in "For non-emergency personnel".

6.2 Environmental precautions

Storage tanks must be positioned within a bunded area.

Spillages in water or at sea:
Depending upon its temperature the product may be liquid, semi-solid or solid. Protect drains from spills and prevent entry of product, since this may result in blockage on cooling. Should blockage occur, notify the appropriate authority immediately. Product less dense than water: In case of small spillages in closed waters (i.e. ports), contain product with floating barriers or other equipment. Collect spilled product by absorbing with specific floating absorbents. If possible, large spillages in open waters should be contained with floating barriers or other mechanical means. If this is not possible, control the spreading of the spillage, and collect the product by skimming or other suitable mechanical means. The use of dispersants should be advised by an expert, and, if required, approved by local authorities. Collect recovered product and other contaminated materials in suitable tanks or containers for recycle, recovery or safe disposal. Product which is denser than water will sink to the bottom, and usually no intervention will be feasible. If possible, collect the product and contaminated materials with mechanical means, and store/dispose of according to relevant regulations. In special situations (to be assessed on case-by-case basis, according to expert judgement and local conditions), excavations of trenches on the bottom to collect the product with sand may be a feasible option.

Depending upon its temperature the product may be liquid, semi-solid or solid. Protect drains from spills and prevent entry of product, since this may result in blockage on cooling. Should blockage occur, notify the appropriate authority immediately.

6.3 Methods and materials for containment and cleaning up

Small spill

Eliminate all ignition sources. Stop leak if without risk. Move containers from spill area. Absorb with an inert material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill

Eliminate all ignition sources. Immediately contact emergency personnel. Stop leak if without risk. Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Dike spill area and do not allow product to reach sewage system and surface or ground water. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations. Contaminated absorbent material may pose the same hazard as the spilt product. Dispose of via a licensed waste disposal contractor.

SECTION 6: Accidental release measures

6.4 Reference to other sections

See Section 1 for emergency contact information.
See Section 5 for firefighting measures.
See Section 8 for information on appropriate personal protective equipment.
See Section 12 for environmental precautions.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

7.1 Precautions for safe handling

Protective measures

Contact with hot product may cause burns. Put on appropriate personal protective equipment. Avoid exposure - obtain special instructions before use. Avoid exposure during pregnancy. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing vapour or mist. Avoid contact of spilt material and runoff with soil and surface waterways. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Do not reuse container. Empty containers retain product residue and can be hazardous.

Advice on general occupational hygiene

Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Wash thoroughly after handling. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Regular periodic self inspection of the skin is recommended, especially those areas subject to contamination. In the event of any localised changes in appearance or texture of the skin being noticed, medical advice should be sought without delay.

7.2 Conditions for safe storage, including any incompatibilities

Do not enter storage tanks. If entry to vessels is necessary, follow permit to work procedures. Electrical equipment should not be used unless it is intrinsically safe (i.e. will not produce sparks). Entry to any tanks or other confined space requires a full risk assessment and appropriate control measures to be put in place in conformance with appropriate regulations and industry practice on confined space entry. Explosive air/vapour mixtures can occur, particularly in unventilated or confined spaces. If hydrogen sulphide is present, the flammable limits can be from 4.3 to 45.5% by volume and its presence may promote the formation of pyrophoric iron compounds. If product comes into contact with hot surfaces, or leaks occur from pressurised fuel pipes, the vapour or mists generated will create a flammability or explosion hazard. Light hydrocarbon vapours can build up in the headspace of tanks. These can cause flammability/explosion hazards even at temperatures below the normal flash point (note: flash point must not be regarded as a reliable indicator of the potential flammability of vapour in tank headspaces). Tank headspaces should always be regarded as potentially flammable and care should be taken to avoid static electrical discharge and all ignition sources during filling, ullaging and sampling from storage tanks. Product contaminated rags, paper or material used to absorb spillages, represent a fire hazard, and should not be allowed to accumulate. Dispose of safely immediately after use. This material can contain hydrogen sulphide (H_2S), a very toxic and extremely flammable gas. Vapours containing hydrogen sulphide may accumulate during storage or transport and may also be vented during filling of tanks. Hydrogen sulphide has a typical "bad egg" smell but at high concentrations the sense of smell is rapidly lost, therefore do not rely on sense of smell for detecting hydrogen sulphide. Use specially designed measuring instruments for determining its concentration. When the product is pumped (e.g. during filling, discharge or ullaging) and when sampling, there is a risk of static discharge. Ensure equipment used is properly earthed or bonded to the tank structure.

Keep away from heat and direct sunlight. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Store in accordance with local regulations. Store in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Use appropriate containment to avoid environmental contamination.

PGS Storage: Storage according to PGS 15 or 16

7.3 Specific end use(s)

Recommendations

See section 1.2 and Exposure scenarios in annex, if applicable.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
Fuel oil, residual	**ACGIH TLV (United States).** TWA: 0.2 mg/m³, (Benzene-soluble)
Residues (petroleum), atmospheric	**ACGIH TLV (United States).** STEL: 1480 mg/m³ 15 minutes. Form: Petrol (Recommended) STEL: 500 ppm 15 minutes. Form: Petrol (Recommended) TWA: 890 mg/m³ 8 hours. Form: Petrol (Recommended) TWA: 330 ppm 8 hours. Form: Petrol (Recommended) TWA: 100 ppm 8 hours. Form: Stoddard Solvent (Recommended) TWA: 525 mg/m³ 8 hours. Form: Stoddard Solvent (Recommended)
Gas oils (petroleum), heavy vacuum	**MinSZW Wettelijke Grenswaarden (Netherlands).** OEL, 8-h TWA: 5 mg/m³ 8 hours. Issued/Revised: 1/2007 Form: mist
Distillates (petroleum), light catalytic cracked	**ACGIH TLV (United States).** TWA: 525 mg/m³ 8 hours. Form: Stoddard Solvent (Recommended) TWA: 100 ppm 8 hours. Form: Stoddard Solvent (Recommended)
Hydrogen Sulphide	**MinSZW Wettelijke Grenswaarden (Netherlands).** OEL, 8-h TWA: 2.3 mg/m³ 8 hours. Issued/Revised: 1/2007

Whilst specific OELs for certain components may be shown in this section, other components may be present in any mist, vapour or dust produced. Therefore, the specific OELs may not be applicable to the product as a whole and are provided for guidance only.

Recommended monitoring procedures

If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Derived No Effect Level

Product/ingredient name	Type	Exposure		Value	Population	Effects
Fuel oil, residual	DNEL	Short term Inhalation	15 minutes	4700 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	8 hours TWA	0.065 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Inhalation	8 hours TWA	0.12 mg/m³	Workers	Systemic
	DNEL	Long term Oral	24 hours TWA	0.015 mg/kg bw/day	Consumers	Systemic
Residues (petroleum), atmospheric	DNEL	Short term Inhalation	15 minutes	4700 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	8 hours TWA	0.065 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Inhalation	8 hours TWA	0.12 mg/m³	Workers	Systemic
	DNEL	Long term Oral	24 hours TWA	0.015 mg/kg bw/day	Consumers	Systemic
Residues (petroleum), hydrocracked	DNEL	Short term Inhalation	15 minutes	4700 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	8 hours TWA	0.065 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Inhalation	8 hours TWA	0.12 mg/m³	Workers	Systemic
	DNEL	Long term Oral	24 hours TWA	0.015 mg/kg bw/day	Consumers	Systemic
Gas oils (petroleum), heavy vacuum	DNEL	Short term Inhalation	15 minutes	4700 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	8 hours TWA	0.065 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Inhalation	8 hours TWA	0.12 mg/m³	Workers	Systemic

SECTION 8: Exposure controls/personal protection

	DNEL	Long term Oral	24 hours TWA	0.015 mg/kg bw/day	Consumers	Systemic
Distillates (petroleum), light catalytic cracked	DNEL	Short term Dermal	15 minutes	2230 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	8 hours TWA	2.4 mg/kg bw/ day	Workers	Systemic
	DNEL	Long term Inhalation	8 hours TWA	30 mg/m³	Workers	Systemic
	DNEL	Long term Oral	24 hours TWA	1 mg/kg bw/day	Man via the environment	Systemic

Predicted No Effect Concentration

No PNECs available

8.2 Exposure controls

Appropriate engineering controls

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective occupational exposure limits.
All activities involving chemicals should be assessed for their risks to health, to ensure exposures are adequately controlled. Personal protective equipment should only be considered after other forms of control measures (e.g. engineering controls) have been suitably evaluated. Personal protective equipment should conform to appropriate standards, be suitable for use, be kept in good condition and properly maintained.
Your supplier of personal protective equipment should be consulted for advice on selection and appropriate standards. For further information contact your national organisation for standards.
The final choice of protective equipment will depend upon a risk assessment. It is important to ensure that all items of personal protective equipment are compatible.

Individual protection measures

Hygiene measures

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Ensure that eyewash stations and safety showers are close to the workstation location.

Respiratory protection

If local exhaust ventilation or other methods of ventilation are not possible or are insufficient, wear suitable respiratory protective devices. Wear suitable respiratory protective devices if there is a risk of exposure limits being exceeded. The choice of suitable respiratory device will depend upon a risk assessment of the workplace environment and the task being carried out. If required, the respiratory device must be certified as safe in defined explosive atmospheres (EX Label). Respiratory protective devices must be checked to ensure they fit correctly each time they are worn. Please consult European standard EN 529 for further guidance on the selection, use, care and maintenance of respiratory protective devices.

Suitable breathing apparatus (independent of ambient atmosphere) must be worn if any of the following situations apply.
- When the workplace atmosphere is considered to be immediately dangerous to life and health.
- When there is a risk of the workplace atmosphere being oxygen deficient.
- When the workplace atmosphere is uncontrolled.
- When the workplace atmosphere is unknown.
- When there is a risk of loss of consciousness or asphyxiation
- When entry into a confined space is required.
- When there is a risk of gases being released that could be a fire or explosion hazard.
- When the concentration of contaminants in the atmosphere exceeds the level of protection (maximum allowed concentration) given by a filtering device
- When the contaminants have a low odour that would not be tasted or smelt by the wearer of a filtering device if the filter became exhausted or saturated.
- When there is a risk of hydrogen sulphide exposure limits being exceeded.

If there is a requirement for the use of a respiratory protective device, but the use of breathing apparatus (independent of ambient atmosphere) is not required, then a suitable filtering device must be worn.
The filter class must be suitable for the maximum contaminant concentration (gas/vapour/ aerosol/particulates) that may arise when handling the product.

Recommended: Gas filter suitable for gases and vapours. Filter type: A.
Combined filter suitable for gases, vapours and particles (dust, smoke, mist, aerosol). Filter type: AP.

Eye/face protection

Recommended: Chemical splash goggles.

Skin protection

SECTION 8: Exposure controls/personal protection

Hand protection

General Information:

Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. The correct choice of protective gloves depends upon the chemicals being handled, and the conditions of work and use. Most gloves provide protection for only a limited time before they must be discarded and replaced (even the best chemically resistant gloves will break down after repeated chemical exposures).

Gloves should be chosen in consultation with the supplier / manufacturer and taking account of a full assessment of the working conditions.

Recommended: Nitrile gloves.

Breakthrough time:

Breakthrough time data are generated by glove manufacturers under laboratory test conditions and represent how long a glove can be expected to provide effective permeation resistance. It is important when following breakthrough time recommendations that actual workplace conditions are taken into account. Always consult with your glove supplier for up-to-date technical information on breakthrough times for the recommended glove type.
Our recommendations on the selection of gloves are as follows:

Continuous contact:

Gloves with a minimum breakthrough time of 240 minutes, or >480 minutes if suitable gloves can be obtained.
If suitable gloves are not available to offer that level of protection, gloves with shorter breakthrough times may be acceptable as long as appropriate glove maintenance and replacement regimes are determined and adhered to.

Short-term / splash protection:

Recommended breakthrough times as above.
It is recognised that for short-term, transient exposures, gloves with shorter breakthrough times may commonly be used. Therefore, appropriate maintenance and replacement regimes must be determined and rigorously followed.

Glove Thickness:

For general applications, we recommend gloves with a thickness typically greater than 0.35 mm.

It should be emphasised that glove thickness is not necessarily a good predictor of glove resistance to a specific chemical, as the permeation efficiency of the glove will be dependent on the exact composition of the glove material. Therefore, glove selection should also be based on consideration of the task requirements and knowledge of breakthrough times.
Glove thickness may also vary depending on the glove manufacturer, the glove type and the glove model. Therefore, the manufacturers' technical data should always be taken into account to ensure selection of the most appropriate glove for the task.

Note: Depending on the activity being conducted, gloves of varying thickness may be required for specific tasks. For example:

- Thinner gloves (down to 0.1 mm or less) may be required where a high degree of manual dexterity is needed. However, these gloves are only likely to give short duration protection and would normally be just for single use applications, then disposed of.

- Thicker gloves (up to 3 mm or more) may be required where there is a mechanical (as well as a chemical) risk i.e. where there is abrasion or puncture potential.

Skin and body

Cold material:
Wear suitable protective clothing.
Footwear highly resistant to chemicals.
When there is a risk of ignition wear inherently fire resistant protective clothes and gloves.
Refer to standard: ISO 11612
When there is a risk of ignition from static electricity, wear anti-static protective clothing. For greatest effectiveness against static electricity, overalls, boots and gloves should all be anti-static.
Refer to standard: EN 1149
Cotton or polyester/cotton overalls will only provide protection against light superficial

SECTION 8: Exposure controls/personal protection

contamination.
Work clothing / overalls should be laundered on a regular basis. Laundering of contaminated work clothing should only be done by professional cleaners who have been told about the hazards of the contamination. Always keep contaminated work clothing away from uncontaminated work clothing and uncontaminated personal clothes.
When the risk of skin exposure is high (from experience this could apply to the following tasks: cleaning work, maintenance and service, filling and transfer, taking samples and cleaning up spillages) then a chemical protective suit and boots will be required.

Thermal hazards Hot material: Protection should be provided for exposed areas of the neck and head. Wear suitable protective clothing to protect against heat and brief contact with flame.

Environmental exposure controls Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance

Physical state	Liquid.
Colour	Brown./ Black. [Dark]
Odour	Oily.
Odour threshold	Not available.
pH	Not available.
Melting point/freezing point	Not available.
Initial boiling point and boiling range	150 to 750°C (302 to 1382°F)
Pour point	-15 to 36 °C
Flash point	Closed cup: >100°C (>212°F) [Pensky-Martens.]
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	Lower: 0.5% Upper: 5%
Vapour pressure	<0.133 kPa (<1 mm Hg) at 20°C
Vapour density	>0.9 [Air = 1]
Relative density	Not available.
Density	935 to 1020 kg/m³ (0.935 to 1.02 g/cm³) at 15°C
Solubility(ies)	insoluble in water.
Partition coefficient: n-octanol/ water	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Kinematic: 180 to 1600 mm^2/s (180 to 1600 cSt) at 40°C Kinematic: >10 mm^2/s (>10 cSt) at 50°C
Explosive properties	Not available.
Oxidising properties	Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity No specific test data available for this product. Refer to Conditions to avoid and Incompatible materials for additional information.

10.2 Chemical stability The product is stable.

10.3 Possibility of hazardous reactions Under normal conditions of storage and use, hazardous polymerisation will not occur.
Under normal conditions of storage and use, hazardous reactions will not occur.

10.4 Conditions to avoid Avoid all possible sources of ignition (spark or flame). Avoid excessive heat.

SECTION 10: Stability and reactivity

10.5 Incompatible materials Reactive or incompatible with the following materials: oxidising materials.

10.6 Hazardous decomposition products Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Product/ingredient name	Result / Route	Test authority / Number	Species	Dose	Exposure	Remarks
Fuel oil, residual	LC50 Inhalation Dusts and mists	EPA 798.115	Rat	4500 mg/m³	4 hours	Based on Carbon black oil
	LC50 Inhalation Dusts and mists	EPA 798.115	Rat	4100 mg/m³	4 hours	Based on Carbon black oil
	LD50 Dermal	EU B.3	Rabbit	>2000 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Dermal	OECD 434	Rabbit	>2000 mg/kg	-	Based on Heavy fuel oil
	LD50 Oral	OECD 401	Rat	5270 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Oral	OECD 401	Rat	4320 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), atmospheric	LC50 Inhalation Dusts and mists	EPA 798.115	Rat	4500 mg/m³	4 hours	Based on Carbon black oil
	LC50 Inhalation Dusts and mists	EPA 798.115	Rat	4100 mg/m³	4 hours	Based on Carbon black oil
	LD50 Dermal	EU B.3	Rabbit	>2000 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Dermal	OECD 434	Rabbit	>2000 mg/kg	-	Based on Heavy fuel oil
	LD50 Oral	OECD 401	Rat	5270 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Oral	OECD 401	Rat	4320 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), hydrocracked	LC50 Inhalation Dusts and mists	EPA 798.115	Rat	4500 mg/m³	4 hours	Based on Carbon black oil
	LC50 Inhalation	EPA 798.115	Rat	4100 mg/m³	4 hours	Based on Carbon

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	Dusts and mists						black oil
	LD50 Dermal	EU	B.3	Rabbit	>2000 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Dermal	OECD	434	Rabbit	>2000 mg/kg	-	Based on Heavy fuel oil
	LD50 Oral	OECD	401	Rat	5270 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Oral	OECD	401	Rat	4320 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
Gas oils (petroleum), heavy vacuum	LC50 Inhalation Dusts and mists	EPA	OTS 798. 115	Rat	4500 mg/m³	4 hours	Based on Carbon black oil
	LC50 Inhalation Dusts and mists	EPA	OTS 798. 115	Rat	4100 mg/m³	4 hours	Based on Carbon black oil
	LD50 Dermal	EU	B.3	Rabbit	>2000 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Dermal	OECD	434	Rabbit	>2000 mg/kg	-	Based on Heavy fuel oil
	LD50 Oral	OECD	401	Rat	5270 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
	LD50 Oral	OECD	401	Rat	4320 mg/kg	-	Based on Catalytic cracked clarified oil (CCCO)
Distillates (petroleum), light catalytic cracked	LC50 Inhalation Dusts and mists	OECD	403	Rat	4.65 to 5.55 mg/l aerosol	4 hours	Based on light catalytically cracked distillate
	LD50 Dermal	OECD	402	Rabbit	>2000 mg/kg intact and abraded skin	-	Based on light catalytically cracked distillate
	LD50 Oral	OECD	401	Rat	3200 mg/kg	-	Based on light catalytically cracked distillate
	LD50 Oral	OECD	401	Rat	4660 mg/kg	-	Based on light catalytically cracked distillate

Irritation/Corrosion

SECTION 11: Toxicological information

Product/ingredient name	Test authority / Test number		Species	Route / Result	Test concentration	Remarks
Fuel oil, residual	EU	B.4	Rabbit	Skin - Non-irritant to skin.	-	Based on Heavy fuel oil
	EU	B.5	Rabbit	Eyes - Non-irritating to the eyes.	-	Based on Heavy fuel oil
Residues (petroleum), atmospheric	EU	B.4	Rabbit	Skin - Non-irritant to skin.	-	Based on Heavy fuel oil
	EU	B.5	Rabbit	Eyes - Non-irritating to the eyes.	-	Based on Heavy fuel oil
Residues (petroleum), hydrocracked	EU	B.4	Rabbit	Skin - Non-irritant to skin.	-	Based on Heavy fuel oil
	EU	B.5	Rabbit	Eyes - Non-irritating to the eyes.	-	Based on Heavy fuel oil
Gas oils (petroleum), heavy vacuum	EU	B.4	Rabbit	Skin - Non-irritant to skin.	-	Based on Heavy fuel oil
	EU	B.5	Rabbit	Eyes - Non-irritating to the eyes.	-	Based on Heavy fuel oil
Distillates (petroleum), light catalytic cracked	OECD	405	Rabbit	Eyes - Non-irritating to the eyes.	-	Based on light catalytically cracked distillate
	OECD	404	Rabbit	Skin - Irritant	-	Based on light catalytically cracked distillate

Sensitiser

Product/ingredient name	Route	Test authority / Test number		Species	Result	Remarks
Fuel oil, residual	skin	EU	B.6	Guinea pig	Not sensitising	Based on Heavy fuel oil
Residues (petroleum), atmospheric	skin	EU	B.6	Guinea pig	Not sensitising	Based on Heavy fuel oil
Residues (petroleum), hydrocracked	skin	EU	B.6	Guinea pig	Not sensitising	Based on Heavy fuel oil
Gas oils (petroleum), heavy vacuum	skin	EU	B.6	Guinea pig	Not sensitising	Based on Heavy fuel oil
Distillates (petroleum), light catalytic cracked	skin	OECD	406	Guinea pig	Not sensitising	Based on light catalytically cracked distillate

GERM CELL MUTAGENICITY

Product/ingredient name	Test authority / Test number	Cell		Type	Result	Remarks
Fuel oil, residual	Equivalent to OECD 476	-	Experiment: In vitro	Subject: Mammal - species unspecified	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 471	-	Experiment: In vitro	Subject: Non-mammalian species	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 475	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 474	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), atmospheric	Equivalent to OECD 476	-	Experiment: In vitro	Subject: Mammal - species unspecified	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 471	-	Experiment: In vitro	Subject: Non-mammalian species	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 475	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)

SECTION 11: Toxicological information

	Equivalent to OECD 474	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), hydrocracked	Equivalent to OECD 476	-	Experiment: In vitro	Subject: Mammal - species unspecified	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 471	-	Experiment: In vitro	Subject: Non-mammalian species	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 475	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 474	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
Gas oils (petroleum), heavy vacuum	Equivalent to OECD 476	-	Experiment: In vitro	Subject: Mammal - species unspecified	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 471	-	Experiment: In vitro	Subject: Non-mammalian species	Positive	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 475	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
	Equivalent to OECD 474	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on Catalytic cracked clarified oil (CCCO)
Distillates (petroleum), light catalytic cracked	OECD 471	Cell: Somatic	Experiment: In vitro	Subject: Non-mammalian species	Positive	Based on coker gas oil
	Equivalent to OECD 475	Cell: Germ	Experiment: In vivo	Subject: Unspecified	Negative	Based on straight run middle distillate

Carcinogenicity

Product/ingredient name	Test authority / Test number		Species	Route	Exposure	Result	Remarks
Fuel oil, residual	Equivalent to OECD	451	Mouse	Dermal	Lifetime	Positive	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), atmospheric	Equivalent to OECD	451	Mouse	Dermal	Lifetime	Positive	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), hydrocracked	Equivalent to OECD	451	Mouse	Dermal	Lifetime	Positive	Based on Catalytic cracked clarified oil (CCCO)
Gas oils (petroleum), heavy vacuum	Equivalent to OECD	451	Mouse	Dermal	Lifetime	Positive	Based on Catalytic cracked clarified oil (CCCO)
Distillates (petroleum), light catalytic cracked	Equivalent to OECD	451	Mouse	Dermal	2 years	Positive	Based on catalytically cracked light cycle oil

Reproductive toxicity

SECTION 11: Toxicological information

Product/ingredient name	Test authority / Test number		Species	Route	Exposure	Developmental	Maternal toxicity	Fertility	Remarks
Fuel oil, residual	EPA	OTS 798. 4700	Rat	Dermal	70 days no effects observed	-	-	Negative	Based on Catalytic cracked clarified oil (CCCO)
	EPA	OTS 798. 4900	Rat	Dermal	20 days Effects observed	Positive	-	-	Based on atmospheric residue
Residues (petroleum), atmospheric	EPA	OTS 798. 4700	Rat	Dermal	70 days no effects observed	-	-	Negative	Based on Catalytic cracked clarified oil (CCCO)
	EPA	OTS 798. 4900	Rat	Dermal	20 days Effects observed	Positive	-	-	Based on atmospheric residue
Residues (petroleum), hydrocracked	EPA	OTS 798. 4700	Rat	Dermal	70 days no effects observed	-	-	Negative	Based on Catalytic cracked clarified oil (CCCO)
	EPA	OTS 798. 4900	Rat	Dermal	20 days Effects observed	Positive	-	-	Based on atmospheric residue
Gas oils (petroleum), heavy vacuum	EPA	OTS 798. 4700	Rat	Dermal	70 days	-	-	Negative	no effects observed (Based on Catalytic cracked clarified oil (CCCO))
	EPA	OTS 798. 4900	Rat	Dermal	20 days	Positive	-	-	Effects observed (Based on atmospheric residue)
Distillates (petroleum), light catalytic cracked	not guideline	-	Rat	Dermal	31 days Effects observed at maternally toxic doses.	-	-	Negative	Based on light coker gas oil
	not guideline	-	Rat	Dermal	31 days	Negative	-	-	Based on light coker gas oil

Specific target organ toxicity

Product / Ingredient Name	Hazard	Test authority / Test number		Species	Route	Type	Dose	Exposure	Target organs	Remarks
Fuel oil, residual	STOT - RE	Equivalent to EPA	OPPTS 870. 3250	Rat	Dermal	LOAEL	20 to 200 mg/kg	90 days	liver blood	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	Equivalent to OECD	401	Rat	Oral	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	EPA	OTS 798. 1150	Rat	Inhalation	LOAEL	10 to 20 mg/l	4 hours	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	OECD	434	Rabbit	Dermal	LOAEL	>2000 mg/kg	-	-	Based on Catalytic

SECTION 11: Toxicological information

										cracked clarified oil (CCCO)
Residues (petroleum), atmospheric	STOT - RE	Equivalent to EPA	OPPTS 870. 3250	Rat	Dermal	LOAEL	20 to 200 mg/kg	90 days	liver blood	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	Equivalent to OECD	401	Rat	Oral	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	EPA	OTS 798. 1150	Rat	Inhalation	LOAEL	10 to 20 mg/l	4 hours	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	OECD	434	Rabbit	Dermal	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
Residues (petroleum), hydrocracked	STOT - RE	Equivalent to EPA	OPPTS 870. 3250	Rat	Dermal	LOAEL	20 to 200 mg/kg	90 days	liver blood	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	Equivalent to OECD	401	Rat	Oral	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	EPA	OTS 798. 1150	Rat	Inhalation	LOAEL	10 to 20 mg/l	4 hours	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	OECD	434	Rabbit	Dermal	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
Gas oils (petroleum), heavy vacuum	STOT - RE	Equivalent to EPA	OPPTS 870. 3250	Rat	Dermal	LOAEL	20 to 200 mg/kg	90 days	liver blood	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	Equivalent to OECD	401	Rat	Oral	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	EPA	OTS 798. 1150	Rat	Inhalation	LOAEL	10 to 20 mg/l	4 hours	-	Based on Catalytic cracked clarified oil (CCCO)
	STOT - SE	Equivalent to OECD	434	Rabbit	Dermal	LOAEL	>2000 mg/kg	-	-	Based on Catalytic cracked clarified oil (CCCO)
Distillates (petroleum), light catalytic cracked	STOT - RE	Equivalent to OECD	410	Rabbit	Dermal	NOAEL	>200 mg/kg bw/day	28 days	blood	Based on light catalytically cracked distillate
	STOT - RE	Equivalent to OECD	411	Rat	Dermal	NOAEL	20 to 200 mg/kg bw/day	90 days	liver Thymus	Based on light catalytically cracked

SECTION 11: Toxicological information

									distillate
STOT - RE	Equivalent to OECD	411	Rat	Dermal	LOAEL	20 to 200 mg/kg bw/day	90 days	blood kidneys	Based on coker light gas oil
STOT - SE	Equivalent to OECD	401	Rat	Oral	LOAEL	>2000 mg/kg bw	90 days	-	Based on Catalytic cracked clarified oil (CCCO)
STOT - SE	Equivalent to OECD	402	Rabbit	Dermal	LOAEL	>2000 mg/kg bw	90 days	-	Based on Catalytic cracked clarified oil (CCCO)
STOT - RE	Equivalent to OECD	413	Rat	Inhalation	NOAEL	>0.2 mg/l 6 hours	13 weeks	-	Based on Diesel fuel
STOT - RE	Equivalent to OECD	403	Rat	Inhalation	LOAEL	>5 mg/l 4 hours	4 hours	-	Based on Catalytic cracked clarified oil (CCCO)

Information on the likely routes of exposure Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation Harmful by inhalation.

Ingestion No known significant effects or critical hazards.

Skin contact Irritating to skin. Will cause burns if hot material contacts skin.

Eye contact Will cause burns if hot material contacts eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Ingestion Adverse symptoms may include the following:
reduced foetal weight
increase in foetal deaths
skeletal malformations

Skin contact Adverse symptoms may include the following:
irritation
redness

Eye contact No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Inhalation Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer. May be harmful by inhalation if exposure to vapour, mists or fumes resulting from thermal decomposition products occurs. Vapour, mist or fume may irritate the nose, mouth and respiratory tract.

Ingestion If swallowed, may irritate the mouth, throat and digestive system. If swallowed, may cause abdominal pain, stomach cramps, nausea, vomiting and diarrhoea.

Skin contact As with all such products containing potentially harmful levels of PCAs, prolonged or repeated skin contact may eventually result in dermatitis or more serious irreversible skin disorders including cancer.

Eye contact Potential risk of transient stinging or redness if accidental eye contact occurs. Vapour, mist or fume may cause eye irritation. Exposure to vapour, mist or fume may cause stinging, redness and watering of the eyes.

Potential chronic health effects

General Harmful: danger of serious damage to health by prolonged exposure in contact with skin. Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer.

Carcinogenicity May cause cancer. Risk of cancer depends on duration and level of exposure.

Mutagenicity No known significant effects or critical hazards.

Developmental effects Possible risk of harm to the unborn child.

Fertility effects No known significant effects or critical hazards.

SECTION 12: Ecological information

12.1 Toxicity

Product/ingredient name	Test authority / Test number		Species	Type / Result	Exposure	Effects	Remarks
Fuel oil, residual	OECD	202	Daphnia	Acute EL50 2 mg/l Nominal Fresh water	48 hours	Mobility	Based on Heavy fuel oil
	OECD	203	Fish	Acute LL50 79 mg/l Nominal Fresh water	96 hours	-	Based on residual fuel oil
	Modelled data	-	Daphnia	Chronic NOEL 0.27 mg/l Nominal Fresh water	21 days	Reproduction	-
	Modelled data	-	Fish	Chronic NOEL 0.1 mg/l Nominal Fresh water	28 days	Mortality	-
Residues (petroleum), atmospheric	OECD	202	Daphnia	Acute EL50 2 mg/l Nominal Fresh water	48 hours	Mobility	Based on Heavy fuel oil
	OECD	203	Fish	Acute LL50 79 mg/l Nominal Fresh water	96 hours	-	Based on residual fuel oil
	Modelled data	-	Daphnia	Chronic NOEL 0.27 mg/l Nominal Fresh water	21 days	Reproduction	-
	Modelled data	-	Fish	Chronic NOEL 0.1 mg/l Nominal Fresh water	28 days	Mortality	-
Residues (petroleum), hydrocracked	OECD	202	Daphnia	Acute EL50 2 mg/l Nominal Fresh water	48 hours	Mobility	Based on Heavy fuel oil
	OECD	203	Fish	Acute LL50 79 mg/l Nominal Fresh water	96 hours	-	Based on residual fuel oil
	Modelled data	-	Daphnia	Chronic NOEL 0.27 mg/l Nominal Fresh water	21 days	Reproduction	-
	Modelled data	-	Fish	Chronic NOEL 0.1 mg/l Nominal Fresh water	28 days	Mortality	-
Gas oils (petroleum), heavy vacuum	OECD	202	Daphnia	Acute EL50 2 mg/l Nominal Fresh water	48 hours	Mobility	Based on Heavy fuel oil
	OECD	203	Fish	Acute LL50 79 mg/l Nominal Fresh water	96 hours	-	Based on residual fuel oil
	Modelled data	-	Daphnia	Chronic NOEL 0.27 mg/l Nominal Fresh water	21 days	Reproduction	-
	Modelled data	-	Fish	Chronic NOEL 0.1 mg/l Nominal Fresh water	28 days	Mortality	-
Distillates (petroleum), light catalytic cracked	Modelled data	-	Algae	Acute EL50 0.202 mg/l Nominal Fresh water	72 hours	(growth rate)	-
	Modelled data	-	Daphnia	Acute EL50 0.319 mg/l Nominal Fresh water	48 hours	Mobility	-
	Modelled data	-	Other	Acute EL50 1.954 mg/l Nominal Fresh water	40 hours	growth inhibition	-
	Modelled data	-	Fish	Acute LL50 0.156 mg/l Nominal Fresh water	96 hours		-
	Modelled data	-	Other	Acute NOEL 0.241 mg/l Nominal Fresh water	40 hours	growth inhibition	-
	not guideline	-	Other	Chronic NOAEL 5000 ppm Fresh water	18 weeks	Growth	-
	Modelled data	-	Daphnia	Chronic NOEL 0.053 mg/l Nominal Fresh water	21 days	Immobilisation	-
	Modelled data	-	Fish	Chronic NOEL 0.029 mg/l Nominal Fresh water	14 days	Mortality	-

Environmental hazards Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

12.2 Persistence and degradability

Partially biodegradable.

12.3 Bioaccumulative potential

This product is not expected to bioaccumulate through food chains in the environment.

SECTION 12: Ecological information

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC}) Not available.

Mobility Spillages may penetrate the soil causing ground water contamination. This material may accumulate in sediments.

12.5 Results of PBT and vPvB assessment

PBT Not applicable.

vPvB Not applicable.

12.6 Other adverse effects

Other ecological information This product has a density close to that of water. If released to water the product may sink. Spills are unlikely to form a distinct film on the water surface, and may become dispersed as globules if mixed or agitated.

SECTION 13: Disposal considerations

The information in this section contains generic advice and guidance. The list of Identified Uses in Section 1 should be consulted for any available use-specific information provided in the Exposure Scenario(s).

13.1 Waste treatment methods

Product

Methods of disposal The generation of waste should be avoided or minimised wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

Hazardous waste Yes.

European waste catalogue (EWC)

Waste code	Waste designation
13 07 01*	fuel oil and diesel

However, deviation from the intended use and/or the presence of any potential contaminants may require an alternative waste disposal code to be assigned by the end user.

Packaging

Methods of disposal Dispose of via an authorised person/ licensed waste disposal contractor in accordance with local regulations. Recycle, if possible.

Special precautions This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Empty containers represent a fire hazard as they may contain flammable product residues and vapour. Never weld, solder or braze empty containers. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

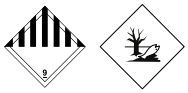
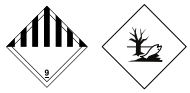
Other information Empty packages may contain some remaining product. Hazard warning labels are a guide to the safe handling of empty packaging and should not be removed.

Empty containers represent a fire hazard as they may contain flammable product residues and vapour. Never weld, solder or braze containers unless they are cleaned and do not contain flammable vapours and residues.

At sea, used or unwanted product should be stored for eventual discharge into port approved waste oil disposal facilities.

Dusts generated during the removal of ash deposits from engine/boiler combustion surfaces or exhaust spaces, will be harmful if inhaled and may cause nausea and eye, nose and throat irritation. Repeated contact may result in serious irreversible disorders.
Before working in combustion/exhaust spaces or handling fuel oil ash/dust the area should be thoroughly damped down with water. If this is not possible, wear full breathing apparatus or positive pressure filter sets. Protective clothing must always be worn. When inspecting combustion/exhaust spaces, wear full face dust respirator and protective clothing.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	UN 3082	UN 3082	UN 3082	UN 3082
14.2 UN proper shipping name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Heavy fuel oil)	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Heavy fuel oil)	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.. Marine pollutant (Heavy fuel oil)	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Heavy fuel oil)
14.3 Transport hazard class(es)	9 	9 	9 	9 
14.4 Packing group	III	III	III	III
14.5 Environmental hazards	Yes.	Yes.	Yes.	No.
Additional information	**Hazard identification number** 90 **Tunnel code** E	**Remarks** Table:C.Danger: 9+ (N1, CMR, F or S).	**Emergency schedules (EmS)** F-A, S-F	-

14.6 Special precautions for user Not available.

ADR/RID Classification code: M6

ADN Classification code: M6

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code **Proper shipping name** MARPOL Annex 1 rules apply for bulk shipments by sea.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles Restricted to professional users.

Other regulations

REACH Status The company, as identified in Section 1, sells this product in the EU in compliance with the current requirements of REACH.

United States inventory (TSCA 8b) Not determined.

Australia inventory (AICS) Not determined.

Canada inventory Not determined.

China inventory (IECSC) Not determined.

Japan inventory (ENCS) Not determined.

Korea inventory (KECI) Not determined.

SECTION 15: Regulatory information

Philippines inventory (PICCS) Not determined.

National regulations

15.2 Chemical Safety Assessment Not applicable.

SECTION 16: Other information

Abbreviations and acronyms

ADN = European Provisions concerning the International Carriage of Dangerous Goods by Inland Waterway
ADR = The European Agreement concerning the International Carriage of Dangerous Goods by Road
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
CAS = Chemical Abstracts Service
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
CSA = Chemical Safety Assessment
CSR = Chemical Safety Report
DMEL = Derived Minimal Effect Level
DNEL = Derived No Effect Level
DPD = Dangerous Preparations Directive [1999/45/EC]
DSD = Dangerous Substances Directive [67/548/EEC]
EINECS = European Inventory of Existing Commercial chemical Substances
ES = Exposure Scenario
EUH statement = CLP-specific Hazard statement
EWC = European Waste Catalogue
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
OECD = Organisation for Economic Co-operation and Development
PBT = Persistent, Bioaccumulative and Toxic
PNEC = Predicted No Effect Concentration
RID = The Regulations concerning the International Carriage of Dangerous Goods by Rail
RRN = REACH Registration Number
SADT = Self-Accelerating Decomposition Temperature
SVHC = Substances of Very High Concern
STOT-RE = Specific Target Organ Toxicity - Repeated Exposure
STOT-SE = Specific Target Organ Toxicity - Single Exposure
TWA = Time weighted average
UN = United Nations
UVCB = Complex hydrocarbon substance
VOC = Volatile Organic Compound
vPvB = Very Persistent and Very Bioaccumulative

Full text of abbreviated H statements

H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H332	Harmful if inhaled.
H350	May cause cancer.
H361d	Suspected of damaging the unborn child.
H373	May cause damage to organs through prolonged or repeated exposure.
H410	Very toxic to aquatic life with long lasting effects.

Full text of classifications [CLP/GHS]

Acute Tox. 4, H332	ACUTE TOXICITY: INHALATION - Category 4
Aquatic Chronic 1, H410	LONG-TERM AQUATIC HAZARD - Category 1
Asp. Tox. 1, H304	ASPIRATION HAZARD - Category 1
Carc. 1B, H350	CARCINOGENICITY - Category 1B
Repr. 2, H361d	TOXIC TO REPRODUCTION [Unborn child] - Category 2
Skin Irrit. 2, H315	SKIN CORROSION/IRRITATION - Category 2
STOT RE 2, H373	SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 2 SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) [blood system and liver] - Category 2

SECTION 16: Other information

Full text of abbreviated R phrases

R45- May cause cancer.
R63- Possible risk of harm to the unborn child.
R20- Also harmful by inhalation.
R48/21- Also harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R65- Also harmful: may cause lung damage if swallowed.
R38- Irritating to skin.
R66- Repeated exposure may cause skin dryness or cracking.
R50/53- Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Full text of classifications [DSD/DPD]

Carc. Cat. 2 - Carcinogen category 2
Repr. Cat. 3 - Toxic to reproduction category 3
Xn - Harmful
Xi - Irritant
N - Dangerous for the environment

History

Date of issue/ Date of revision 30/05/2013.

Date of previous issue 15/07/2011.

Prepared by Product Stewardship

Indicates information that has changed from previously issued version.

Notice to reader

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.

The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from BP Group.

It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken. You can contact the BP Group to ensure that this document is the most current available. Alteration of this document is strictly prohibited.

Annex to the extended Safety Data Sheet (eSDS)

Industrial

Identification of the substance or mixture

Product definition	Mixture
Code	SBX2296
Product name	Residual Fuel Oil (Flashpoint > 100°C) - Blended

Section 1:: Title

Short title of the exposure scenario	Heavy Fuel Oil Use of Substance as a Fuel - Industrial
List of use descriptors	**Identified use name:** Use as a fuel - Industrial **Process Category:** PROC01, PROC02, PROC03, PROC08a, PROC08b, PROC16 **Sector of end use:** SU03 **Subsequent service life relevant for that use:** No. **Environmental Release Category:** ERC07 **Specific Environmental Release Category:** ESVOC SpERC 7.12a.v1
Processes and activities covered by the exposure scenario	Covers the use as a fuel (or fuel additives and additive components) within closed or contained systems, including incidental exposures during activities associated with its transfer, use, equipment maintenance and handling of waste.
Assessment Method	See Section 3

Section 2: Operational conditions and risk management measures

Section 2.1: Control of worker exposure

Product characteristics:

Physical state:	Liquid, vapour pressure < 0.5 kPa at STP.
Concentration of substance in product:	Covers percentage substance in the product up to 100% (unless stated differently).
Frequency and duration of use:	Covers daily exposures up to 8 hours (unless stated differently).
Other given operational conditions affecting workers exposure:	Assumes use at not more than 20°C above ambient temperature, unless stated differently. Assumes a good basic standard of occupational hygiene is implemented.

Contributing scenarios: Operational conditions and risk management measures

General measures (carcinogens): Consider technical advances and process upgrades (including automation) for the elimination of releases.
Minimise exposure using measures such as closed systems, dedicated facilities and suitable general/local exhaust ventilation.
Drain down systems and clear transfer lines prior to breaking containment.
Clean/flush equipment, where possible, prior to maintenance.
Where there is potential for exposure: restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.
Ensure safe systems of work or equivalent arrangements are in place to manage risks.
Regularly inspect, test and maintain all control measures.
Consider the need for risk-based health surveillance.

General exposures (closed systems): Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

General exposures (closed systems) Product sampling: Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out activities involving exposure for more than 1 hour. Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

bulk closed unloading Outdoor.: Transfer via enclosed lines. Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Drum/batch transfers: Ensure material transfers are under containment or extract ventilation. or Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Avoid carrying out activities involving exposure for more than 1 hour. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic'

employee training.

Operation of solids filtering equipment: Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Bulk product storage: Store substance within a closed system. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Use as a fuel (closed systems): Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Equipment cleaning and maintenance: Drain down system prior to equipment break-in or maintenance. Wear chemical-resistant gloves (tested to EN374) in combination with specific activity training. Retain drain-downs in sealed storage pending disposal or for subsequent recycle.

Section 2.2:: Control of environmental exposure

Product characteristics:	Substance is complex UVCB Predominantly hydrophobic
Amounts used:	
Fraction of EU tonnage used in region:	0.1
Regional use tonnage (tonnes/year):	1.1e7
Fraction of Regional tonnage used locally:	1.4e-1
Annual site tonnage (tonnes/year):	1.5e6
Maximum daily site tonnage (kg/day):	5.0e6
Frequency and duration of use:	Continuous release.
Emission Days (days/year):	300
Environment factors not influenced by risk management:	
Local freshwater dilution factor:	10
Local marine water dilution factor:	100
Release fraction to air from process (initial release prior to RMM):	7.0e-4
Release fraction to soil from process (initial release prior to RMM):	0
Release fraction to wastewater from process (initial release prior to RMM):	4.4e-7
Technical conditions and measures at process level (source) to prevent release:	Common practices vary across sites thus conservative process release estimates used.
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil:	Risk from environmental exposure is driven by freshwater sediment. On-site wastewater treatment required. Prevent discharge of undissolved substance to or recover from onsite wastewater.
Treat air emission to provide a typical removal efficiency of (%):	95
Treat on-site wastewater (prior to receiving water discharge) to provide the required removal efficiency of [3] (%):	87.7
If discharging to domestic sewage treatment plant, provide the required onsite wastewater removal efficiency of [3] (%):	0
Organisational measures to prevent/limit release from site:	Do not apply industrial sludge to natural soils. sludge should be incinerated, contained or reclaimed.
Conditions and measures related to municipal sewage treatment plant:	
Estimated substance removal from wastewater via on-site sewage treatment (%):	88.8
Total efficiency of removal from wastewater after on-site and off-site (domestic treatment plant) RMMs (%):	88.8
Maximum allowable site tonnage (M_{Safe}) based on release following total wastewater treatment removal (kg/d):	5.2e6
Assumed on-site sewage treatment plant flow (m^3/d):	2000

Conditions and measures related to external treatment of waste for disposal:	Combustion emissions limited by required exhaust emission controls. Combustion emissions considered in regional exposure assessment.
Conditions and measures related to external recovery of waste:	This substance is consumed during use and no waste from the substance is generated.
RCR - Air Compartment Driven:	5.73E-01
RCR - Water Compartment Driven:	9.09E-01

Section 3:: Exposure estimation

Exposure estimation and reference to its source - Environment	
Exposure assessment (environment):	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model.

Exposure estimation and reference to its source - Workers	
Exposure assessment (human):	Not available.

Section 4:: Guidance to check compliance with the exposure scenario

Environment	Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures. Required removal efficiency for wastewater can be achieved using onsite/ offsite technologies, either alone or in combination. Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination. Further details on scaling and control technologies are provided in SpERC factsheet.
Health	Predicted exposures are not expected to exceed the DN(M)EL when the Risk Management Measures/Operational Conditions outlined in Section 2 are implemented. Where other Risk Management Measures/Operational Conditions are adopted, then users should ensure that risks are managed to at least equivalent levels. Available hazard data do not enable the derivation of a DNEL for carcinogenic effects. Available hazard data do not support the need for a DNEL to be established for other health effects. Risk Management Measures are based on qualitative risk characterisation.

Annex to the extended Safety Data Sheet (eSDS)

Professional

Identification of the substance or mixture

Product definition	Mixture
Code	SBX2296
Product name	Residual Fuel Oil (Flashpoint > 100°C) - Blended

Section 1:: Title

Short title of the exposure scenario	Heavy Fuel Oil Use of Substance as a Fuel - Professional
List of use descriptors	**Identified use name:** Use as a fuel - Professional **Process Category:** PROC01, PROC02, PROC03, PROC08a, PROC08b, PROC16 **Sector of end use:** SU22 **Subsequent service life relevant for that use:** No. **Environmental Release Category:** ERC09a, ERC09b **Specific Environmental Release Category:** ESVOC SpERC 9.12b.v1
Processes and activities covered by the exposure scenario	Covers the use as a fuel (or fuel additives and additive components) within closed or contained systems, including incidental exposures during activities associated with its transfer, use, equipment maintenance and handling of waste.
Assessment Method	See Section 3

Section 2: Operational conditions and risk management measures

Section 2.1: Control of worker exposure

Product characteristics:

Physical state:	Liquid, vapour pressure < 0.5 kPa at STP.
Concentration of substance in product:	Covers percentage substance in the product up to 100% (unless stated differently).
Frequency and duration of use:	Covers daily exposures up to 8 hours (unless stated differently).
Other given operational conditions affecting workers exposure:	Assumes use at not more than 20°C above ambient temperature, unless stated differently. Assumes a good basic standard of occupational hygiene is implemented.

Contributing scenarios: Operational conditions and risk management measures

General measures (carcinogens): Consider technical advances and process upgrades (including automation) for the elimination of releases.
Minimise exposure using measures such as closed systems, dedicated facilities and suitable general/local exhaust ventilation.
Drain down systems and clear transfer lines prior to breaking containment.
Clean/flush equipment, where possible, prior to maintenance.
Where there is potential for exposure: restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.
Ensure safe systems of work or equivalent arrangements are in place to manage risks.
Regularly inspect, test and maintain all control measures.
Consider the need for risk-based health surveillance.

General exposures (closed systems) Product sampling: Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out activities involving exposure for more than 1 hour. Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Wear chemical-resistant gloves (tested to EN374) in combination with specific activity training.

General exposures (closed systems): Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out activities involving exposure for more than 1 hour. Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

bulk closed unloading: Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training. Avoid carrying out activities involving exposure for more than 1 hour. or Ensure material transfers are under containment or extract ventilation.

Drum/batch transfers: Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Wear

chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training. Avoid carrying out activities involving exposure for more than 1 hour. or Ensure material transfers are under containment or extract ventilation.

refuelling: Ensure material transfers are under containment or extract ventilation. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training. Avoid carrying out activities involving exposure for more than 1 hour.

Use as a fuel (closed systems): Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Equipment cleaning and maintenance: Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear chemical-resistant gloves (tested to EN374) in combination with specific activity training. Drain down system prior to equipment break-in or maintenance. Retain drain-downs in sealed storage pending disposal or for subsequent recycle. Clear spills immediately.

Section 2.2:: Control of environmental exposure

Product characteristics:	Substance is complex UVCB Predominantly hydrophobic
Amounts used:	
Fraction of EU tonnage used in region:	0.1
Regional use tonnage (tonnes/year):	3.3e5
Fraction of Regional tonnage used locally:	5.0e-4
Annual site tonnage (tonnes/year):	1.7e2
Maximum daily site tonnage (kg/day):	4.6e2
Frequency and duration of use:	Continuous release.
Emission Days (days/year):	365
Environment factors not influenced by risk management:	
Local freshwater dilution factor:	10
Local marine water dilution factor:	100
Technical conditions and measures at process level (source) to prevent release:	Common practices vary across sites thus conservative process release estimates used.
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil:	Risk from environmental exposure is driven by humans via indirect exposure (primarily ingestion). No wastewater treatment required.
Treat air emission to provide a typical removal efficiency of (%):	Not applicable.
Treat on-site wastewater (prior to receiving water discharge) to provide the required removal efficiency of [3] (%):	0
If discharging to domestic sewage treatment plant, provide the required onsite wastewater removal efficiency of [3] (%):	0
Organisational measures to prevent/limit release from site:	Do not apply industrial sludge to natural soils. sludge should be incinerated, contained or reclaimed.
Conditions and measures related to municipal sewage treatment plant:	
Estimated substance removal from wastewater via on-site sewage treatment (%):	88.8
Total efficiency of removal from wastewater after on-site and off-site (domestic treatment plant) RMMs (%):	88.8
Maximum allowable site tonnage (M_{Safe}) based on release following total wastewater treatment removal (kg/d):	2.3e3
Assumed on-site sewage treatment plant flow (m^3/d):	2000
Conditions and measures related to external treatment of waste for disposal:	Combustion emissions limited by required exhaust emission controls. Combustion emissions considered in regional exposure assessment.
Conditions and measures related to external recovery of waste:	This substance is consumed during use and no waste from the substance is generated.
RCR - Air Compartment Driven:	2.67E-02
RCR - Water Compartment Driven:	1.71E-01

Section 3:: Exposure estimation

Exposure estimation and reference to its source - Environment	
Exposure assessment (environment):	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model.

Exposure estimation and reference to its source - Workers	
Exposure assessment (human):	The ECETOC TRA tool has been used to estimate workplace exposures unless otherwise indicated.

Section 4:: Guidance to check compliance with the exposure scenario

Environment	Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures. Required removal efficiency for wastewater can be achieved using onsite/ offsite technologies, either alone or in combination. Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination. Further details on scaling and control technologies are provided in SpERC factsheet.
Health	Predicted exposures are not expected to exceed the DN(M)EL when the Risk Management Measures/Operational Conditions outlined in Section 2 are implemented. Where other Risk Management Measures/Operational Conditions are adopted, then users should ensure that risks are managed to at least equivalent levels. Available hazard data do not enable the derivation of a DNEL for carcinogenic effects. Available hazard data do not support the need for a DNEL to be established for other health effects. Risk Management Measures are based on qualitative risk characterisation.

Annex to the extended Safety Data Sheet (eSDS)

Industrial

Identification of the substance or mixture

Product definition	Mixture
Code	SBX2296
Product name	Residual Fuel Oil (Flashpoint > 100°C) - Blended

Section 1:: Title

Short title of the exposure scenario	Heavy Fuel Oil Formulation and (Re)packing of Substance - Industrial
List of use descriptors	**Identified use name:** Formulation and (re)packing of substances and mixtures **Process Category:** PROC01, PROC02, PROC03, PROC08a, PROC08b, PROC15 **Sector of end use:** SU03, SU10 **Subsequent service life relevant for that use:** No. **Environmental Release Category:** ERC02 **Specific Environmental Release Category:** ESVOC SpERC 2.2.v1
Processes and activities covered by the exposure scenario	Formulation of the substance and its mixtures in batch or continuous operations within closed or contained systems, including incidental exposures during storage, materials transfers, mixing, maintenance, sampling and associated laboratory activities
Assessment Method	See Section 3

Section 2: Operational conditions and risk management measures

Section 2.1: Control of worker exposure

Product characteristics:

Physical state:	Liquid, vapour pressure < 0.5 kPa at STP.
Concentration of substance in product:	Covers percentage substance in the product up to 100% (unless stated differently).
Frequency and duration of use:	Covers daily exposures up to 8 hours (unless stated differently).
Other given operational conditions affecting workers exposure:	Assumes use at not more than 20°C above ambient temperature, unless stated differently. Assumes a good basic standard of occupational hygiene is implemented.

Contributing scenarios: Operational conditions and risk management measures

General measures (carcinogens): Consider technical advances and process upgrades (including automation) for the elimination of releases.
Minimise exposure using measures such as closed systems, dedicated facilities and suitable general/local exhaust ventilation.
Drain down systems and clear transfer lines prior to breaking containment.
Clean/flush equipment, where possible, prior to maintenance.
Where there is potential for exposure: restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.
Ensure safe systems of work or equivalent arrangements are in place to manage risks.
Regularly inspect, test and maintain all control measures.
Consider the need for risk-based health surveillance.

General exposures (closed systems) Process sampling: Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out activities involving exposure for more than 15 minutes. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

General exposures (closed systems): Handle substance within a closed system. Sample via a closed loop or other system to avoid exposure. Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Bulk product storage: Store substance within a closed system. Avoid carrying out operation for more than 4 hours. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Product sampling: Sample via a closed loop or other system to avoid exposure. Avoid carrying out activities involving exposure for more than 15 minutes. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic'

employee training.

Laboratory activities: Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. Wear suitable gloves tested to EN374.

marine vessel/barge (un)loading: Transfer via enclosed lines. Avoid carrying out operation for more than 4 hours. Clear transfer lines prior to de-coupling. Retain drain-downs in sealed storage pending disposal or for subsequent recycle. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

road tanker/rail car loading: Ensure material transfers are under containment or extract ventilation. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Drum/batch transfers: Ensure material transfers are under containment or extract ventilation. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). or Ensure operation is undertaken outdoors. Avoid carrying out activities involving exposure for more than 1 hour. Wear chemical-resistant gloves (tested to EN374) in combination with 'basic' employee training.

Equipment cleaning and maintenance: Drain down and flush system prior to equipment break-in or maintenance. Wear chemical-resistant gloves (tested to EN374) in combination with specific activity training. Retain drain-downs in sealed storage pending disposal or for subsequent recycle.

Section 2.2:: Control of environmental exposure

Product characteristics:	Substance is complex UVCB Predominantly hydrophobic
Amounts used:	
Fraction of EU tonnage used in region:	0.1
Regional use tonnage (tonnes/year):	1.1e7
Fraction of Regional tonnage used locally:	2.6e-3
Annual site tonnage (tonnes/year):	3.0e4
Maximum daily site tonnage (kg/day):	1.0e5
Frequency and duration of use:	Continuous release.
Emission Days (days/year):	300
Environment factors not influenced by risk management:	
Local freshwater dilution factor:	10
Local marine water dilution factor:	100
Release fraction to air from process (initial release prior to RMM):	2.2e-3
Release fraction to soil from process (initial release prior to RMM):	0.0001
Release fraction to wastewater from process (initial release prior to RMM):	5.0e-6
Technical conditions and measures at process level (source) to prevent release:	Common practices vary across sites thus conservative process release estimates used.
Technical on-site conditions and measures to reduce or limit discharges, air emissions and releases to soil:	Risk from environmental exposure is driven by humans via indirect exposure (primarily ingestion). If discharging to domestic sewage treatment plant, no onsite wastewater treatment required. Prevent discharge of undissolved substance to or recover from onsite wastewater.
Treat air emission to provide a typical removal efficiency of (%):	0
Treat on-site wastewater (prior to receiving water discharge) to provide the required removal efficiency of [3] (%):	54.0
If discharging to domestic sewage treatment plant, provide the required onsite wastewater removal efficiency of [3] (%):	0
Organisational measures to prevent/limit release from site:	Do not apply industrial sludge to natural soils. sludge should be incinerated, contained or reclaimed.
Conditions and measures related to municipal sewage treatment plant:	
Estimated substance removal from wastewater via on-site sewage treatment (%):	88.8
Total efficiency of removal from wastewater after on-site and off-site (domestic treatment plant) RMMs (%):	88.8

Maximum allowable site tonnage (M_{Safe}) based on release following total wastewater treatment removal (kg/d):	1.1e5
Assumed on-site sewage treatment plant flow (m^3/d):	2000
Conditions and measures related to external treatment of waste for disposal:	External treatment and disposal of waste should comply with applicable local and/or national regulations.
Conditions and measures related to external recovery of waste:	External recovery and recycling of waste should comply with applicable local and/or national regulations.
RCR - Air Compartment Driven:	7.19E-01
RCR - Water Compartment Driven:	2.43E-01

Section 3:: Exposure estimation

Exposure estimation and reference to its source - Environment	
Exposure assessment (environment):	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model.

Exposure estimation and reference to its source - Workers	
Exposure assessment (human):	The ECETOC TRA tool has been used to estimate workplace exposures unless otherwise indicated.

Section 4:: Guidance to check compliance with the exposure scenario

Environment	Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures. Required removal efficiency for wastewater can be achieved using onsite/ offsite technologies, either alone or in combination. Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination. Further details on scaling and control technologies are provided in SpERC factsheet.
Health	Predicted exposures are not expected to exceed the DN(M)EL when the Risk Management Measures/Operational Conditions outlined in Section 2 are implemented. Where other Risk Management Measures/Operational Conditions are adopted, then users should ensure that risks are managed to at least equivalent levels. Available hazard data do not enable the derivation of a DNEL for carcinogenic effects. Available hazard data do not support the need for a DNEL to be established for other health effects. Risk Management Measures are based on qualitative risk characterisation.

SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer:	**Shintech Louisiana, LLC** 3 Greenway Plaza, Suite 1150 Houston, TX 77046 (713) 965-0713
PRODUCT NAME:	**Vinyl Chloride Monomer**
CAS#:	75-01-4
Synonyms:	VCM, Vinyl Chloride Monomer; Monochloroethylene; Chloroethene; Chloroethylene; Ethylene
Product Use:	PVC Manufacturing
CHEMICAL FORMULA:	CH_2 CH Cl

For information regarding a chemical emergency involving a spill or leak, call:

24 — Hour Emergency Contact:

U.S.: 1-800-424-9300 — CHEMTREC

SECTION 2 – HAZARDS IDENTIFICATION

Global Harmonization System (GHS) Classification:

Category 2 Skin corrosion/irritation

Category 2 Eye damage/eye irritation

Category 1 Known human Carcinogen

Category 1 Specific target organ toxicity - Single and repeated exposure

National Fire Protection Association (NFPA) Rating Hazardous Materials Identification Systems (HMIS) Rating

	NFPA	HMIS	
Health	2	2	4 = Extreme/Severe ~~W~~ = Water Reactive
Fire	4	4	3 = High/Serious
Reactivity	2	1	2 = Moderate
			1 = Slight
			0 = Minimum

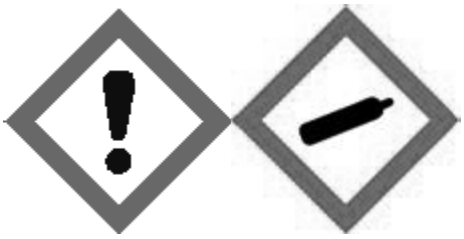
EMERGENCY OVERVIEW

Color:	Colorless
Odor:	Sweet
Physical State:	Compressed, Liquefied gas
Signal Word:	**DANGER**

DANGER! POISON! Extremely flammable liquid and vapor — Vapor may cause flash fire. May be fatal if inhaled. May cause frostbite. Inhalation may cause central nervous system effects and narcosis. May cause anesthetic effects. Possible cancer hazard. Keep upwind of spill. Vapor explosion hazard. Vapors may travel a long distance; ignition and/or flash back may occur. Flammable gas that is heavier than air. Stay out of low areas. Warn public of downwind explosion hazard. Elevated temperatures can cause hazardous polymerization. Eliminate ignition sources. Avoid temperatures above 400°C (752°F)

GHS Label Elements:





GHS Hazard Statements: May cause frostbite if contact is made with eyes and skin

Brief inhalation exposure (minutes) to easily attainable concentrations may cause serious adverse effects, even death

Has caused cancer in humans

OSHA Hazard Communication Standard: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

GHS Precautionary Statements:

Storage: Keep container closed and properly labeled.

Store in cool, dry place.

Avoid heat, flames, sparks and other sources of ignition.

Ventilation Controls: Do not breathe vapor.

Hygiene Measures: When using, do not smoke.

Avoid contact with skin and eyes.

Personal Protective Equipment: Wear suitable protective clothing, gloves, and eye/face protection.

First Aid: (See Section 4)

Environmental Protection: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

POTENTIAL HEALTH EFFECTS:

Inhalation: Mist may cause severe irritation of upper respiratory tract (nose and throat). May cause chemical burns to the respiratory tract.

Skin Contact: Brief contact may cause severe skin burns. Symptoms

may include pain, severe local redness and tissue damage.

Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts.

Eye Contact: May cause severe irritation with corneal injury which may result in permanent impairment of vision, even blindness. Chemical burns may occur. Mist may cause eye irritation.

Ingestion: Swallowing may result in burns of the mouth and throat. Swallowing may result in gastrointestinal irritation, ulceration, nausea and/or vomiting. Aspiration into the lungs may occur during ingestion or vomiting, causing tissue damage or lung injury.

Conditions Aggravated by Exposure: Respiratory disorders, pre-existing skin disorders, eye/vision disorders.

Target Organs Effected: Skin, Eyes, Respiratory System.

SECTION 3 – COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous ingredients (specific)	%	CAS Number
Vinyl Chloride	**>99.9**	75-01-4

SECTION 4 – FIRST AID MEASURES

INHALATION: Move person to fresh air. If not breathing, give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc.). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

SKIN CONTACT: Immediately flush skin with plenty of water for 15 minutes. Seek medical attention immediately. Liquid VCM may cause frostbite on contact.

INGESTION: Not a likely route of exposure.

EYE CONTACT: In case of frostbite, immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes,

	then continue flushing eyes for at least 15 minutes. Obtain medical attention promptly, preferably from an ophthalmologist.
NOTES TO PHYSICIAN:	Treat for frostbite if present. Maintain adequate ventilation and oxygenation of the patient. The following disease states have been observed in industrial workers exposed to vinyl chloride vapors: acroosteolysis, scleroderma, and Raynaud's phenomenon. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Stimulants such as epinephrine may induce ventricular fibrillation.

SECTION 5 – FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA:	Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam. Do not use direct water stream. Straight or direct water streams may not be effective to extinguish fire. Alcohol resistant foams (ATC type) are preferred. General purpose synthetic foams (including AFFF) or protein foams may function, but will be less effective.
FIRE FIGHTING PROCEDURES:	Keep people away. Isolate fire and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water may not be effective in extinguishing fire. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. Fight fire from protected location or safe distance. Consider the use of unmanned hose holders or monitor nozzles. Immediately withdraw all personnel from the area in case of rising sound from venting safety device or discoloration of the container. Do not use direct water stream. May spread fire. Eliminate ignition sources. Move container from fire area if this is possible without hazard. For tank, rail car or tank truck: Stop the leak if possible without personal risk. Let burn unless the leak can be stopped immediately. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage. Avoid accumulation of water. Product may be carried across water surface spreading fire or contacting an ignition source.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTERS:	Wear positive-pressure self-contained breathing apparatus (SCBA) and protective firefighting clothing (includes firefighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during firefighting operations. If contact is likely, change to full chemical resistant firefighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight fire from a remote location.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Container may vent and/or rupture due to fire. When product is stored in closed containers, a flammable atmosphere can develop. Electrically ground and bond all equipment. Flammable mixtures of this product are readily ignited even by static discharge. Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Flammable mixtures may exist within the vapor space of containers at room temperature. Flammable concentrations of vapor can accumulate at temperatures above flash point; see Section 9.
HAZARDOUS COMBUSTION PRODUCTS:	During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include and are not limited to: Hydrogen chloride. Carbon monoxide. Carbon dioxide. Combustion products may include trace amounts of: Phosgene

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Steps to be Taken if Material is Released or Spilled:	See Section 13, Disposal Considerations, for additional information. Pump with explosion-proof equipment. If available, use foam to smother or suppress. Knock down and dilute vapors with water fog or spray. Isolate area until gas has dispersed.
Personal Precautions:	Evacuate area. Keep upwind of spill. Keep personnel out of low areas. Ventilate area of leak or spill. No smoking in area. For large spills, warn public of downwind explosion hazard. Eliminate all sources of ignition in vicinity of spill or released vapor to avoid fire or explosion. Vapor explosion

	hazard. Keep out of sewers. Check area with combustible gas detector before reentering area. Ground and bond all containers and handling equipment.
Environmental Precautions:	Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

SECTION 7 – HANDLING AND STORAGE

HANDLING:

General Handling:	**General Handling:** Keep away from heat, sparks and flame. Avoid contact with eyes. Do not breathe vapor. Use with adequate ventilation. Keep container closed. No smoking, open flames or sources of ignition in handling and storage area. Electrically bond and ground all containers, personnel and equipment before transfer or use of material. Use of non-sparking or explosion-proof equipment may be necessary, depending upon the type of operation.
Other Precautions:	Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Never use air pressure for transferring product. Containers, even those that have been emptied, can contain vapors. Do not cut, drill, grind, weld, or perform similar operations on or near empty containers.
STORAGE REQUIREMENTS:	Store and handle in accordance with all current regulations and standards. Keep container tightly closed and properly labeled. Store in a cool, dry place. Do not enter confined spaces unless adequately ventilated. Avoid heat, flames, sparks and other sources of ignition. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Keep separated from incompatible substances.

SECTION 8 - EXPOSURE CONTROL / PERSONAL PROTECTION

EXPOSURE LIMITS

Vinyl Chloride:	1.0 ppm OSHA-PEL (8 Hour TWA) 5 ppm OSHA /STEL (Average, not exceeding any 15 minute period) 0.5 ppm OSHA action level

	1 ppm ACGIH-TLV (8 Hour TWA) 5 ppm (13 mg/m3) MEXICO TWA A "skin" notation following the exposure guideline refers to the potential for dermal absorption of the material including mucous membranes and the eyes either by contact with vapors or by direct skin contact. It is intended to alert the reader that inhalation may not be the only rouge of exposure and that measures to minimize dermal exposures should be considered.

PERSONAL PROTECTION

Eye/face Protection:	For handling the gas, wear safety glasses. When contact with the liquid (condensed gas) is possible, wear chemical goggles
Hand Protection:	Use gloves with insulation for thermal protection, when needed. Use gloves with insulation for thermal protection (EN 407), when needed.
Clothing:	Wear chemical resistant clothing to prevent skin contact.
Respiratory Protection:	Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required, a NIOSH approved respirator (29 CFR 1910.132, 1910.134 and 1910.1017) with organic vapor cartridges may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits, or when symptoms have been observed that are indicative of overexposure. Respirator must be selected based on the airborne levels found in the work place and must not exceed the working limits of the respirator. SHORT ORGANIC VAPOR CARTRIDGE SERVICE LIFE is anticipated.
Ingestion:	No precautions necessary due to the physical properties of the material.

ENGINEERING CONTROLS

Ventilation:	Provide local exhaust ventilation where vapor may be generated. All energized electrical equipment must be designed in accordance with the electrical classification of the area (e.g., Class I, Division I). Ensure compliance with applicable exposure limits. Use explosion proof ventilation

equipment.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Gas, Liquid
Physical Form	Compressed, liquefied gas
Color	Colorless
Odor	Sweet
Autoignition Temperature	472 °C (882 °F) *Literature*
Vapor pressure	2,524 mmHg @ 20 °*C Literature*
Boiling Point (760 mmHg)	-13.4 °C (7.9 °F) *Literature*
Vapor Density (air=1)	*2.2 Literature*
Specific Gravity (H_2O=1)	0.913 *Literature*
Flash Point – Open cup	-78°C (-108 °F) Cleveland Open Cup ASTM D92
Flammable Limits in Air	Lower: 3.6% *(V) Literature* Upper: 33.0%(V) *Literature*
Freezing Point	-153.8 °C (-244.8 °F) *Literature*
Melting Point	-153.8 °C (-244.8 °F) *Literature*
Solubility in Water (by weight)	*0.7 % Literature*
pH	Not applicable
Molecular Weight	62.5 g/mol
Evaporation Rate (Butyl Acetate =1)	1,000 High - gas
Kinematic Viscosity	No test data available
Volatility	100%
Odor Threshold	Not reliable to prevent excessive exposure
Evaporation Rate	>15
VOC	100%

SECTION 10 – STABILITY AND REACTIVITY

STABILITY/INSTABILITY: Stable under recommended storage conditions. See Storage, Section 7.

Conditions to Avoid:	Avoid contact with air (oxygen). Avoid temperatures above 400°C (752°F) Exposure to elevated temperatures can cause product to decompose. Avoid static discharge. Avoid moisture. Avoid open flames, welding arcs, or other high temperature sources which induce thermal decomposition. Avoid direct sunlight
Incompatibility (materials to avoid):	Avoid contact with: Air. Moist air. Oxygen. Strong oxidizers. Avoid contact with metals such as: Aluminum. Aluminum alloys. Copper.
Hazardous Polymerization:	Can occur. Elevated temperatures can cause hazardous polymerization. Polymerization can be catalyzed by: Air. Free radical initiators. Moisture. Oxygen. Sunlight.
Thermal Decomposition:	Decomposition products depend upon temperature, air supply and the presence of other materials. Decomposition products can include and are not limited to: Hydrogen chloride. Toxic gases are released during decomposition. Decomposition products can include trace amounts of: Phosgene.

SECTION 11 – TOXICOLOGICAL INFORMATION

Toxicity Data:	500 mg/kg oral-rat LD50; 180000 ppm/15 minute(s) inhalation-rat LC50
Carcinogen Status:	OSHA: Carcinogen; NTP: Known Human Carcinogen; !ARC: Human Sufficient Evidence, Animal Sufficient Evidence, Group 1
Local Effects:	Irritant: skin, eye
Acute Toxicity Level:	Toxic: ingestion; Relatively Non-toxic: inhalation.
Target Organs:	Central nervous system
Additional Data:	Long, latent period may exist between exposure and symptom onset. This material does not accumulate in the body and is readily eliminated.

HEALTH EFFECTS

INHALATION:

Acute Exposure: VINYL CHLORIDE: May be irritating. Exposure to 1,000-16,000 ppm may cause central nervous system depression with drowsiness, vertigo, staggering gait, tingling and numbness of hands and feet, impaired hearing and vision, cardiac arrhythmias and possibly unconsciousness; 20,000-25,000 ppm for 3-5 minutes may cause dizziness, lightheadedness, disorientation, nausea and burning sensation of the soles of the feet; and 120,000 ppm may be fatal.

Additional effects may include narcolepsy, headache, undue fatigue, muscle and joint pain, dyspnea, and anesthesia. Death may be due to respiratory paralysis with cardiac arrest. Human and animal pathologic reports show pulmonary edema, hyperemia of kidneys and liver and hepatic degeneration.

Chronic Exposure: VINYL CHLORIDE: Repeated exposure may result in dose-related sensory disorders, nervous system effects, blood system damage, hepatic-like liver changes, liver malfunction, impotence and pulmonary insufficiency. Workers overexposed to this material may exhibit symptoms of peripheral circulation changes resulting in pallor, cyanosis, redness, skin changes, and pseudo-clubbing of the fingers. Occupational overexposure has produced angiosarcomas of the liver. Animal studies show that vinyl chloride is carcinogenic in rats. This material does not bioaccumulate and is readily eliminated.

SKIN CONTACT:

Acute Exposure: VINYL CHLORIDE: Contact may cause irritation with redness and pain. Due to rapid evaporation, the liquid may cause thermal burns with redness, tingling, and pain or numbness. In more severe cases, the skin may become hard and white and develop blisters

Chronic Exposure: VINYL CHLORIDE: Workers overexposed to this material may exhibit symptoms of peripheral circulation changes resulting in pallor, cyanosis, redness, skin changes, and pseudo-clubbing of the fingers. Repeated or prolonged

exposure to irritants may cause dermatitis.

EYE CONTACT

Acute Exposure: VINYL CHLORIDE: Contact may cause immediate and severe irritation, and corneal injury with complete recovery in 48 hours. Due to rapid evaporation, the liquid may cause thermal burns with redness, pain and blurred vision.

Chronic Exposure: VINYL CHLORIDE: Repeated or prolonged exposure to irritants may cause conjunctivitis.

INGESTION

Acute Exposure: VINYL CHLORIDE: This is not a likely route of exposure. If the liquid is swallowed, thermal burns to the lips, mouth and mucous membranes may occur.

Chronic Exposure: VINYL CHLORIDE: This is not a likely route of exposure. Oral administration to rats, mice, and hamsters resulted in angiosarcomas of the liver.

SECTION 12 – ECOLOGICAL INFORMATION

ECOTOXICITY DATA

Fish toxicity: This material is practically non-toxic to fish on an acute basis (LC50>100mg/L).

FATE AND TRANSPORT:

Biodegradation: Biodegradation may occur under anaerobic conditions (in the absence of oxygen)

Persistence: Tropospheric half-life is estimated to be 23 hour(s).

Bioconcentration: Bioconcentration potential is low (BCF <100 or low Pow <3).

SECTION 13 – DISPOSAL CONSIDERATIONS

Reuse or reprocess if possible. Dispose in accordance with all applicable Federal, State/Provincial and local laws and regulations. Subject to disposal regulations: U.S.

EPA 40 CFR 262. Hazardous Waste Number(s): D001. U043. Waste characterization and compliance with applicable laws and regulations are the responsibility of the waste generator.

SHINTECH LOUISIANA, LLC HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN SDS SECTION.

SECTION 14 – TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:

Shipping Name	**Vinyl Chloride, Stabilized**
Hazard Class / Division	**2.1**
Identification No.	**UN1086**
Labeling Requirements	**2.1**
DOT Hazardous Substance(s)	**Vinyl Chloride 1 lb(s) (0.454 kg(s))**

Canadian Transportation of Dangerous Goods

Shipping Name: Vinyl Chloride, stabilized UN Number: UN 1086

Class: 2.1

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales *or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.*

SECTION 15 – REGULATORY INFORMATION

OSHA Hazard Communication Standard:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency

Planning and Community Right-to-Know Act of 1986 Sections 311 and 312

Immediate (Acute) Health Hazard	Yes
Delayed (Chronic) Health Hazard	Yes
Fire Hazard	Yes
Reactive Hazard	No
Sudden Release of Pressure Hazard	Yes

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313:

This product contains the following substances which are subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and which are listed in 40 CFR 372.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:

The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)

WARNING: This product contains a chemical(s) known to the State of California to cause cancer.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

US Toxic Substances Control All components of this product are on the TSCA Inventory or

Act: are exempt from TSCA Inventory requirements under 40 CFR 720.30.

Canada Inventory (DSL/NDSL): All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

SECTION 16 – OTHER INFORMATION

IMPORTANT: The information presented herein, while not guaranteed, was prepared by competent technical personnel and is true and accurate to the best of our knowledge. NO WARRANTY OF MERCHANT ABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTY OR GUARANTY OF ANY OTHER KIND, EXPRESS OR IMPLIED, IS MADE REGARDING PERFORMANCE, SUITABILITY, STABILITY OR OTHERWISE. The information included herein is not intended to be all-inclusive as to the appropriate manner and/or conditions of use, handling and/or storage. Factors pertaining to certain conditions of storage, handling, or use of this product may involve other or additional safety or performance considerations. While our technical personnel will be happy to respond to questions regarding safe handling and use procedures, safe handling and use remains the responsibility of the customer. No suggestions for use are intended to, and nothing herein shall be construed as a recommendation to, infringe any existing patents or violate any laws, rules, regulations or ordinances of any governmental entity.

Shintech Louisiana, LLC urges each customer or recipient of this SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as to the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product.

Revisions:

- **April 2014 – The MSDS was updated to follow new Global Harmonization Guidelines. The MSDS are now called Safety Data Sheets (SDS).**
- **January 2016 – Corrections to improve nomenclature and technical data.**

SDS Status: Revision Date: 01/08/2016

Supersedes: 04/11/2014

SAFETY DATA SHEET
according to the (US) Hazard Communication Standard (29 CFR 1910.1200)

Revision Date 05/18/2020 Version 1.3

SECTION 1.Identification

Product identifier

Product number	100958
Product name	Trichloroethylene EMPLURA®
CAS-No.	79-01-6

Relevant identified uses of the substance or mixture and uses advised against

Identified uses	Reagent for analysis, Chemical production

Details of the supplier of the safety data sheet

Company	EMD Millipore Corporation | 400 Summit Drive | Burlington | Massachusetts 01803 | United States of America | General Inquiries: +1 800-645-5476 | Monday to Friday, 9:00 AM to 4:00 PM Eastern Time (GMT-5) MilliporeSigma is a business of Merck KGaA, Darmstadt, Germany.
Emergency telephone	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2. Hazards identification

GHS Classification

Skin irritation, Category 2, H315
Eye irritation, Category 2A, H319
Skin sensitization, Category 1, H317
Germ cell mutagenicity, Category 2, H341
Carcinogenicity, Category 1B, H350
Specific target organ systemic toxicity - single exposure, Category 3, Central nervous system, H336

For the full text of the H-Statements mentioned in this Section, see Section 16.

GHS-Labeling

The life science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the US and Canada

Hazard pictograms



Signal Word
Danger

Hazard Statements
H350 May cause cancer.
H315 Causes skin irritation.
H317 May cause an allergic skin reaction.
H319 Causes serious eye irritation.
H336 May cause drowsiness or dizziness.
H341 Suspected of causing genetic defects.

Precautionary Statements
P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P261 Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P264 Wash skin thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P272 Contaminated work clothing should not be allowed out of the workplace.
P280 Wear protective gloves/ eye protection/ face protection.
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P304 + P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P321 Specific treatment (see supplemental first aid instructions on this label).
P333 + P313 If skin irritation or rash occurs: Get medical advice/ attention.
P337 + P313 If eye irritation persists: Get medical advice/ attention.
P362 Take off contaminated clothing and wash before reuse.
P403 + P233 Store in a well-ventilated place. Keep container tightly closed.
P405 Store locked up.
P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

None known.

SECTION 3. Composition/information on ingredients

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Chemical nature	Organic substance.	
Formula	Cl_2CCHCl	C_2HCl_3 (Hill)
Molar mass	131.39 g/mol	

Hazardous ingredients

Chemical name (Concentration)
CAS-No.
trichloroethylene (>= 90 % - <= 100 %)
79-01-6
Exact percentages are being withheld as a trade secret.

SECTION 4. First aid measures

Description of first-aid measures

Inhalation
After inhalation: fresh air. Call in physician.

Skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower. Consult a physician.

Eye contact
After eye contact: rinse out with plenty of water. Call in ophthalmologist. Remove contact lenses.

Ingestion
After swallowing: caution if victim vomits. Risk of aspiration! Keep airways free. Pulmonary failure possible after aspiration of vomit. Call a physician immediately. Laxative: Sodium sulfate (1 tablespoon/1/4 l water). activated charcoal (20 - 40 g in 10% slurry).

After swallowing: immediately make victim drink water (two glasses at most). Consult a physician.

Never give anything by mouth to an unconscious person.

Most important symptoms and effects, both acute and delayed

Cough, Shortness of breath, Dizziness, narcosis, agitation, spasms, inebriation, Nausea, Vomiting, Headache
irritant effects, Allergic reactions, somnolence, Drowsiness

Indication of any immediate medical attention and special treatment needed

No information available.

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SECTION 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

Special hazards arising from the substance or mixture

Not combustible.
Fire may cause evolution of:
Hydrogen chloride gas
Ambient fire may liberate hazardous vapors.

Advice for firefighters

Special protective equipment for fire-fighters
Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

Further information
Suppress (knock down) gases/vapors/mists with a water spray jet. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Do not breathe vapors, aerosols. Avoid substance contact. Ensure adequate ventilation. Evacuate the danger area, observe emergency procedures, consult an expert.

Advice for emergency responders:

Protective equipment see section 8.

Environmental precautions

Do not let product enter drains.

Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up carefully with liquid-absorbent material (e.g. Chemizorb®). Dispose of properly. Clean up affected area.

SECTION 7. Handling and storage

Precautions for safe handling

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Observe label precautions.

Work under hood. Do not inhale substance/mixture. Avoid generation of vapors/aerosols.

Conditions for safe storage, including any incompatibilities

Tightly closed. Keep in a well-ventilated place. Keep locked up or in an area accessible only to qualified or authorized persons.

Store at +5°C to +30°C (+41°F to +86°F).

SECTION 8. Exposure controls/personal protection

Exposure limit(s)

Components

Basis	Value	Threshold limits	Remarks
trichloroethylene 79-01-6			
ACGIH	Time Weighted Average (TWA):	10 ppm	
	Short Term Exposure Limit (STEL):	25 ppm	
NIOSH/GUIDE	Recommended exposure limit (REL):	25 ppm	
Z1A	Short Term Exposure Limit (STEL):	200 ppm 1,080 mg/m³	
	Time Weighted Average (TWA):	50 ppm 270 mg/m³	
OSHA/Z2	Time Weighted Average (TWA):	100 ppm	
	Ceiling Limit Value:	200 ppm	
	Maximum concentration:	300 ppm	Ceiling Limit Value 5 minutes in any 2 hours

Engineering measures

Technical measures and appropriate working operations should be given priority over the use of personal protective equipment.

Individual protection measures

Protective clothing should be selected specifically for the workplace, depending on concentration and quantity of the hazardous substances handled. The chemical resistance of the protective equipment should be inquired at the respective supplier.

Hygiene measures

Immediately change contaminated clothing. Apply skin- protective barrier cream.
Wash hands and face after working with substance.

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Eye/face protection
Safety glasses

Hand protection
Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Other protective equipment:
protective clothing

Respiratory protection
required when vapors/aerosols are generated.

required when vapors/aerosols are generated.

SECTION 9. Physical and chemical properties

Physical state	liquid
Color	colorless
Odor	characteristic
Odor Threshold	28 - 2160 ppm
pH	No information available.
Melting point	-120.6 °F (-84.8 °C) at 1,013 hPa
Boiling point/boiling range	189 °F (87 °C) at 1,013 hPa
Flash point	does not flash
Evaporation rate	No information available.
Flammability (solid, gas)	No information available.
Lower explosion limit	No information available.

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Upper explosion limit	No information available.
Vapor pressure	77 hPa at 68 °F (20 °C)
Relative vapor density	4.53
Density	1.46 g/cm3 at 68 °F (20 °C)
Relative density	No information available.
Water solubility	1.28 g/l at 77 °F (25 °C)
Partition coefficient: n-octanol/water	log Pow: 2.53 (20 °C) Bioaccumulation is not expected. (ECHA)
Autoignition temperature	No information available.
Decomposition temperature	> 230 °F (> 110 °C)
Viscosity, dynamic	0.55 mPa.s at 77 °F (25 °C)
Explosive properties	Not classified as explosive.
Oxidizing properties	none
Ignition temperature	770 °F (410 °C)

SECTION 10. Stability and reactivity

Reactivity

See below

Chemical stability

heat-sensitive
The product is chemically stable under standard ambient conditions (room temperature) .

Possibility of hazardous reactions

Violent reactions possible with:

Oxygen, (as liquefied gas)

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Alkaline earth metals, alkali amides, semimetallic hydrogen compounds, perchloric acid, Light metals, aluminum chloride, Strong oxidizing agents, Potassium nitrate

Risk of explosion with:

Alkali metals, Aluminum, Barium, alkali hydroxides, Lithium, magnesium, Powdered metals, sodium amide, Strong oxidizing agents, nitrogen dioxide, Boranes

Oxygen, with, alkali hydroxides

Oxygen, with, Pressure

Risk of ignition or formation of inflammable gases or vapors with:

Titanium, Beryllium, Epoxy constituents

Conditions to avoid

Strong heating (decomposition).
Distillation (Risk of explosion).
no information available

Incompatible materials

various plastics

Hazardous decomposition products

in the event of fire: See section 5.

SECTION 11. Toxicological information

Information on toxicological effects

Likely route of exposure
Inhalation, Eye contact, Skin contact

Target Organs
Eyes
Skin
Respiratory system
Heart
Liver
Kidneys
Central nervous system

Acute oral toxicity
LD50 Rat: 5,400 - 7,200 mg/kg (ECHA)

absorption
Symptoms: Nausea, Vomiting, Risk of aspiration upon vomiting., Aspiration may cause pulmonary edema and pneumonitis.

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Acute inhalation toxicity
LC50 Rat: 64.42 mg/l12500 ppm; 4 h ; vapor
(ECHA)

Symptoms: Possible damages:, mucosal irritations, After a latency period:, Lung edema

Acute dermal toxicity
LD50 Rabbit: > 20,000 mg/kg
(ECHA)

absorption

Skin irritation
Rabbit
Result: irritating
OECD Test Guideline 404

Drying-out effect resulting in rough and chapped skin.
Causes skin irritation.

Eye irritation
Rabbit
Result: Eye irritation
(IUCLID)

Causes serious eye irritation.

Sensitization
Local lymph node assay (LLNA) Mouse
Result: positive
Method: OECD Test Guideline 429

May cause an allergic skin reaction.

Genotoxicity in vivo
Chromosome aberration test
Rat
Result: negative
Method: OECD Test Guideline 474

Genotoxicity in vitro
Ames test
Salmonella typhimurium
Result: negative
Method: OECD Test Guideline 471

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Mutagenicity (mammal cell test): chromosome aberration.
Chinese hamster ovary cells
Result: negative
(ECHA)

Ames test
Escherichia coli
Result: negative
(Lit.)

CMR effects
Mutagenicity:Suspected of causing genetic defects.
Carcinogenicity:May cause cancer.

Specific target organ systemic toxicity - single exposure
May cause drowsiness or dizziness.
Target Organs: Central nervous system

Specific target organ systemic toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
Regarding the available data the classification criteria are not fulfilled.

Carcinogenicity

IARC	Group 1: Carcinogenic to humans	
	trichloroethylene	79-01-6
OSHA	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.	
NTP	Anticipated carcinogen.	
	trichloroethylene	79-01-6
ACGIH	A2: Suspected human carcinogen	
	trichloroethylene	79-01-6

Further information
After absorption:
Headache, Dizziness, Cardiac irregularities, Nausea, agitation, spasms, inebriation, narcosis
Absorption can result in damage to:
Liver, Kidney
After long-term exposure to the chemical:
Toxic effect on:
Central nervous system
Other dangerous properties can not be excluded.
Handle in accordance with good industrial hygiene and safety practice.

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This substance should be handled with particular care.

SECTION 12. Ecological information

Ecotoxicity

Toxicity to fish
flow-through test LC50 Pimephales promelas (fathead minnow): 40.7 mg/l; 96 h
US-EPA

Toxicity to daphnia and other aquatic invertebrates
static test EC50 Daphnia magna (Water flea): 20.8 mg/l; 48 h

Toxicity to algae
ErC50 Chlamydomonas reinhardtii (green algae): 36.5 mg/l; 72 h
Analytical monitoring: yes(ECHA)

Toxicity to bacteria
static test EC50 activated sludge: 260 mg/l; 3 h
OECD Test Guideline 209

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)
NOEC Daphnia magna (Water flea): 10 mg/l; 21 d
(ECOTOX Database)

Persistence and degradability

Biodegradability
2.4 %; 28 d; aerobic
OECD Test Guideline 301C
Not readily biodegradable.

Bioaccumulative potential

Partition coefficient: n-octanol/water
log Pow: 2.53 (20 °C)
Bioaccumulation is not expected. (ECHA)

Bioaccumulation
Bioconcentration factor (BCF): 17
Lepomis macrochirus (Bluegill sunfish) 0.00823 mg/l; 14 d
Temperature: 61 °F(16 °C)

Mobility in soil

Distribution among environmental compartments
Adsorption/Soil
log Koc: 1.97
(experimental)
Mobile in soils

Other adverse effects

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Henry constant
998 Pa*m³/mol
(Lit.) Distribution preferentially in air.

SECTION 13. Disposal considerations

The information presented only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. Disposal should be in accordance with applicable regional, national and local laws and regulations.

SECTION 14. Transport information

Land transport (DOT)

UN number	UN 1710
Proper shipping name	TRICHLOROETHYLENE
Class	6.1
Packing group	III
Environmentally hazardous	--

Air transport (IATA)

UN number	UN 1710
Proper shipping name	TRICHLOROETHYLENE
Class	6.1
Packing group	III
Environmentally hazardous	--
Special precautions for user	no

Sea transport (IMDG)

UN number	UN 1710
Proper shipping name	TRICHLOROETHYLENE
Class	6.1
Packing group	III
Environmentally hazardous	--

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Special precautions for user	yes
EmS	F-A S-A

SECTION 15. Regulatory information

United States of America

SARA 313
The following components are subject to reporting levels established by SARA Title III, Section 313:
Components

trichloroethylene	79-01-6	*100 %*

SARA 302
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.
Clean Water Act
The following Hazardous Substances are listed under the U.S. CleanWater Act, Section 311, Table 116.4A:
Components
trichloroethylene
The following Hazardous Chemicals are listed under the U.S. CleanWater Act, Section 311, Table 117.3:
Components
trichloroethylene
This product contains the following toxic pollutants listed under the U.S. Clean Water Act Section 307
Components
trichloroethylene

DEA List I
Not listed

DEA List II
Not listed
TSCA 12b
Components

trichloroethylene	79-01-6

US State Regulations

Massachusetts Right To Know
Components
trichloroethylene
Pennsylvania Right To Know
Components
trichloroethylene

The life science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the US and Canada

New Jersey Right To Know
Components
trichloroethylene
California Prop 65 Components
WARNING: this product contains a chemical known in the State of California to cause cancer.
Components
trichloroethylene
California Prop 65 Components
WARNING: This product contains a chemical known in the State of California to cause birth defects or other reproductive harm.
Components
trichloroethylene

Notification status

TSCA:	All components of the product are listed in the TSCA-inventory.
DSL:	All components of this product are on the Canadian DSL

SECTION 16. Other information

Training advice
Provide adequate information, instruction and training for operators.

Labeling
Hazard pictograms



Signal Word
Danger

Hazard Statements
H315 Causes skin irritation.
H317 May cause an allergic skin reaction.
H319 Causes serious eye irritation.
H336 May cause drowsiness or dizziness.
H341 Suspected of causing genetic defects.
H350 May cause cancer.
H412 Harmful to aquatic life with long lasting effects.

The life science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the US and Canada

Precautionary Statements
Prevention
P201 Obtain special instructions before use.
P273 Avoid release to the environment.
P280 Wear protective gloves.
Response
P302 + P352 IF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313 IF exposed or concerned: Get medical advice/ attention.

Restricted to professional users.

Full text of H-Statements referred to under sections 2 and 3.

H315	Causes skin irritation.
H317	May cause an allergic skin reaction.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.
H341	Suspected of causing genetic defects.
H350	May cause cancer.

Key or legend to abbreviations and acronyms used in the safety data sheet
Used abbreviations and acronyms can be looked up at www.wikipedia.org.

Revision Date05/18/2020

The branding on the header and/or footer of this document may temporarily not visually match the product purchased as we transition our branding. However, all of the information in the document regarding the product remains unchanged and matches the product ordered. For further information please contact mlsbranding@sial.com.

The information contained herein is based on the present state of our knowledge. It characterizes the product with regard to appropriate safety precautions. It does not represent a warranty of any product properties and we assume no liability for any loss or injury which may result from the use of this information. Users should conduct their own investigations to determine the suitability of the information.
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SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Manufacturer:	**Shintech Louisiana, LLC** 3 Greenway Plaza, Suite 1150 Houston, TX 77046 (713) 965-0713
PRODUCT NAME:	**Vinyl Chloride Monomer**
CAS#:	75-01-4
Synonyms:	VCM, Vinyl Chloride Monomer; Monochloroethylene; Chloroethene; Chloroethylene; Ethylene
Product Use:	PVC Manufacturing
CHEMICAL FORMULA:	CH_2 CH Cl

For information regarding a chemical emergency involving a spill or leak, call:

24 — Hour Emergency Contact:

U.S.: 1-800-424-9300 — CHEMTREC

SECTION 2 – HAZARDS IDENTIFICATION

Global Harmonization System (GHS) Classification:

Category 2 Skin corrosion/irritation

Category 2 Eye damage/eye irritation

Category 1 Known human Carcinogen

Category 1 Specific target organ toxicity - Single and repeated exposure

National Fire Protection Association (NFPA) Rating Hazardous Materials Identification Systems (HMIS) Rating

	NFPA	HMIS	
Health	2	2	4 = Extreme/Severe ~~W~~ = Water Reactive
Fire	4	4	3 = High/Serious
Reactivity	2	1	2 = Moderate
			1 = Slight
			0 = Minimum

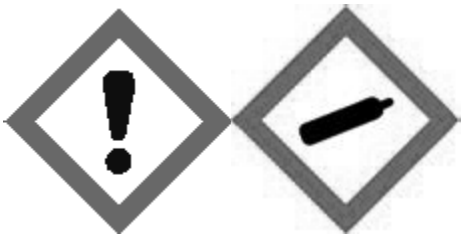
EMERGENCY OVERVIEW

Color:	Colorless
Odor:	Sweet
Physical State:	Compressed, Liquefied gas
Signal Word:	**DANGER**

DANGER! POISON! Extremely flammable liquid and vapor — Vapor may cause flash fire. May be fatal if inhaled. May cause frostbite. Inhalation may cause central nervous system effects and narcosis. May cause anesthetic effects. Possible cancer hazard. Keep upwind of spill. Vapor explosion hazard. Vapors may travel a long distance; ignition and/or flash back may occur. Flammable gas that is heavier than air. Stay out of low areas. Warn public of downwind explosion hazard. Elevated temperatures can cause hazardous polymerization. Eliminate ignition sources. Avoid temperatures above 400°C (752°F)

GHS Label Elements:





GHS Hazard Statements: May cause frostbite if contact is made with eyes and skin

Brief inhalation exposure (minutes) to easily attainable concentrations may cause serious adverse effects, even death

Has caused cancer in humans

OSHA Hazard Communication Standard: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

GHS Precautionary Statements:

Storage: Keep container closed and properly labeled.

Store in cool, dry place.

Avoid heat, flames, sparks and other sources of ignition.

Ventilation Controls: Do not breathe vapor.

Hygiene Measures: When using, do not smoke.

Avoid contact with skin and eyes.

Personal Protective Equipment: Wear suitable protective clothing, gloves, and eye/face protection.

First Aid: (See Section 4)

Environmental Protection: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

POTENTIAL HEALTH EFFECTS:

Inhalation: Mist may cause severe irritation of upper respiratory tract (nose and throat). May cause chemical burns to the respiratory tract.

Skin Contact: Brief contact may cause severe skin burns. Symptoms

may include pain, severe local redness and tissue damage.

Skin Absorption: Prolonged skin contact is unlikely to result in absorption of harmful amounts.

Eye Contact: May cause severe irritation with corneal injury which may result in permanent impairment of vision, even blindness. Chemical burns may occur. Mist may cause eye irritation.

Ingestion: Swallowing may result in burns of the mouth and throat. Swallowing may result in gastrointestinal irritation, ulceration, nausea and/or vomiting. Aspiration into the lungs may occur during ingestion or vomiting, causing tissue damage or lung injury.

Conditions Aggravated by Exposure: Respiratory disorders, pre-existing skin disorders, eye/vision disorders.

Target Organs Effected: Skin, Eyes, Respiratory System.

SECTION 3 – COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous ingredients (specific)	%	CAS Number
Vinyl Chloride	**>99.9**	75-01-4

SECTION 4 – FIRST AID MEASURES

INHALATION: Move person to fresh air. If not breathing, give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc.). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

SKIN CONTACT: Immediately flush skin with plenty of water for 15 minutes. Seek medical attention immediately. Liquid VCM may cause frostbite on contact.

INGESTION: Not a likely route of exposure.

EYE CONTACT: In case of frostbite, immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes,

	then continue flushing eyes for at least 15 minutes. Obtain medical attention promptly, preferably from an ophthalmologist.
NOTES TO PHYSICIAN:	Treat for frostbite if present. Maintain adequate ventilation and oxygenation of the patient. The following disease states have been observed in industrial workers exposed to vinyl chloride vapors: acroosteolysis, scleroderma, and Raynaud's phenomenon. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Stimulants such as epinephrine may induce ventricular fibrillation.

SECTION 5 – FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA:	Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam. Do not use direct water stream. Straight or direct water streams may not be effective to extinguish fire. Alcohol resistant foams (ATC type) are preferred. General purpose synthetic foams (including AFFF) or protein foams may function, but will be less effective.
FIRE FIGHTING PROCEDURES:	Keep people away. Isolate fire and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water may not be effective in extinguishing fire. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of reignition has passed. Fight fire from protected location or safe distance. Consider the use of unmanned hose holders or monitor nozzles. Immediately withdraw all personnel from the area in case of rising sound from venting safety device or discoloration of the container. Do not use direct water stream. May spread fire. Eliminate ignition sources. Move container from fire area if this is possible without hazard. For tank, rail car or tank truck: Stop the leak if possible without personal risk. Let burn unless the leak can be stopped immediately. Burning liquids may be moved by flushing with water to protect personnel and minimize property damage. Avoid accumulation of water. Product may be carried across water surface spreading fire or contacting an ignition source.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTERS:	Wear positive-pressure self-contained breathing apparatus (SCBA) and protective firefighting clothing (includes firefighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during firefighting operations. If contact is likely, change to full chemical resistant firefighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight fire from a remote location.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Container may vent and/or rupture due to fire. When product is stored in closed containers, a flammable atmosphere can develop. Electrically ground and bond all equipment. Flammable mixtures of this product are readily ignited even by static discharge. Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Flammable mixtures may exist within the vapor space of containers at room temperature. Flammable concentrations of vapor can accumulate at temperatures above flash point; see Section 9.
HAZARDOUS COMBUSTION PRODUCTS:	During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. Combustion products may include and are not limited to: Hydrogen chloride. Carbon monoxide. Carbon dioxide. Combustion products may include trace amounts of: Phosgene

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Steps to be Taken if Material is Released or Spilled:	See Section 13, Disposal Considerations, for additional information. Pump with explosion-proof equipment. If available, use foam to smother or suppress. Knock down and dilute vapors with water fog or spray. Isolate area until gas has dispersed.
Personal Precautions:	Evacuate area. Keep upwind of spill. Keep personnel out of low areas. Ventilate area of leak or spill. No smoking in area. For large spills, warn public of downwind explosion hazard. Eliminate all sources of ignition in vicinity of spill or released vapor to avoid fire or explosion. Vapor explosion

	hazard. Keep out of sewers. Check area with combustible gas detector before reentering area. Ground and bond all containers and handling equipment.
Environmental Precautions:	Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

SECTION 7 – HANDLING AND STORAGE

HANDLING:

General Handling:	**General Handling:** Keep away from heat, sparks and flame. Avoid contact with eyes. Do not breathe vapor. Use with adequate ventilation. Keep container closed. No smoking, open flames or sources of ignition in handling and storage area. Electrically bond and ground all containers, personnel and equipment before transfer or use of material. Use of non-sparking or explosion-proof equipment may be necessary, depending upon the type of operation.
Other Precautions:	Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Ignition and/or flash back may occur. Never use air pressure for transferring product. Containers, even those that have been emptied, can contain vapors. Do not cut, drill, grind, weld, or perform similar operations on or near empty containers.
STORAGE REQUIREMENTS:	Store and handle in accordance with all current regulations and standards. Keep container tightly closed and properly labeled. Store in a cool, dry place. Do not enter confined spaces unless adequately ventilated. Avoid heat, flames, sparks and other sources of ignition. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Keep separated from incompatible substances.

SECTION 8 - EXPOSURE CONTROL / PERSONAL PROTECTION

EXPOSURE LIMITS

Vinyl Chloride:	1.0 ppm OSHA-PEL (8 Hour TWA) 5 ppm OSHA /STEL (Average, not exceeding any 15 minute period) 0.5 ppm OSHA action level

	1 ppm ACGIH-TLV (8 Hour TWA) 5 ppm (13 mg/m3) MEXICO TWA A "skin" notation following the exposure guideline refers to the potential for dermal absorption of the material including mucous membranes and the eyes either by contact with vapors or by direct skin contact. It is intended to alert the reader that inhalation may not be the only rouge of exposure and that measures to minimize dermal exposures should be considered.

PERSONAL PROTECTION

Eye/face Protection:	For handling the gas, wear safety glasses. When contact with the liquid (condensed gas) is possible, wear chemical goggles
Hand Protection:	Use gloves with insulation for thermal protection, when needed. Use gloves with insulation for thermal protection (EN 407), when needed.
Clothing:	Wear chemical resistant clothing to prevent skin contact.
Respiratory Protection:	Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required, a NIOSH approved respirator (29 CFR 1910.132, 1910.134 and 1910.1017) with organic vapor cartridges may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits, or when symptoms have been observed that are indicative of overexposure. Respirator must be selected based on the airborne levels found in the work place and must not exceed the working limits of the respirator. SHORT ORGANIC VAPOR CARTRIDGE SERVICE LIFE is anticipated.
Ingestion:	No precautions necessary due to the physical properties of the material.

ENGINEERING CONTROLS

Ventilation:	Provide local exhaust ventilation where vapor may be generated. All energized electrical equipment must be designed in accordance with the electrical classification of the area (e.g., Class I, Division I). Ensure compliance with applicable exposure limits. Use explosion proof ventilation

equipment.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Gas, Liquid
Physical Form	Compressed, liquefied gas
Color	Colorless
Odor	Sweet
Autoignition Temperature	472 °C (882 °F) *Literature*
Vapor pressure	2,524 mmHg @ 20 °*C Literature*
Boiling Point (760 mmHg)	-13.4 °C (7.9 °F) *Literature*
Vapor Density (air=1)	*2.2 Literature*
Specific Gravity (H_2O=1)	0.913 *Literature*
Flash Point – Open cup	-78°C (-108 °F) Cleveland Open Cup ASTM D92
Flammable Limits in Air	Lower: 3.6% *(V) Literature* Upper: 33.0%(V) *Literature*
Freezing Point	-153.8 °C (-244.8 °F) *Literature*
Melting Point	-153.8 °C (-244.8 °F) *Literature*
Solubility in Water (by weight)	*0.7 % Literature*
pH	Not applicable
Molecular Weight	62.5 g/mol
Evaporation Rate (Butyl Acetate =1)	1,000 High - gas
Kinematic Viscosity	No test data available
Volatility	100%
Odor Threshold	Not reliable to prevent excessive exposure
Evaporation Rate	>15
VOC	100%

SECTION 10 – STABILITY AND REACTIVITY

STABILITY/INSTABILITY: Stable under recommended storage conditions. See Storage, Section 7.

Conditions to Avoid:	Avoid contact with air (oxygen). Avoid temperatures above 400°C (752°F) Exposure to elevated temperatures can cause product to decompose. Avoid static discharge. Avoid moisture. Avoid open flames, welding arcs, or other high temperature sources which induce thermal decomposition. Avoid direct sunlight
Incompatibility (materials to avoid):	Avoid contact with: Air. Moist air. Oxygen. Strong oxidizers. Avoid contact with metals such as: Aluminum. Aluminum alloys. Copper.
Hazardous Polymerization:	Can occur. Elevated temperatures can cause hazardous polymerization. Polymerization can be catalyzed by: Air. Free radical initiators. Moisture. Oxygen. Sunlight.
Thermal Decomposition:	Decomposition products depend upon temperature, air supply and the presence of other materials. Decomposition products can include and are not limited to: Hydrogen chloride. Toxic gases are released during decomposition. Decomposition products can include trace amounts of: Phosgene.

SECTION 11 – TOXICOLOGICAL INFORMATION

Toxicity Data:	500 mg/kg oral-rat LD50; 180000 ppm/15 minute(s) inhalation-rat LC50
Carcinogen Status:	OSHA: Carcinogen; NTP: Known Human Carcinogen; !ARC: Human Sufficient Evidence, Animal Sufficient Evidence, Group 1
Local Effects:	Irritant: skin, eye
Acute Toxicity Level:	Toxic: ingestion; Relatively Non-toxic: inhalation.
Target Organs:	Central nervous system
Additional Data:	Long, latent period may exist between exposure and symptom onset. This material does not accumulate in the body and is readily eliminated.

HEALTH EFFECTS

INHALATION:

Acute Exposure: VINYL CHLORIDE: May be irritating. Exposure to 1,000-16,000 ppm may cause central nervous system depression with drowsiness, vertigo, staggering gait, tingling and numbness of hands and feet, impaired hearing and vision, cardiac arrhythmias and possibly unconsciousness; 20,000-25,000 ppm for 3-5 minutes may cause dizziness, lightheadedness, disorientation, nausea and burning sensation of the soles of the feet; and 120,000 ppm may be fatal.

Additional effects may include narcolepsy, headache, undue fatigue, muscle and joint pain, dyspnea, and anesthesia. Death may be due to respiratory paralysis with cardiac arrest. Human and animal pathologic reports show pulmonary edema, hyperemia of kidneys and liver and hepatic degeneration.

Chronic Exposure: VINYL CHLORIDE: Repeated exposure may result in dose-related sensory disorders, nervous system effects, blood system damage, hepatic-like liver changes, liver malfunction, impotence and pulmonary insufficiency. Workers overexposed to this material may exhibit symptoms of peripheral circulation changes resulting in pallor, cyanosis, redness, skin changes, and pseudo-clubbing of the fingers. Occupational overexposure has produced angiosarcomas of the liver. Animal studies show that vinyl chloride is carcinogenic in rats. This material does not bioaccumulate and is readily eliminated.

SKIN CONTACT:

Acute Exposure: VINYL CHLORIDE: Contact may cause irritation with redness and pain. Due to rapid evaporation, the liquid may cause thermal burns with redness, tingling, and pain or numbness. In more severe cases, the skin may become hard and white and develop blisters

Chronic Exposure: VINYL CHLORIDE: Workers overexposed to this material may exhibit symptoms of peripheral circulation changes resulting in pallor, cyanosis, redness, skin changes, and pseudo-clubbing of the fingers. Repeated or prolonged

exposure to irritants may cause dermatitis.

EYE CONTACT

Acute Exposure: VINYL CHLORIDE: Contact may cause immediate and severe irritation, and corneal injury with complete recovery in 48 hours. Due to rapid evaporation, the liquid may cause thermal burns with redness, pain and blurred vision.

Chronic Exposure: VINYL CHLORIDE: Repeated or prolonged exposure to irritants may cause conjunctivitis.

INGESTION

Acute Exposure: VINYL CHLORIDE: This is not a likely route of exposure. If the liquid is swallowed, thermal burns to the lips, mouth and mucous membranes may occur.

Chronic Exposure: VINYL CHLORIDE: This is not a likely route of exposure. Oral administration to rats, mice, and hamsters resulted in angiosarcomas of the liver.

SECTION 12 – ECOLOGICAL INFORMATION

ECOTOXICITY DATA

Fish toxicity: This material is practically non-toxic to fish on an acute basis (LC50>100mg/L).

FATE AND TRANSPORT:

Biodegradation: Biodegradation may occur under anaerobic conditions (in the absence of oxygen)

Persistence: Tropospheric half-life is estimated to be 23 hour(s).

Bioconcentration: Bioconcentration potential is low (BCF <100 or low Pow <3).

SECTION 13 – DISPOSAL CONSIDERATIONS

Reuse or reprocess if possible. Dispose in accordance with all applicable Federal, State/Provincial and local laws and regulations. Subject to disposal regulations: U.S.

EPA 40 CFR 262. Hazardous Waste Number(s): D001. U043. Waste characterization and compliance with applicable laws and regulations are the responsibility of the waste generator.

SHINTECH LOUISIANA, LLC HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN SDS SECTION.

SECTION 14 – TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:

Shipping Name	**Vinyl Chloride, Stabilized**
Hazard Class / Division	**2.1**
Identification No.	**UN1086**
Labeling Requirements	**2.1**
DOT Hazardous Substance(s)	**Vinyl Chloride 1 lb(s) (0.454 kg(s))**

Canadian Transportation of Dangerous Goods

Shipping Name: Vinyl Chloride, stabilized UN Number: UN 1086

Class: 2.1

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales *or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.*

SECTION 15 – REGULATORY INFORMATION

OSHA Hazard Communication Standard:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency

Planning and Community Right-to-Know Act of 1986 Sections 311 and 312

Immediate (Acute) Health Hazard	Yes
Delayed (Chronic) Health Hazard	Yes
Fire Hazard	Yes
Reactive Hazard	No
Sudden Release of Pressure Hazard	Yes

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313:

This product contains the following substances which are subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and which are listed in 40 CFR 372.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:

The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)

WARNING: This product contains a chemical(s) known to the State of California to cause cancer.

Component	CAS #	Amount
Vinyl Chloride	75-01-4	>99.9%

US Toxic Substances Control All components of this product are on the TSCA Inventory or

Act: are exempt from TSCA Inventory requirements under 40 CFR 720.30.

Canada Inventory (DSL/NDSL): All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

SECTION 16 – OTHER INFORMATION

IMPORTANT: The information presented herein, while not guaranteed, was prepared by competent technical personnel and is true and accurate to the best of our knowledge. NO WARRANTY OF MERCHANT ABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTY OR GUARANTY OF ANY OTHER KIND, EXPRESS OR IMPLIED, IS MADE REGARDING PERFORMANCE, SUITABILITY, STABILITY OR OTHERWISE. The information included herein is not intended to be all-inclusive as to the appropriate manner and/or conditions of use, handling and/or storage. Factors pertaining to certain conditions of storage, handling, or use of this product may involve other or additional safety or performance considerations. While our technical personnel will be happy to respond to questions regarding safe handling and use procedures, safe handling and use remains the responsibility of the customer. No suggestions for use are intended to, and nothing herein shall be construed as a recommendation to, infringe any existing patents or violate any laws, rules, regulations or ordinances of any governmental entity.

Shintech Louisiana, LLC urges each customer or recipient of this SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this SDS and any hazards associated with the product. The information herein is provided in good faith and believed to be accurate as to the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. The information presented here pertains only to the product as shipped. Since conditions for use of the product are not under the control of the manufacturer, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product.

Revisions:

- **April 2014 – The MSDS was updated to follow new Global Harmonization Guidelines. The MSDS are now called Safety Data Sheets (SDS).**
- **January 2016 – Corrections to improve nomenclature and technical data.**

SDS Status: Revision Date: 01/08/2016

Supersedes: 04/11/2014

SAFETY DATA SHEET

Version 8.1
Revision Date 03/28/2020
Print Date 05/15/2020

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Volatile Organic Contaminants Mix 1

Product Number : 47274
Brand : Supelco
Index-No. : 603-001-00-X

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 Spruce Street
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone number

Emergency Phone # : +1-703-527-3887

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Acute toxicity, Oral (Category 3), H301
Acute toxicity, Inhalation (Category 3), H331
Acute toxicity, Dermal (Category 3), H311
Specific target organ toxicity - single exposure (Category 1), H370

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram



Signal word Danger

Hazard statement(s)
H301 + H311 + H331 Toxic if swallowed, in contact with skin or if inhaled.
H370 Causes damage to organs.

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Precautionary statement(s)

P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing.
P301 + P310 + P330	IF SWALLOWED: Immediately call a POISON CENTER/doctor. Rinse mouth.
P302 + P352 + P312	IF ON SKIN: Wash with plenty of soap and water. Call a POISON CENTER or doctor/ physician if you feel unwell.
P304 + P340 + P311	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/ physician.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P361	Remove/Take off immediately all contaminated clothing.
P363	Wash contaminated clothing before reuse.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Component		Classification	Concentration
Methanol			
CAS-No. EC-No. Index-No. Registration number	67-56-1 200-659-6 603-001-00-X 01-2119433307-44-XXXX	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301, H331, H311, H370	>= 90 - <= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

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In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
No data available

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

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Recommended storage temperature 2 - 8 °C
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Methanol	67-56-1	TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		STEL	250 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200 ppm 260 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250 ppm 325 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200 ppm 260 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		C	1,000 ppm	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		
		PEL	200 ppm 260 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		

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		STEL	250 ppm 325 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Methanol	67-56-1	Methanol	15 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			

8.2 Exposure controls

Appropriate engineering controls
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 30 min
Material tested:Camatril® (KCL 730 / Aldrich Z677442, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

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Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	No data available
g)	Flash point	()No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	No data available
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information
No data available

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SECTION 10: Stability and reactivity

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Acids, Oxidizing agents, Alkali metals, Acid chlorides, Acid anhydrides, Reducing agents

10.6 Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - No data available
In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

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Additional Information
RTECS: Not available

Methyl alcohol may be fatal or cause blindness if swallowed., Cannot be made non-poisonous., Effects due to ingestion may include:, Nausea, Dizziness, Gastrointestinal disturbance, Weakness, Confusion., Drowsiness, Unconsciousness, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Stomach - Irregularities - Based on Human Evidence

SECTION 12: Ecological information

12.1 Toxicity
No data available

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
No data available

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

SECTION 14: Transport information

DOT (US)
UN number: 1230 Class: 3 Packing group: II
Proper shipping name: MethanolSOLUTION

Reportable Quantity (RQ): 5000 lbs
Poison Inhalation Hazard: No

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IMDG
UN number: 1230 Class: 3 (6.1) Packing group: II EMS-No: F-E, S-D
Proper shipping name: METHANOLSOLUTION

IATA
UN number: 1230 Class: 3 (6.1) Packing group: II
Proper shipping name: MethanolSOLUTION

SECTION 15: Regulatory information

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

SARA 311/312 Hazards
Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01
Styrene	100-42-5	2007-07-01
1,2-Dibromo-3-chloropropane	96-12-8	2007-07-01
1,2-Dibromoethane	106-93-4	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

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SECTION 16: Other information

Further information

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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

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Version: 8.1 Revision Date: 03/28/2020 Print Date: 05/15/2020

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Attachment 8:

Contractor Significant Incident Report

Contractor Significant Incident Report (CSIR-1)

Report Date:	**Contracting Activity/ROICC Office**

1. Accident Classification:

☐ Injury ☐ Illness ☐ Fatality ☐ Property Damage ☐ Procedural Issues ☐ Environmental

Involving:

☐ Hazardous Materials ☐ Electrical ☐ Equip/Motor Vehicle/ Material Handling ☐ Diving ☐ Falls

☐ Confined Space ☐ Crane/Rigging ☐ Trenching/Entrapment ☐ Fire ☐ Other

☐ Waterfront Operations ☐ Demolition/Renovation

2. Personal Data:

A. Name (Last, First, M.)	B. Age	C. Sex	D. Social Security Number

E. Job Description/Title	F. Employed By	G. Supervisor s Name

3. Witness Data (Attach Witness Summary Statements to Report):

A. Name (Last, First, M.)	B. Age	C. Sex

D. Job Description/Title	E. Employed By

4. General Information:

A. Date of Accident (Month/Day/Year)	B. Time of Accident	C. Exact Location of Accident	D. Type of Construction Equipment (Make, Model, Serial Number, Vin #)

E. Contract Number/Title	F. Construction Activity SIC	G. Hazardous Material Spill/Release

H. Type of Contract

☐ Construction
☐ A/E
☐ Service
☐ RAC
☐ CLEAN
☐ JOC
☐ OTHER_____

I. Contractor's Name/Address/Phone Number

(1) Prime:

(2) Sub:

J. Safety Manager's Name	Phone #	K. Insurance Carrier	
(1) Prime:	(2) Sub:	(1) Prime:	(2) Sub:

L. Work Activity at Time of Accident

M. Personal Protective Equipment?

(1) Available & Used (2) Not Required
(3) Available & not used (4) Not Related to mishap
(5) Wrong PPE for job
(6) List Type(s) used:

5. Injury/Illness/Fatality Information:

A. Severity of Illness/Injury	B. Estimated Days Lost	C. Estimated Days Hospitalized	D. Estimated Days Restricted Duty

E. List Body Part(s) Affected	F. Nature of Illness/Injury	G. Type and Source of Injury/Illness (1) Type: (2) Source:

6. A. Accident Description (Describe in your own words) (Use additional paper if necessary)

B. Who provided first aid and/or cleanup of mishap site?

C. Any blood borne pathogen exposure by other than EMT's? If so who?

D. Was site secured and witness interviews taken immediately?

E. List OSHA and EM 385-1-1 standards/requirements that were violated?

7. Causal Factors (Explain yes answers on a supplementary sheet)	YES	NO
Design - Was design of facility, workplace, or equipment a factor?		
Inspection/Maintenance - Were inspection & maintenance procedures a factor?		
Persons Physical Condition - In your opinion, was the physical condition of the person a factor?		
Operating Procedures - Were operating procedures a factor?		
Job Practices - Were any job safety/health practices not followed when the accident occurred?		
Human Factors - Did any human factors such as size or strength of person etc., contribute to the accident?		

	YES	NO

Environmental Factors - Did heat, cold, dust, sun, glare, etc., contribute to the accident?

Chemical & Physical Agent Factors - Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents such as noise, radiation, etc., contribute to the accident?

Office Factors - Did office setting such as lifting office furniture, carrying, stopping, etc., contribute to the accident?

Support Factors - Were inappropriate tools/resources provided to properly perform the activity task?

Personal Protective Equipment - Did the improper selection use, or maintenance of personal protective equipment contribute to the accident?

Drugs/Alcohol - In your opinion, were drugs or alcohol a factor?

Activity Hazard Analysis - Was the lack of an adequate (IAW EM 385-1-1 Sec 01.A.09) Activity Hazard Analysis a contributing factor?
- Was it site specific and address the type of work/operations performed when the mishap occurred?

Management - Did the lack of adequate supervision contribute to the accident?

- Was inadequate information provided at pre-con meeting?

8. Training:		
A. Was/were person(s) trained to perform activity/task?		

B. Type of training?

C. Date of most recent formal training? / / D. List topics discussed

9. Fully Explain What Allowed or Caused The Accident, Include Direct and Indirect Causes:

A. Direct Cause

B. Indirect Cause

C. Action(s) taken to prevent re occurrences or provide on-going corrective actions.

D. Corrective Action Dates	

(1) Beginning (Mo/Da/Yr) / / (2) Anticipated Completion Date (Mo/Da/Yr) / /

10. OSHA

A. Date OSHA was notified / /	C. Date of OSHA Citation / /
B. Date OSHA Investigated / /	D. $ Amount of Penalties:

11. Report Preparer

Print Name & Title of Supervisor Completing Report

Signature: _____ Date (Mo/Da/Yr) _____

12. Management Review (Contracting Officer)

A. ☐ Accepted	B. ☐ Amendments Required	C. ☐ Comments (include program improvements required for your Command. NAVFACHQ Construction Safety Program and EM 385-1-1)

D. Print Name & Title of Official Completing Report

Signature: _____ Date: (Mo/Da/Yr) _____

13. Safety And Occupational Health Officer Review

A. ☐ Concur B. ☐ Non Concur		C. ☐ Additional Actions/Comments

D. Print Name & title of Safety Personnel Reviewing

Signature: _____ Date (Mo/Da/Yr) _____

Attachment 9:

ADEC Oil and Hazardous Substances Spill Notification Instructions and Forms

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

OIL & HAZARDOUS SUBSTANCES SPILL NOTIFICATION FORM

ADEC USE ONLY

ADEC SPILL #:	ADEC FILE #:	ADEC LC:

PERSON REPORTING:	PHONE NUMBER:	REPORTED HOW? (ADEC USE ONLY) ☐ Phone ☐ Fax ☐ PERS ☐ E-mail
DATE/TIME OF SPILL:	DATE/TIME DISCOVERED:	DATE/TIME REPORTED TO ADEC:

INCIDENT LOCATION/ADDRESS:	DATUM: ☐ NAD27 ☐ NAD83 ☐ WGS84 ☐ Other _____ LAT. LONG.	PRODUCT SPILLED:

QUANTITY SPILLED: ☐ gallons ☐ pounds	QUANTITY CONTAINED: ☐ gallons ☐ pounds	QUANTITY RECOVERED: ☐ gallons ☐ pounds	QUANTITY DISPOSED: ☐ gallons ☐ pounds

	POTENTIAL RESPONSIBLE PARTY:	OTHER PRP, IF ANY:	VESSEL NAME:
Name/Business:			
Mailing Address:			VESSEL NUMBER:
Contact Name:			> 400 GROSS TON VESSEL: ☐ Yes ☐ No
Contact Number:			

SOURCE OF SPILL:	CAUSE CLASSIFICATION:
CAUSE OF SPILL: ☐ Under Investigation	☐ Accident ☐ Human Factors ☐ Structural/Mechanical ☐ Other

CLEANUP ACTIONS:

DISPOSAL METHODS AND LOCATION:

AFFECTED AREA SIZE:	SURFACE TYPE: *(gravel, asphalt, name of river etc.)*	RESOURCES AFFECTED/THREATENED: *(Water sources, wildlife, wells, etc.)*

COMMENTS:

ADEC USE ONLY

SPILL NAME:	NAME OF DEC STAFF RESPONDING:	C-PLAN MGR NOTIFIED? ☐ Yes ☐ No

DEC RESPONSE: ☐ Phone follow-up ☐ Field visit ☐ Took Report	CASELOAD CODE: ☐ First and Final ☐ Open/No LC ☐ LC Assigned	CLEANUP CLOSURE ACTION: ☐ NFA ☐ Monitoring ☐ Transferred to CS or STP

COMMENTS:

Status of Case: ☐ Open ☐ Closed DATE CASE CLOSED:

REPORT PREPARED BY:	DATE:

IT'S THE LAW!

AS 46.03.755, 18 AAC 75.300, 75.325 and 18 AAC 78.200

REPORT
OIL AND HAZARDOUS SUBSTANCE SPILLS

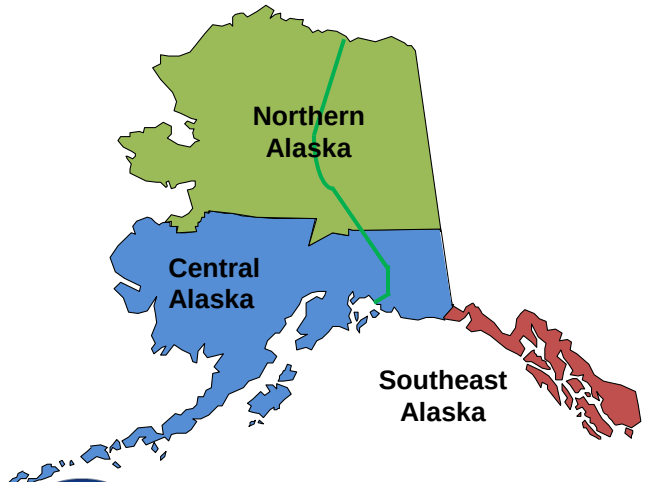
During Normal Business Hours

call the nearest response team office:

Central Alaska: Anchorage	**(907) 269-3063** Fax: (907) 269-7648
Northern Alaska: Fairbanks	**(907) 451-2121** Fax: (907) 451-2362
Southeast Alaska: Juneau	**(907) 465-5340** Fax: (907) 465-5245
Alaska Pipeline: Fairbanks	**(907) 451-2121** Fax: (907) 451-2362

Outside Normal Business Hours

Toll Free	**1-800-478-9300**
International	**1-907-269-0667**



Alaska Department of Environmental Conservation
Division of Spill Prevention and Response
www.dec.alaska.gov/spar/ppr/spill-information/reporting

Hazardous Substance

Any hazardous substance spill, other than oil, must be reported immediately.

Oil – Petroleum Products

To Water

- Any amount spilled to water must be reported immediately.

To Land

- Spills in ***excess of 55 gallons*** must be reported immediately.
- Spills in ***excess of 10 gallons, but 55 gallons or less***, must be reported within 48 hours after the person has knowledge of the spill.
- Spills of ***1 to 10 gallons*** must be recorded in a spill reporting log submitted to ADEC each month.

To Impermeable Secondary Containment Areas

- Any spills in ***excess of 55 gallons*** must be reported within 48 hours.

Additional Requirements for Underground Storage Tank Spill Reporting

Regulated Underground Storage Tank (UST) systems are defined at 18 AAC 78.005. Releases at heating oil tanks must be reported.

- You must report a *suspected* belowground release from a UST system, in any amount, within 24 hours *(18 AAC 78.220(c))*.
- You must report if your release detection system indicates two consecutive months of invalid or inconclusive results.
- If you observe unusual operating conditions, sudden loss, erratic dispensing (slow flow/no flow) or discharge to soil or water, **report it to the UST Unit:**

907-269-3055 or 269-7679

rev. July/2018

Attachment 10:

Physical Agent Data Sheets

Physical Agent Data Sheet (PADS)

Cold Stress

Exposure to cold can cause the body's internal temperature to drop to a dangerously low level. This is called hypothermia. Exposure to temperatures below freezing can cause frostbite of the hands, feet, and face.

Hypothermia Can Kill

Hypothermia occurs when a person's body loses heat faster than it can be produced. The body's "normal" deep body temperature is 99.6 degrees Fahrenheit. If your body temperature drops to 95 degrees Fahrenheit, uncontrollable shivering occurs. If cooling continues, these other symptoms may occur:

Vague, slow, slurred speech

Forgetfulness, memory lapses

Inability to use hands

Frequent stumbling

Drowsiness

Exhaustion, collapse

Unconsciousness

Death

Hypothermia impairs your judgment. You may not be able to make good decisions about your situation. Preventing hypothermia is the best way to avoid being a victim.

Preventing Hypothermia: Be Prepared

Hypothermia can occur at temperatures above freezing. Cold, wet, windy conditions make prime hypothermia weather.

Stay Dry - Avoid Exposure

Wet clothing draws heat very quickly away from the body. Whenever you may be away from shelter or your vehicle, carry waterproof, windproof outer clothing. Put this clothing on before you get wet. Wear inner clothing which retains warmth even when it's wet, such as wool. Limit use of cotton if possible. clothing. Down clothing is good for cold, dry weather but it loses almost all insulating value if it gets wet. Wear layers of clothing which may be removed or put back on depending on the degree of physical activity. Being wet from sweat is just as dangerous as being wet from rain or snow.

Terminate Exposure

If you do not have adequate clothing to stay warm and dry, get out of the wind and rain or snow. Return to shelter. Utilize or create heat source. Change damp or wet clothes.

Treatment of Hypothermia

Be able to recognize the symptoms of hypothermia in yourself and others. The victim may deny he/she is in trouble. Even mild symptoms demand attention.

1. Get the victim out of wet and windy weather.
2. Remove all wet clothing.
3. If the person is only mildly affected:

    a. Give warm drinks

    b. Put into dry clothing and a warm sleeping bag or blanket.

If more seriously affected (very clumsy, confused, unable to shiver):

1. Treat very gently.
2. Place the victim naked into a warm sleeping bag or blanket.
3. Warm objects such as hot water bottles, or heat packs should be wrapped in towels or clothing. Arrange for evacuation. Do not give warm drinks until the victim has regained a clear conscious.

Frostbite[1]

Frostbite is the freezing of some part of the body. Fingers, toes, and even whole arms and legs can be lost as a result of frostbite. Such injuries have happened in more isolated areas of Alaska.

Protection From the Cold

In extreme cold it is important to prevent heat loss from as many areas of the body as possible. Exposed limbs and head are major areas of heat loss, but keeping enough blood flowing to the hands and feet is the key to preventing frostbite. The trunk and the head, then, should be warm enough so that the brain is able to command the blood vessels in the hands and feet to open up.

Essential Clothing

This includes thermal underwear, insulated footwear or mukluks with liners, double mittens and a parka, preferably down-filled with a good ruff. A parka which can be opened at the neck to allow heat to escape will prevent overheating and sweating. Quilted or skin pants are necessary if no warm shelter is immediately available. Tight clothes, especially tight gloves or tight boots, should not be worn. They interfere with the blood flow and reduce insulation against the cold.

Traveling

The traveler, even on a snowmobile, or in a heated automobile, should always be prepared to walk in severe cold. This means carrying along proper clothing and more extensive survival gear. If an accident, mechanical breakdown, or other interruption occurs during travel, the clothes you have must provide enough warmth to sustain life. Hands and feet should be well protected at all times to hinder the development of frostbite until help arrives.

Some Special Warnings

Don't touch cold metal with bare or wet hands. You will freeze to the metal and tear away skin. If necessary, thaw gently with heat, warm water or urine.

Be careful when handling gasoline, kerosene or liquids other than water. Contact at cold temperatures can cause immediate frostbite.

Remember that frostbite is more likely to occur when you are injured, frightened or careless.

Other Factors Leading to Frostbite

Tall thin persons are more likely to get frostbite than those of stocky build.

People in poor physical condition are more susceptible than those in good health.

Certain diseases slow down the blood flow in the hands and feet, especially in elderly people, and encourage frostbite.

Heavy smokers often have poor circulation in the vital organs and to the arms and legs, and are also susceptible.

Children and elderly people, unable to produce large amounts of body heat for long periods of time, may experience a lowering of deep body temperature and, ultimately, frostbite.

Alcohol causes the blood vessels to dilate (become larger). This lends a sense of warmth, but it also insures a faster loss of body heat. More important, people act with poor judgement after drinking.

In short, poor circulation and poor production of body heat will lower resistance to frostbite.

How to Recognize Frostbite

Pain in the hands and feet is felt only when the temperature of the tissue is changing very rapidly. There may be no pain with gradual freezing.

Loss of the sensations of touch, pressure, and pain may occur without awareness of any numbness or other sensation. Therefore, it is important to test these sensations often and to wear clothing that is loose and does not restrict the flow of blood to the limbs.

Exposed parts of the body should be inspected routinely. This is done best by a partner. Just before freezing, the skin, especially the face with its many blood vessels, becomes bright red. Then small patches of white appear, as freezing actually occurs.

The skin also becomes less elastic. This is best noted in the finger pads, which remain pitted when touched or squeezed. Any further cooling will surely result in frostbite.

Serious freezing is most common in the feet because of less awareness of them, poor circulation and sensation, and inadequate foot gear. Hands are next in order of serious injury. Exposed head parts are less likely to become frostbitten than feet because they are conditioned to exposure and have a better blood supply.

Early Treatment of Frostbite: Proper Rewarming

1. Next to the extent of freezing, inadequate or improper treatment of a frozen part is the most common cause of serious loss of tissue.
2. In many cases rewarming cannot be done without the part again becoming frozen. For example, removing clothing from other parts of the body to warm a frozen part may only result in the loss of more body heat, greater extent of injury, and the ultimate refreezing of the afflicted part.

   Thawing and refreezing should aways be avoided. It is best to continue, even if it means walking on a frozen foot, until shelter is available and rewarming can be done satisfactorily.
3. Limbs should be rewarmed in stirred water just above normal body temperature (about 100 - 105 degrees Fahrenheit). Using a thermometer is the only accurate way to measure this temperature. Never try to thaw in cold water or snow. Since feeling is lost, fires, stoves, exhaust pipes, etc., should never be used. Serious damage to the tissue could result.
4. If the major part of the limb is frozen when rewarming is started, deep body temperature will fall as the cooled blood begins to flow throughout the body. To prevent such cooling, warm liquids by mouth should be given. Even total immersion of the body in a warm bath may be necessary.
5. Rewarming is an acutely painful experience and medication to alleviate pain should be given if available. After thawing, a deep aching pain may persist for several days, depending upon severity of the injury. Pain is actually a good sign, since it indicates that nerve function is still present.
6. The afflicted part should be moved gently and voluntarily during rewarming.
7. A dull purple color indicates more serious injury and requires medical attention. So does swelling or blisters. Other means for improving circulation are available but must be administered by medical personnel.

Summary

Most cases of frostbite occur as a result of lack of knowledge, careless preparation, unavoidable accident, or the effects of alcohol on judgement. Intelligent forethought can prevent injury.

If freezing does occur, proper rewarming in warm water will give maximum benefit. The injured limb should be handled gently and a medical judgement be made of the extent of the injury and the need for further treatment.

Reference

1. Frostbite information compiled and distributed by the Providence Hospital Thermal Unit.

Physical Agent Data Sheet (PADS)

Heat Stress

Description

Heat stress is caused by working in hot environments like laundries, bakeries, or around boilers or incinerators. Four environmental factors affect the amount of heat stress felt by employees in hot work areas: temperature, humidity, radiant heat (such as from the sun or a furnace), and air velocity. How well or how poorly an individual reacts to heat stress is dependent on personal characteristics such as age, weight, fitness, medical condition, and acclimatization.

The body has several methods of maintaining the proper internal body temperature. When internal body temperature increases, the circulatory system reacts by increasing the amount of blood flow to the skin so the extra heat can by given off.

Sweating is another means the body uses to maintain stable internal temperatures. When sweat evaporates, cooling results. However, sweating is effective only if the humidity level is low enough to permit evaporation and if the fluids and salts lost are replaced.

Health Effects—Heat Disorders

Heat stroke, the most serious health problem for workers in hot environments is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include: mental confusion, delirium, loss of consciousness, convulsions or coma; a body temperature of 106 degrees Fahrenheit or higher; and hot dry skin which may be red, mottled or bluish. Victims of heat stroke will die unless treated promptly. While medical help should be called, the victim must be removed immediately to a cool area and his/her clothing soaked with cool water. He/she should be fanned vigorously to increase cooling. Prompt first aid can prevent permanent injury to the brain and other vital organs.

Heat exhaustion develops as a result of loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt, or both. The worker with heat exhaustion still sweats, but experiences extreme weakness or fatigue, giddiness, nausea, or headache. The skin is clammy and moist, the complexion pale or flushed, and the body temperature normal or slightly higher. Treatment is usually simple: the victim should rest in a cool place and drink salted liquids. Salt tablets are not recommended. Severe cases involving victims who vomit or lose consciousness may require longer treatment under medical supervision.

Heat cramps, painful spasms of the bone muscles, are caused when workers drink large quantities of water but fail to replace their bodies' salt loss. Tired muscles, those used for performing the work, are usually the ones most susceptible to cramps. Cramps may occur during or after working hours and may be relieved by taking salted liqids by mouth or saline solutions intravenously for quicker relief, if medically determined to be required.

Fainting may be a problem for the worker unacclimatized to a hot environment who simply stands still in

the heat. Victims usually recover quickly after a brief period of lying down. Moving around, rather that standing still, will usually reduce the possibility of fainting.

Heat rash, also known as prickly heat, may occur in hot and humid environments where sweat is not easily removed from the surface of the skin by evaporation. When extensive or complicated by infection, heat rash can be so uncomfortable that it inhibits sleep and impairs a worker's performance or even results in temporary total disability. It can be prevented by showering, resting in a cool place, and allowing the skin to dry.

Medical Conditions Aggravated By Exposure to Heat

Persons with heart or circulatory diseases or those who are on "low salt" diets should consult with their physicians prior to working in hot environments.

Preventing Heat Disorders

One of the best ways to reduce heat stress on workers is to minimize heat in the workplace. However, there are some work environments where heat production is difficult to control, such as when furnaces or sources of steam or water are present in the work area, or when the workplace itself is outdoors and exposed to varying warm weather conditions.

Acclimatization

Humans are, to a large extent, capable of adjusting to the heat. This adjustment to heat, under normal circumstances, usually takes about 5 to 7 days, during which time the body will undergo a series of changes that will make continued exposure to heat more endurable.

On the first day of work in a hot environment, the body temperature, pulse rate, and general discomfort will be higher. With each succeeding daily exposure, all of these responses will gradually decrease, while the sweat rate will increase. When the body becomes acclimated to the heat, the worker will find it possible to perform work with less strain and distress.

Gradual exposure to heat gives the body time to become accustomed to higher environmental temperatures. Heat disorders in general are more likely to occur among workers who have not been given time to adjust to working in the heat or among workers who have been away from hot environments and who have gotten accustomed to lower temperatures. Hot weather conditions of the summer are likely to affect the worker who is not acclimatized to heat. Likewise, workers who return to work after a leisurely vacation or extended illness may be affected by the heat in the work environment. Whenever such circumstances occur, the worker should be gradually reacclimatized to the hot environment.

Lessening Stressful Conditions

Many industries have attempted to reduce the hazards of heat stress by introducing engineering controls, training workers in the recognition and prevention of heat stress, and implementing work-rest cycles. Heat stress depends, in part, on the amount of heat the worker's body produces while a job is being performed. The amount of heat produced during hard, steady work is much higher than that produced during intermittent or light work. Therefore, one way of reducing the potential for heat stress is to make the job easier or lessen its duration by providing adequate rest time. Mechanization of work procedures

can often make it possible to isolate workers from the heat source (perhaps in an air-conditioned booth) and increase overall productivity by decreasing the time needed for rest. Another approach to reducing the level of heat stress is the use of engineering controls which include ventilation and heat shielding.

Number and Duration of Exposures

Rather than be exposed to heat for extended periods of time during the course of a job, workers should, wherever possible, be permitted to distribute the workload evenly over the day and incorporate work-rest cycles. Work-rest cycles give the body an opportunity to get rid of excess heat, slow down the production of internal body heat, and provide greater blood flow to the skin.

Workers employed outdoors are especially subject to weather changes. A hot spell or a rise in humidity can create overly stressful conditions. The following practices can help to reduce heat stress:

Postponement of nonessential tasks

Permit only those workers acclimatized to heat to perform the more strenuous tasks, or

Provide additional workers to perform the task keeping in mind that all workers should have the physical capacity to perform the task and that they should be accustomed to the heat.

Thermal Conditions in the Workplace

A variety of engineering controls can be introduced to minimize exposure to heat. For instance, improving the insulation on a furnace wall can reduce its surface temperature and the temperature of the area around it. In a laundry room, exhaust hoods installed over those sources releasing moisture will lower the humidity in the work area. In general, the simplest and least expensive methods of reducing heat and humidity can be accomplished by:

Opening windows in hot work areas,

Using fans, or

Using other methods of creating airflow such as exhaust ventilation or air blowers.

Rest Areas

Providing cool rest areas in hot work environments considerably reduces the stress of working in those environments. There is no conclusive information available on the ideal temperature for a rest area. However, a rest area with a temperature near 76 degrees Fahrenheit appears to be adequate and may even feel chilly to a hot, sweating worker, until acclimated to the cooler environment. The rest area should be as close to the workplace as possible. Individual work periods should not be lengthened in favor of prolonged rest periods. Shorter but frequent work-rest cycles are the greatest benefit to the worker.

Drinking Water

In the course of a day’s work in the heat, a worker may produce as much as 2 to 3 gallons of sweat. Because so many heat disorders involve excessive dehydration of the body, it is essential that water intake during the workday be about equal to the amount of sweat produced.

Most workers exposed to hot conditions drink less fluids than needed because of an insufficient thirst drive. A worker, therefore, should not depend on thirst to signal when and how much to drink. Instead, the worker should drink 5 to 7 ounces of fluids every 15 or 20 minutes to replenish the necessary fluids in the body. There is no optimum temperature of drinking water, but most people tend not to drink warm or very cold fluids as readily as they will cool ones. whatever the temperature of the water, it must be palatable and readily available to the worker. Individual drinking cups should be provided, never use a common drinking cup.

Heat acclimatized workers lose much less salt in their sweat than do workers who are not adjusted to the heat. The average American diet contains sufficient salt for acclimatized workers even when sweat production is high. If, for some reason, salt replacement is required, the best way to compensate for the loss is to add a little extra salt to the food. Salt tablets should not be used. CAUTION: PERSONS WITH HEART PROBLEMS OR THOSE ON A "LOW SODIUM" DIET WHO WORK IN HOT ENVIRONMENTS SHOULD CONSULT A PHYSICIAN ABOUT WHAT TO DO UNDER THESE CONDITIONS.

Protective Clothing

Clothing inhibits the transfer of heat between the body and the surrounding environment. Therefore, in hot jobs where the air temperature is lower than skin temperature, wearing clothing reduces the body's ability to lose heat into the air.

When air temperature is higher than skin temperature, clothing helps to prevent the transfer of heat from the air to the body. The advantage of wearing clothing, however, may be nullified if the clothes interfere with the evaporation of sweat.

In dry climates, adequate evaporation of sweat is seldom a problem. In a dry work environment with very high air temperatures, the wearing of clothing could be an advantage to the worker. The proper type of clothing depends on the specific circumstance. Certain work in hot environments may require insulated gloves, insulated suits, reflective clothing, or infrared reflecting face shields. For extremely hot conditions, thermally-conditioned clothing is available. One such garment carries a self-contained air conditioner in a backpack, while another is connected to a compressed air source which feeds cool air into the jacket or coveralls through a vortex tube. Another type of garment is a jacket which has pockets that can be filled with dry ice or containers of ice.

Recommended Exposure Limits

These Threshold Limit Values (TLVS) refer to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs shown in Table I are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38 degrees Celsius (100.4 degrees Fahrenheit).

Since measurement of deep body temperature is impractical for monitoring the workers' heat load, the measurement of environmental factors is required which most nearly correlate with deep body temperature and other physiological responses to heat. At the present time, Wet Bulb Globe Temperature Index (WBGT) is the simplest and most suitable technique to measure the environmental factors. WBGT

values are calculated by the following equations:

Outdoors with solar load: WBGT = 0.7 NWB + 0.2 GT + 0.1 DB

Indoors or Outdoors with no solar load: WBGT = 0.7 NWB + 0.3 GT

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Where:  WBGT = Wet Bulb Globe Temperature Index
        NWB = Natural Wet Bulb Temperature
        DB = Dry Bulb Temperature
        GT = Globe Temperature
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The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry bulb thermometer.

Higher heat exposures that shown in Table I are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant at work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38.0 degrees Celsius (100.4 degrees Fahrenheit).

Table 1
Permissible Heat Exposure Threshold Limit Values
(Values are given in degrees Centigrade WBGT (Fahrenheit)]

	Work Load		
Work- Rest Regimen	**Light**	**Moderate**	**Heavy**
Continuous work	30.0 (86.0)	26.7 (80.1)	25.0 (77.0)
75% Work, 25% Rest/Hour	30.6 (87.1)	28.0 (82.4)	25.9 (78.6)
50% Work, 50% Rest/Hour	31.4 (88.5)	29.4 (85.0)	27.9 (82.2)
25% Work, 75% Rest/Hour	32.2 (90.0)	31.1 (88.0)	30.0 (86.0)

References

1. "Working in Hot Environments," US Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, 1986.
2. "Threshold Limit Values and Biological Exposure Indices for 1986 - 1987," American Conference of Governmental Industrial, Hygienists, 6500 Glenway Avenue, Building D-7, Cincinnati, OH 45211-4438.

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Labor Standards and Safety Division

Physical Agent Data Sheet (PADS) - Radio Frequency/Microwave Radiation

Other PADS:
Cold Stress
Hand-Arm Vibration
Heat
Ionizing Radiation (PDF)
Lasers
Noise
Radio Waves
Ultraviolet Radiation

- Health Hazards
- Safety and Health Precautions
- Permissible Exposure Limits
- Microwave Ovens

Description

Radiofrequency and microwave radiation are both forms of energy called electromagnetic radiation. Sunshine contains three other forms of electromagnetic radiation: ultraviolet rays, infrared (heat) waves, and visible light waves.

These forms of energy are transmitted by waves. The distance between wave peaks is the "wavelength." The number of wave peaks passing a given point in one second is the "frequency."

Radiofrequency or radiowaves have a range of frequencies and wavelengths. Very High Frequency (VHF) radiowaves are used for TV and FM radio. Medium Frequency (MF) radiowaves are used for AM radio. Radiofrequency is used in heat sealers and glue driers.

Microwaves are actually just radiowaves of higher frequencies. Microwaves are used for radar and satellite communications, for telephone and TV transmissions, for microwave ovens, and for diathermy in medical clinics.

Electromagnetic radiation can interact with objects (or people) in three different ways. The energy waves can pass through an object without being changed, like light through a window. It can be reflected, like light off a mirror, or it can be absorbed and cause the object to heat up, like a sidewalk in the sun.

The health hazards of electromagnetic radiation are related only to the absorption of energy. The effects of absorbed energy depend on many different factors such as its wavelength and frequency, its intensity and duration. Different materials also absorb energy differently.

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Health Hazards

When microwaves or radiowaves are absorbed by body tissues, localized or spot heating can occur. The increased temperature can damage tissues, especially those with poor temperature control such as the lens of the eye.

Cataracts, clouding of the lens of the eye, may occur at the very high energy levels encountered close to radiating radar antennas. Heat damage to tissues is caused by high levels of exposure for short periods of time.

The health effects of low levels of exposure to radiowaves or microwaves for long periods of time are much harder to find and to prove. Some scientific studies show health effects from long-term, lowlevel exposure, other studies do not.

The following list includes health effects which some researchers suspect may be related to excessive radiofrequency/microwave exposure:

- Psychological changes, e.g., insomnia, irritability, mood swings,
- depression
- Headaches
- Nervous system abnormalities
- Hormonal changes
- Miscarriages and birth defects
- Male Infertility
- Altered immunity
- Leukemia

Of course, many of these health effects are relatively common, and most people having these problems have NOT had excessive exposure to radiofrequency/microwave radiation.

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Safety and Health Precautions

Employers who have people working around devices which produce radiofrequency/microwave radiation need to be sure that those devices are properly shielded to prevent leakage of radiation. Safety information regarding proper use and shielding of those devices can usually be obtained from owner/operators manuals, manufacturers, and the Alaska Department of Labor Occupational Safety and Health Section.

Radiofrequency sealers and heaters have been among the major sources of employee exposure to radiofrequency/microwave radiation. When these machines are used, employees should use mechanical or electrical devices that allow them to stay as far away form the source of radiation as possible. Whenever possible, these sealers should be turned off when not being used. Maintenance and adjustment of this type of equipment should be performed only by trained technicians and only when the machines are turned off.

Warnings should be posted to keep everyone away from the source of radiation except for those workers who are absolutely essential to performing the job.

People who are regularly exposed to significant levels of radiofrequency/microwave radiation should have preemployment and annual physical exams. The doctors should pay careful attention to the eyes to look for cataracts, to the nervous system for any abnormalities to the blood, to detect any early evidence of leukemia, and to the reproductive system to detect any abnormalities. Information concerning the frequency and intensity of the radiation exposures and duration of exposures should be provided to the physician.

In work areas where there is known or suspected to be significant amounts of radiofrequency/microwave radiation present, specialists should measure the amounts of radiation present. If excessive radiofrequency/microwave radiation is detected, modifications in the workplace should be made to reduce radiation exposure of workers. Afterwards, additional measurements should be made to determine if the radiation exposure has been reduced.

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Permissible Exposure Limits

The State of Alaska's permissible exposure limit is specified in Article I of Subchapter 4, Occupational Health and Environmental Control Code [04.0106 (a)], Alaska Occupational Safety and Health Standards. For normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 GHz, the radiation protection guide is 10 mW/cm (milliwatts per square centimeter) as averaged over any possible six-minute period.

Further information can be obtained from the Alaska Department of Labor, Occupational Safety and Health Section.

Microwave Cooking Ovens

Microwave ovens used for heating food, when used in accordance with manufacturer's instructions, do not expose personnel to microwave radiation.

Microwave ovens do not need to be included in an employer's Hazard Communication program.

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Labor and Workforce Development || Job Seeker || Employer || Worker

Physical Agent Data Sheet (PADS)

Ionizing Radiation

Description

Ionizing Radiation is the name given to a band of energy on the electromagnetic spectrum. X-rays and radioactive substances are examples of ionizing radiation.

In order to understand the difference between ionizing and nonionizing radiation it is necessary to review the structure of an atom.

All matter is made up of molecules which are chains of atoms hooked together in various combinations and shapes. An atom is the smallest unit of an element (like helium, oxygen or carbon) that still has all the properties of that element. Atoms are so small they cannot be seen with even the most powerful microscope.

All atoms are made up of three major subatomic particles: protons, neutrons, and electrons. Protons and neutrons make up the nucleus or center of the atom. Protons have a positive electric charge but neutrons have no electric charge. Electrons circle the nucleus and have a negative charge. In most atoms the negative charges of the electrons exactly balance the positive charges of the protons in the nucleus. If an atom has too many or too few electrons in orbit to balance the protons, the atom is called an ion.

The number of protons in the nucleus of an atom determines which element it is. An atom of helium has two protons and two neutrons. An atom of carbon has six protons and six neutrons. If the atom has too many or too few neutrons for the number of protons, the atom is unstable and is called an isotope. It will give off bursts of energy (radiation) in an attempt to become stable.

These bursts of energy or disintegrations may be in the form of alpha particles (two protons and two neutrons), beta particles (a negatively-charged electron), or gamma rays (an energy wave). If these charged particles or waves interact with another atom, they have enough energy to knock an electron out of its orbit, creating an ion. That is why this type of radiation is called ionizing radiation.

other forms of energy, like visible light, radiowaves, and infrared light, do not have enough power to knock electrons out of their orbits so they are called non-ionizing radiation.

Amounts of ionizing radiation can be expressed in several different units. A roentgen (R) is an amount of x-rays or gamma radiation which causes a specified amount of ionization among the atoms and molecules in a cubic centimeter of air. Another unit is the rad which applies to all ionizing radiation. It is a measure of the amount of energy absorbed from radiation in a specific volume of material.

A third unit which is more useful and used more commonly is the REM (Roentgen Equivalent Man). Measuring radiation in rems or millirems (one thousandth of a rem) allows direct comparison of the biological effects of different types of radiation.' Alpha particles, beta particles, and x-rays or gamma radiation, differ in their ability to cause damage in tissues due to their differences in ionizing and penetrating ability. Alpha particles are 20 times more damaging in tissue as the same amount of x-rays. Measuring radiation in rems takes this difference into account so that one rem of alpha radiation in

tissues has the same effect as one rem of beta radiation or one rem of x-rays. A rem is a relatively large quantity of radiation so most human exposures are measured in millirems. An easy way to remember the difference between these units is that a roentgen is a measure of how much you are exposed to, the rad is how much you absorb, and the rem is how much damage it does.

All people receive ionizing radiation from naturally occurring sources. Depending on where you live, most people receive an exposure in the range of 100 - 200 millirems per year from cosmic radiation from outer space and from naturally occurring isotopes (excluding radon) in the ground, air, food, and water. Radon is estimated to add another 150 -200 millirems per year to our background.

Medical and dental uses of x-rays can also contribute to a person's yearly radiation exposure. A typical well conducted chest x-ray involves an exposure of 10 - 30 milliroentgens.

With the use of radioactive isotopes in industry and the increasing use of x-ray sources, ionizing radiation exposures may occur in a wide variety of occupations. The following examples show the diversity of occupations potentially exposed to ionizing radiation.

Aircraft workers Military personnel
Atomic energy plant workers Nurses
Biologists Oil well loggers
Cathode ray tube makers Ore assayers
Ceramic workers Pathologists
Chemists Petroleum refinery workers
Density testers Physicians
Dental assistants Physicists
Dentists Pipeline oil flow testers
Dermatologists Pipeline weld radiographers
Drug makers Plasma torch operators
Drug sterilizers Plastic technicians
Electron microscope makers Prospectors
Electron microscopists Radar tube makers
Electrostatic eliminator operators Radiologists
Embalmers Radium laboratory workers
Fire alarm makers Radium refinery workers
Food preservers Research workers
Food sterilizers Television tube makers
Gas mantle makers Thickness gauge operators
High voltage television repairmen Thorium-aluminum alloy workers
High voltage vacuum tube makers Thorium-magnesium alloy workers
High voltage vacuum tube users Thorium ore producers
Industrial fluoroscope operators Tile glaziers
Industrial radiographers Uranium dye workers
Inspectors using, and workers in Uranium mill workers
proximity to, sealed gamma ray Uranium miners sources
sources (cesium-137, cobalt-60, Veterinarians
and iridium-192) X-ray aides
Klystron tube operators X-ray diffraction apparatus operators

Liquid level gauge operators X-ray technicians
Luminous dial painters X-ray tube makers
Machinists, fabricated metal product

Health Effects

The health risks and effects of exposure to ionizing radiation are dependent on the type of radiation (alpha, beta, gamma or x-ray), the energy, the dose rate, the quantity, and the body part exposed.

Alpha particles, due to their relatively large size and mass, do not travel very far in air (a few centimeters) and cannot pass through skin or even a sheet of paper. Alpha radiation is only hazardous if inhaled or ingested. It is the most damaging to tissue, however if it is inhaled or ingested. Beta particles are more penetrating than alpha; a thin sheet of aluminum will stop beta radiation, but beta radiation is not as damaging to tissue.

X-rays (and gamma) are the most penetrating and least damaging to tissue. Their penetrating capability makes them useful for medical diagnoses.

Some body parts are more sensitive to damage from ionizing radiation than other body parts. The reproductive and blood-forming organs and the eyes are the most sensitive while the extremities such as arms, hands, and feet are less sensitive.

The quantity of ionizing radiation to which a person is exposed is the greatest factor in the risk and severity of a radiation-related injury. Information on the health effects of a single large dose of ionizing radiation is readily available from studies of the casualties and survivors of the atomic explosions in Hiroshima and Nagasaki, from studies of people exposed to radioactive fallout from the early atom bomb testing and from accidents involving ionizing radiation.

Table 1 briefly outlines the health effects of a single acute dose of whole body radiation.

Table 1

Dose	Acute Effects
less than 25 rems	No detectable effect
25 - 50 rems	Drop in white blood cell count, no serious injury
50 - 100 rems	Possible injury and sickness; no disability
100 - 200 rems	Acute radiation sickness (nausea, vomiting, diarrhea, weakness, shock, skin sores, hair loss); possible disability
200 - 400 rems	Acute radiation sickness; disability certain, possible death without treatment

400 - 500 rems	50% death rate without treatment
> 600 rems	100% death rate

Occupational exposure to ionizing radiation is usually limited to a small area of the body such as the hands resulting in reddening of the skin or dermititis. Whole body radiation and acute radiation sickness occurs very rarely in occupational settings.

The health effects of long term exposure to low levels of ionizing radiation are less easily studied and documented. The concern about possible health effects, cancer and genetic effects in particular, from low level radiation stems from the known health effects of high doses of radiation and the assumption that the degree of risk is directly related to the degree of exposure. It is assumed (not proven) for safety sake, that any exposure to radiation above natural background levels contributes to small increases in the risk of developing cancer. Reducing exposure to the lowest level possible will, therefore, reduce the risk to the lowest level possible.

Emergency Procedures

The following emergency procedures were developed for medical facilities but can be generally applied to any workplace where radioactive substances are used.

A. Spills

Accidental spillage of radioactive material is rare, but cannot be prevented absolutely, and may occur in any laboratory, in any hall or passageway traversed by messengers transporting such material.

Except for a major accident to a shipping container or a serious spill in the hot laboratory, the amount of radioactive material involved in a spill will usually be small and the radiation from it will not constitute a serious hazard. The real danger is the spread of the contamination on shoes or other contaminated garments. The following is a general outline of the procedure to be followed in the event of a spill.

1. Confine the spill immediately by dropping paper towels or other absorbent material onto it.
2. Put on waterproof gloves.
3. Check shoes for visible signs of contamination. If it appears possible that they are contaminated, remove shoes when leaving the contaminated region.
4. If fans, ventilators, or air conditioners are operating in the area, they should be shut off. Preferably this should be done by someone not involved in the spill and therefore not likely to spread contamination.
5. Mark off or isolate in some way the entire suspect area and police it to be sure that no one walks through it.
6. CALL THE RADIATION PROTECTION SUPERVISOR. If the number is not posted in a convenient place, and you do not know it, call the telephone operator, report an emergency and ask the operator to find the supervisor.
7. In general, inexperienced personnel should not attempt to clean up a spill. It is better to wait a little while for the supervisor than to risk spreading the contamination by erroneous procedures. If the spilled material is covered and bystanders are kept a few feet away, there is little or no danger

from the radiation.

8. If any of the spilled material has splashed onto a person or clothing, immediate steps should be taken to remove it. Laboratory coats or outer garments should be taken off and left in the contaminated area. Hands or other skin areas should be washed thoroughly with soap. If it is certain that shoes or feet are not contaminated, it is permissible to walk to a washing facility, which subsequently, however, must be treated as a contaminated area until cleared by the Radiation Protection Supervisor. If there is doubt about contamination of the feet, a washbowl and soap should be brought to the suspect area for cleaning them.
9. The Radiation Protection Supervisor should bring decontamination materials and a survey meter, and the clean-up operation will proceed under the supervision of the RPS.
10. If the RPS is not immediately available, or clean-up must proceed without him or her, one person should do the work. This person should put on waterproof gloves, shoe covers and a surgical face mask if it is available. He will then take up the spilled material with absorbent paper, which must be handled with forceps or tongs, and deposit it immediately in a waterproof container. After as much as possible has been removed in this way, the surface should be washed with damp, not wet, rags held in forceps, always working toward the center of the contaminated area rather than away from it.
11. A survey meter should have been obtained from the office of the Radiation Protection Supervisor, and careful monitoring carried out during this procedure, on area and personnel. The meter should preferably be operated by someone who is not involved in the spill, so that the instrument is not likely to be contaminated.
12. Reduction of counting rate to five times background, over an area of 1 or 2 square feet or to ten times background over a few square inches is usually satisfactory, especially for short-lived nuclides. Eventually, the Radiation Protection Supervisor should check the area and give it clearance.
13. When the operation is finished, gloves and other protective garments should be carefully checked for residual contamination. If any is found, the garments should be left with the other contaminated material for ultimate clearance or disposal by the RPS.

B. Loss of a Sealed Source

The following is a general outline of the procedure to be followed in the event of loss of a sealed source:

1. Call the Radiation Protection Supervisor.
2. If all sources are supposed to have been removed from the patient, he or she should be checked with a survey meter to make sure that none has inadvertently been left behind.
3. Try to make sure that all bandages, linen, and bedding have been kept in the patient's room. If this is not the case, try to stop them on the way to the laundry or the incinerator.
4. Check all this material, a little at a time. Then check the room, to be sure the source is not on the floor or furniture.
5. Check the drain tap of any accessible plumbing facility.
6. Check the incinerator.
7. Check all barrels of ashes or garbage. The more active the source, the easier it should be to find it.

C. A Ruptured or Broken Sealed Source

1. Shut off all fans and ventilators.
2. Drop damp towels on the suspect material; throw nothing away.
3. Call the Radiation Protection Supervisor. The RPS will remove the questionable material and check the area for contamination.
4. If possible, evacuate the room. If not, keep all personnel several feet from the suspect material until the RPS arrives.

D. A Major Calamity: Fire, Earthquake, Tornado, A Massive Spill

1. Call the Radiation Protection Supervisor.
2. Prevent access to suspect areas, or removal of anything from them. Shut off ventilating system; close drains if possible.
3. Do not try to do anything until the RPS arrives. The RPS must be given complete charge.

Medical Treatment

Medical treatment of a person who has been accidentally over exposed to ionizing radiation will depend on the dose. Exposures less than 25 rems generally do not require treatment. The treatment will also depend on whether the source of the radiation is outside the body such as from x-ray equipment or a gamma emitter, or from inside the body such as when a radioactive dust is inhaled or ingested.

When the source of radiation is outside the body, and treatment is considered necessary, it is started after the entire radiation dose has been received. The dose cannot be lessened, therefore the objective of the treatment is to lessen the acute effects of radiation sickness, prevent secondary infections and provide transfusions to supplement weakened and damaged blood cells.

When the source of the radiation (the emitter) has been inhaled or swallowed, radiation exposure will continue and the goal of treatment is to reduce the quantity of the emitter in the body. This may be accomplished by speeding up the excretion of the emitter by chelation therapy. A chelating agent is a chemical which binds with Radioactive heavy metals enabling the body to excrete them faster. Chelation therapy is effective for internal emitters which are soluble in body fluids. Insoluble emitting substances which have been inhaled can be removed to some extent by bronchopulmonary lavage, a procedure which rinses out the lung's air sacs and airways.

Safety Procedures and Control Measures

The specific aspects, equipment, and procedures of a workplace radiation safety program will depend on the nature of the source, the type of radiation emitted, and the circumstances of its use. only general concepts of protection and control can be covered in a data sheet of this scope. The National Council on Radiation Protection and Measurements (NCRP) offers recommendations for specific uses of radiation emitting substances and equipment. A list of publications available from NCRP and an order form are attached to this data sheet.

Restricted Access: Only authorized trained personnel, should be allowed in work areas where radiation

emitting substances or equipment are used. Signs and warning notices using the standard radiation symbol must be posted.

Shielding: The selection of materials and designs for shielding will depend on the type of radiation, the use factor of the equipment, occupancy times, and workload.

Ventilation: Operations that routinely produce airborne contamination should utilize engineered containment and ventilation systems to prevent airborne releases. Appropriate respirators may be used but only when effective engineering controls are not feasible.

Radiation Monitoring: Radiation survey equipment appropriate for the type of radiation to be measured must be maintained and used to evaluate exposure conditions for employees. Working areas must be monitored at a frequency which will ensure safe working conditions. Individuals working in most industrial settings and many medical facilities must wear appropriate radiation monitoring devices to measure actual occupational exposures. Records of results for area and personal monitoring must be maintained.

Licensing and Registration: All by-product radioactive material and special nuclear material must be licensed by the Nuclear Regulatory Commission, and conditions of that license met by the user. Radioactive materials not under the jurisdiction of the Nuclear Regulatory commission and all x-ray sources must be registered with the State Department of Health and Social Services. Use must meet requirements of the State Radiation Protection Regulations, DH & SS, in addition to the Occupational Health and Environmental Control regulations of the Department of Labor. The NRC and the state may conduct inspections of licensees and registrants to ensure compliance.

Personal Protective Equipment

Respirators used for protection against airborne contamination should be approved by the National Institute of Occupational Safety and Health (NIOSH). If air-purifying respirators are used if only high efficiency (HEPA) cartridges approved for dusts, fumes, mists, and radionuclides or radon daughters (progeny) may be used. A good respirator program must include consideration of respirator type, fit, maintenance, testing, and training.

Protective clothing must be provided if the potential for skin or clothing contamination exists. Selection must be based on the nature of the contaminant (liquid or dry material) and the type of radiation emitted. Appropriate methods of laundering or disposal are also required. Contaminated clothing must not be taken home.

Permissible Exposure Limit

The Occupational Health and Environmental Control regulations state:

_____

(b) Exposure of individuals to radiation in restricted areas.

(1) No employer shall possess,, use, ortransfer sources of ionizing radiation in such a manner as to cause anyindividual in a restricted area to receive in any period of one calendar quarterfrom sources in the employer's possession or control a dose in excess of thelimits specified in Table 1-18.

Table 1-18 Rems per calendar quarter	
Whole body: Head and trunk; active bloodforming organs; lens of eyes; or gonads	1 1/4
Hands and forearms; feet and ankles	18 3/4
Skin of whole body	7 1/2

(2) An employer may permit an individual in a restricted area to receive doses to the whole body greater that those permitted so long as:

(A) During any calendar quarter the dose to the whole body hall not exceed three rems; and

(B) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed five (N-18) rems, where "IN" equals the individual's age in years at his last birthday; and

(C) The employer maintains adequate past and current exposure records which show that the addition of such a dose will not cause the individual to exceed the amount authorized, "Dose to the whole body" shall be deemedto include any dose to the whole body, gonad, active bloodformingorgans, head and trunk, or lens of the eye.

(3) No employer shall permit any employee who is under 18 years of age to receive in any period of one calendar quarter a dose in excess of ten percent of the limits specified in Table 1-18.

These regulations also cover definitions, exposure to airborne radioactive material,precautionary measures and personal monitoring, caution signs, labels and symbols, evacuationwarnings, instruction of personnel, waste disposal, notification of incidents, reports of overexposure,records and disclosure.

References

1. Occupational Diseases - A Guide to Their Recognition, DHEW (NIOSH) Publication No. 77-181. 1978.

2. Radiation Protection for Medical and Allied Health Personnel, National Council on Radiation Protection and Measurements Report No. 48. 1986.
3. Cralley, Lewis J. and Cralley, Lester V. Patty's Industrial Hygiene and Toxicology Volume III, pg. 359 - 404, John Wiley and Sons, Inc. 1979.

Physical Agent Data Sheet (PADS)

Lasers

Description

A laser is a device which produces a concentrated beam of electromagnetic energy. The beam of energy can be in the form of visible light or in the form of invisible infrared or ultraviolet radiation.

Lasers differ in many ways, but there are certain characteristics which all lasers have in common. For all lasers, the production of the concentrated beam of energy requires three basic processes. First, an energy source is applied to a solid, gaseous or liquid substance called the lasing material. The lasing material then produces radiation having a specific wavelength. Then by using mirrors, lenses and shutters, the light or infrared waves or ultraviolet rays are magnified and focused to produce the laser beam.

Lasers may be different from one another in several specific ways. The basic categories are:

1. Type of lasing material used.

   The lasing material may be solid, like ruby crystals or glass; may be a gas or mixture of gases, such as carbon dioxide or a helium-neon mixture; or liquid containing special dyes.
2. Source of energy applied.

   The energy applied to the lasing material may come from a powerful light source, electric current, or a chemical reaction.
3. Continuous or pulsed emission of the laser beam.

   The energy applied to the lasing material may be continuous or applied on pulses. Some lasers can produce hundreds of thousands of pulses per second.

Hazards

The hazards related to the use of lasers vary depending on the type of laser, the power of the laser, the purpose and manner in which the laser is used, and the safety features of the laser.

Health Hazards

Eye injuries are the most serious danger from laser beams. The cornea of the eye is like a glass window that allows light to enter the eye. It is located in the very front part of the eyeball. The cornea is very sensitive and injuries to the cornea can be very painful. most injuries to the cornea heal without permanent damage. If the deep layers of the cornea are affected, permanent injuries can occur. The types of eye injuries which occur from improper use of lasers depend on the wavelengths of the laser beams. Laser injuries to the cornea are usually caused by lasers having short wavelengths in the ultraviolet and long wavelengths in the infrared ranges.

The lens of the eye is located toward the front of the eyeball but behind the cornea. Injuries to the lens

can result in loss of transparency of the lens. The lens becomes cloudy and then blocks some of the light rays entering the eye, thus making it hard to create clear images on the retina. When the lens of the eye becomes cloudy, it is called a cataract. While damage to the cornea usually heals completely in a day or two, damage to the lens almost always persists. Very slight damage to the lens may go unnoticed, but repeated minimal damage can add up to serious damage later on. Damage to the lens may not cause problems until many years after the injuries to the lens occurred. Lens damage is most likely to occur with certain lasers that produce beams in the near-ultraviolet and near-infrared wavelength range.

The retina of the eye is the surface upon which visual images are produced. It is located in the back of the eyeball. Certain lasers in the wavelength ranges of visible light and near-infrared wavelength ranges can burn permanent blind spots in the retina causing partially or totally obscured vision.

Skin burns may also occur from the use of lasers but are less likely to occur and are less serious than eye injuries. When skin is exposed to a potentially dangerous laser beam, a person will usually feel the heat and remove the exposed part of the body from the path of the laser beam.

Electrical Hazards

Some lasers require high voltage power supplies and some workers have received electrical shock because of carelessness while working around these power supplies. Almost all laser power supplies under certain circumstances, could possible cause electrical shock or electrocution. Following the general safety standards for other electrical or electronic equipment provides protection against the dangers of electrical shock or electrocution.

Chemical Hazards

Laser welding or cutting of metals will cause formation of many of the same metal oxides and other fumes that are produced in conventional welding processes. Explosions can occur when ice collects in valves or connectors in lasers which require very cold liquids, such as liquid nitrogen.

Lasers are commonly used in the workplace to perform the following functions:

Welding and machining
Surgery
Communication: via fiber optic technology
Shock hardening, glazing, drilling
Cutting textiles
Leveling and alignment of building sites

Safety Classifications of Lasers

For safety purposes, lasers are divided into Classes I, II, III, and IV; Class I being least hazardous and Class IV most hazardous. Almost all reported eye injuries have been from Class IV lasers.

Almost all lasers that produce visible light beams are so bright that they can produce eye injuries. Therefore, to reduce risk of health hazards to the eye, many are designed in a way, such as enclosing the laser beam in a box, which prevents direct eye exposure to the beam.

Any laser which by itself is in Class II, III, or IV may be reclassified to a lower risk category if the laser beam is enclosed in such a way to decrease the risk of hazardous exposure to people.

Class I lasers are considered entirely safe even if used improperly. Class I lasers do not require any warning labeling. Some more hazardous lasers may be placed in the Class I category when they are part of a consumer or office machine which shields the user from the hazards of the laser beam. These machines, however, must have some type of warnings which are visible if the shields are removed.

Class II lasers are often referred to as "low-power" or "low-risk" lasers. These lasers are hazardous only when someone stares directly into the laser beam even though the beam hurts the eyes. Class II lasers require warnings to avoid staring directly into the beam.

Class III lasers are Moderate Risk or Medium Power lasers. They can produce eye injuries when the laser beams are viewed directly or when a sharp reflection is viewed directly. Class III is subdivided into Class IIIA and IIIB. Class IIIA is considered to be hazardous only when the laser beam is collected and focused by optical instruments, for example when surveyors look into a laser beam with a telescope-like instrument. Class IIIA lasers require warnings to prevent such hazardous practices. These lasers can cause serious eye injuries before someone who accidentally looks directly into the beam has a chance to blink.

Class IV lasers produce beams that when reflected, even if it is not a sharp reflection, may cause serious eye and skin injuries, and where the beam may be a fire hazard. It is critical that the dangers of Class IV lasers are clearly marked with warning signs.

Safety Precautions

Class I Controls

No user safety rules are necessary.

Class II Controls

1. Never permit a person to continuously stare into the laser source if exposure levels exceed the applicable permissible exposure level for the duration of intended staring.
2. Never point the laser at an individual's eye unless a useful purpose exists and the exposure level and duration will not exceed the permissible limit.

Class III Controls

1. Do not aim the laser at an individual's eye.
2. Permit only experienced personnel to operate the laser.
3. Enclose as much of the beam path as possible. Even a transparent enclosure will prevent individuals from placing their head or reflecting objects within the beam path. Terminations should be used at the end of the useful path of the direct and any secondary beams.
4. Shutters, polarizers and optical filters should be placed at the laser exit port to reduce the beam power to the minimal useful level.
5. Control spectators.
6. A warning light or buzzer should indicate laser operation. This is especially needed if the beam is not visible, e.g., for infrared lasers.
7. Do not permit laser tracking of nontarget vehicles or aircraft.
8. Operate the laser only in a restricted area, for example, in a closed room without windows, and

place a warning sign on the door.

9. Place the laser beam path well above or well below the eye level of any sitting or standing observers whenever possible. The laser should be mounted firmly to assure that the beam travels only along its intended path.
10. Always use proper laser eye protection if a potential hazard exists for the direct beam or a specular reflection.
11. A key switch should be installed to minimize tampering by unauthorized individuals.
12. The beam or its specular reflection should never be directly viewed with optical instruments such as binoculars or telescopes without sufficient protective filters.
13. Remove all unnecessary mirror-like surfaces from within the vicinity of the laser beam path.

Class IV Controls

Fortunately, these high-power lasers are seldom used outside of research laboratories and restricted industrial environments where personnel access is carefully controlled.

These lasers should only be operated within a localized enclosure, or in a controlled workplace, or where the beam is directed into outer space. If a complete local enclosure is not possible, laser operation indoors should be in a light-tight room with interlocked entrances to assure that the laser cannot emit while a door is open.

1. Eye protection is needed for all individuals working within the controlled area. If the laser beam irradiance is sufficient to be a serious skin or fire hazard, a suitable shielding should be used between the laser beam and any personnel.
2. Remote firing with video monitoring or other remote (safe) viewing techniques should be chosen when feasible.
3. Outdoor high-power laser devices such as satellite laser transmission systems and laser radar (LIDAR) should have positive stops on the azimuth and elevation transverse to assure that the beam cannot intercept occupied areas or nontarget aircraft.
4. Beam shutters, beam polarizers, and beam filters should always be used to limit use to authorized personnel only. The flashlamps in optical pump systems should be shielded to eliminate any direct viewing.
5. Backstops should be diffusely reflecting-fire resistant target materials where feasible. Safety enclosures should be used around microwelding and microdrilling work pieces to contain hazardous reflections from the work area. Microscopic viewing systems used to study the work piece should ensure against hazardous levels of reflection of laser irradiation back through the optics.

Emergency Procedures

Anyone who is suspected of having a laser-related eye injury should be examined as soon as possible by an ophthalmologist, a physician who specializes in the care of eye injuries and diseases.

Laser-related skin burns should be treated as any other skin burns. Cold water should be applied immediately to the burn area for first and second degree burns (reddened skin or blistering skin). Third degree burns (open wound) should be covered with a sterile dressing and the person taken to a medical

facility. Never put ointments, creams or butter on burns.

Permissible Exposure Limits

Lasers used in construction shall comply with:

e. Nonionizing radiation

1. Only qualified and trained employees shall be assigned to install, adjust, and operate laser equipment.
2. Proof of qualification of the laser equipment operator shall be available and in posession of operator at all times.
3. The employer shall provide antilaser eye protection as specified in section 50 of this subchapter for employees working in areas where a potential exposure to direct or reflected laser light greater than 5 milliwatts exist.
4. Areas in which lasers are used shall be posted with standard laser warning placards.
5. Beam shutters or caps shall be utilized, or the laser turned off, when laser transmission is not actually required. The laser shall be turned off whenever the laser is left unattended.
6. Only mechanical or electronic means shall be used as a detector for guiding the internal alignment of the lasers.
7. The laser beam shall not be directed at employees.
8. Under conditions of rain, snow, fog or dust the use of laser systems is prohibited.
9. Laser equipment shall bear a label to indicate maximum output.
10. Employees shall not be exposed to light intensities above:

    a. Direct staring: one microwatt per square centimeter.
    b. Incidental observing: two and one-half watts per square centimeter.
    c. Diffused reflected light: two and one-half watts per square centimeter.
11. Laser units in operation shall be set up above the heads of the employees.

References

1. Sliney, D. & Walbarsht, M., Safety with Lasers and Other Optical Sources. Plenum Press, New York, NY 10013.

Physical Agent Data Sheet (PADS)

Noise

Description

Sound is created when a vibrating source (like a bell, motor or a stereo speaker) sends sound waves through the air to your ear. Every sound has two aspects: its pitch (frequency) and its loudness (intensity). On a stereo, frequency is determined by the bass/treble control. Intensity is determined by the volume control. Noise (unwanted sound) is usually made up of many frequencies. The disturbing and harmful effects of noise depend both on the loudness and the frequency of the tones making up noise.

Loudness is measured in units called decibels (dB). A conversational voice is about 65 dB. A shout is 90 dB or greater.

Frequency is measured in units called Hertz (Hz). The frequency of a locomotive horn is about 250 Hz. The frequency of a table saw is about 4,000 Hz.

Health Effects

Excessive noise can destroy the ability to hear, and may also put stress of other parts of the body, including the heart.

For most effects of noise, there is no cure, so that prevention of excessive noise exposure is the only way to avoid health damage.

Hearing

The damage done by noise depends mainly on how loud it is and on the length of exposure. The frequency or pitch can also have some effect, since high-pitched sounds are more damaging than low-pitched sounds.

Noise may tire out the inner ear, causing temporary hearing loss. After a period of time away from the noise hearing may be restored. Some workers who suffer temporary hearing loss may find that by the time their hearing returns to normal, it is time for another work shift so, in that sense, the problem is "permanent."

With continual noise exposure, the ear will lose its ability to recover from temporary hearing loss, and the damage will become permanent. Permanent hearing loss results from the destruction of cells in the inner ear, cells which can never be replaced or repaired. Such damage can be caused by long-term exposure to loud noise or, in some cases" by brief exposures to very loud noises.

Normally, workplace noise first affects the ability to hear high frequency (high-pitched) sounds. This means that even though a person can still hear some noise, speech or other sounds may be unclear or distorted.

Workers suffering from noise-induced hearing loss may also experience continual ringing in their ears,

called "tinnitus." At this time, there is no cure for tinnitus, although some doctors are experimenting with treatment.

Other Effects

Although research on the effects of noise is not complete, it appears that noise can cause quickened pulse rate, increased blood pressure and a narrowing of the blood vessels over a long period of time, these may place an added burden on the heart.

Noise may also put stress on other parts of the body by causing the abnormal secretion of hormones and tensing of the muscles.

Workers exposed to noise sometimes complain of nervousness, sleeplessness and fatigue. Excessive noise exposure also can reduce job performance and may cause high rates of absenteeism.

Permissible Exposure Limit

The Action level for noise is an average noise level of 85 dB for an eight-hour day. When employees are exposed to noise levels, which exceed the Permissible Exposure Limit, the employer must install or use engineering or administrative controls to lower the noise levels. While these controls are being designed or installed employees must wear hearing protection. If the controls still do not reduce noise exposures to below 90 dB, hearing protection must continue to be worn.

Protective Measures

Suitable hearing protectors (earplugs or muffs) must be made available at no cost to employees who are exposed to an average of 85 dB or greater for an eight-hour day. Employees must be given the opportunity to select from three different types of appropriate hearing protectors.

Hearing tests (audiometric exams) must be given to employees who are exposed to an average of 85 dB or greater for an eight-hour day. Hearing tests will show whether employees are experiencing any hearing losses. Hearing tests are also useful in showing how well the earplugs and earmuffs are working. Hearing tests must be given annually.

Employees should also receive training in the effects of noise on hearing, an explanation of the hearing tests, and instruction on the proper fitting and care of earplugs or muffs.

Noise away from work can also cause hearing loss. Hearing protectors should be worn when operating noisy equipment or tools such as chain saws, brush cutters, power lawn mowers, or when using firearms.

Physical Agent Data Sheet (PADS)

Ultraviolet Radiation

Description

Ultraviolet (UV) is the name for a band of energy on the electromagnetic spectrum that lies between visible light and x-rays. UV has some of the properties of visible light and other properties of the x-rays. Like visible light, some UV is actually visible but most is invisible like x-rays. UV, like light, cannot penetrate very far into most solids. Some UV, like x-rays, can ionize atoms or molecules which visible light cannot do.

Common sources of UV include the sun (especially when reflected by water, snow or ice), sun tanning lamps, mercury discharge lamps, welding arcs, plasma torches, and some lasers.

Health Hazards

The nature and seriousness of UV injuries depend on the length of exposure, the intensity of the UV, the type or wavelength of UV, the sensitivity of the individual, and the presence of certain chemicals (photosensitizers).

Skin

UV from the sun causes sunburns and skin cancer. UV from other sources can also cause skin burns varying in degree from mild reddening of the skin (first degree burns) to more severe and painful blistering (second degree burns). Long-term skin exposure to UV can cause actinic skin (a dry, brown, inelastic wrinkled skin) and skin cancer. Fair skinned individuals are more likely to develop both sunburns and skin cancer.

Some drugs, such as the antibiotic tetracycline, can cause skin burns from UV to happen faster and to be more severe. Products containing coal tar can also cause this reaction. These substances are called photosensitizers.

UV exposure may trigger cold sores (Herpes Simplex) in some individuals.

Eyes

When UV is absorbed by the eyes and eyelids, it can cause keratoconjunctivitis or "welders' flash." This is a very painful condition that feels like grit in the eyes and may make the eyes water and very sensitive to light. The condition usually occurs 6-12 hours after exposure and may last 6-24 hours. The painful injury may make a person unwilling or unable to open his/her eyes during this time period, but most discomfort is gone within 48 hours with no lasting injury. The maximum sensitivity of the eye occurs at a UV wavelength of 270 manometers. Cataracts or clouding of the lens of the eye can occur during high exposures to wavelengths in the range of 295-300 nanometers.

Skin Safety and Health Precautions

Skin burns from high, short-term exposure to UV and skin cancer from long-term exposure can be prevented by covering exposed skin with clothing and protective equipment such as gloves and face shields.* Barrier creams or lotions with sun protection factors (SPF) of 15-18 will also help prevent skin burns.

* Welders' helmets should provide protection for the neck area as well as the face and eyes.

Eyes

Tinted goggles and/or face shields should be worn to prevent burns of the cornea and eyelids. Selection of the appropriate degree of tint should be based on the anticipated wavelength and intensity of the UV source. (see Table 1)

Table 1
Shade No. 3.0: is for glare of reflected sunlight from snow, water, sand, etc.; stray light from cutting and welding, metal pouring and work around furnaces and foundries; and soldering (for goggles or spectacles with side shields worn under helmets in arc welding operations, particularly gas-shielded arc welding operations).
Shade Nos. 4.0 and 5.0: are for light acetylene cutting and welding; light electric spot welding.
Shade Nos. 6.0 and 7.0: are for gas cutting, medium gas welding, and non-gas-shielded arc welding using current values up to 30 amperes.
Shade Nos. 8.0 and 9.0: are for heavy gas cutting and nongas-shielded arc welding and cutting using current values from 30 to 75 amperes.
Shade Nos. 10.0 and 11.0: are for arc welding and cutting using current values from 75 to 200 amperes.
Shade Nos. 12.0 and 13.0: are for arc welding and cutting using current values from 200 to 400 amperes.
Shade No. 14.0: is for arc welding and cutting using current values over 400 amperes (including carbon arc welding and cutting), and for atomic hydrogen welding.
NOTE: ordinary window glass, 1/811 in thickness, is sufficient protection for the eyes and skin against the ultraviolet radiation from ordinary sources such as sunlight. In cases of extremely intense sources of ultraviolet and visible radiation, it is not adequate.

In sunny conditions on water, snow and ice, extra precautions should be taken to protect against reflected

sunlight. Sunglasses with side shields should be worn. When applying protective ointments or lotions, special attention should be paid to the nose, lips, underside of the chin, and tops of the ears.

In workplaces, operations such as welding which produce high levels of UV should be performed behind enclosures or barriers to absorb the radiation and shield nearby workers.

UV sources like mercury discharge lamps should be operated only with all safety devices in place and in accordance with manufacturer's instructions.

First Aid Procedures

Skin burns: immediate application of cold (cold water, ice, cold clean cloths) to the affected area will reduce the severity and relieve pain associated with first and second degree burns. Do not apply any burn ointments, creams, or butter to skin burns.

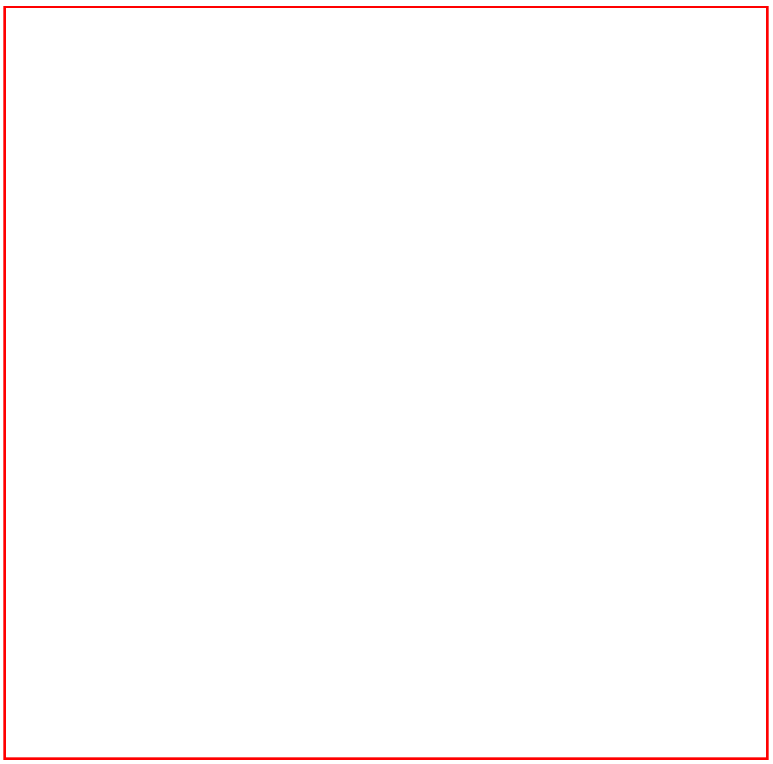
Eyes: place sterile dressings over the eyes of a person suffering from UV burns of the eyes and seek medical attention.

Recommended Exposure Limits[2]

The following section is very technical and is included for the use of safety and health professionals who have the skills and equipment to measure UV levels.

These threshold limit values (TLVS) refer to ultraviolet radiation in the spectral region between 200 and 400 nm and represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effect. These values for exposure of the eye or skin apply to ultraviolet radiation from arcs, gas and vapor discharges, flourescent and incandescent sources, and solar radiation, but do not apply to ultraviolet lasers. These values do not apply to ultraviolet radiation exposure of photosensitive individuals or of individuals concomitantly exposed to photosensitizing agents. These values should be used as guides in the control of exposure to continuous sources where the exposure duration shall not be less that 0.1 sec (Figure 1).

Figure 1



These values should be used as guides in the control of exposure to ultraviolet sources and should not be regarded as a fine line between safe and dangerous levels.

Recommended Values

The threshold limit value for occupational exposure to ultraviolet radiation incident upon skin or eye where irradiance values are known and exposure time is controlled are as follows:

1. For the near ultraviolet spectral region (320 to 400 nm), total radiance incident upon the unprotected skin or eye should not exceed 1 mW/cm for periods greated than 110 seconds (approximately 16 minutes) and for exposure times less than 10 seconds should not exceed one J/cm.

2. For the actinic ultraviolet spectral region (200 to 315 nm), radiant exposure incident upon the unprotected skin or eye should not exceed the values given in Table 2 within an 8-hour period.

Table 2
Relative Spectral Effectiveness by Wavelength*

Wavelength (nm)	TLV (mJ/cm^2)	Relative Special Effectiveness Sl
200	100	0.03
210	40	0.075
220	25	0.12
230	16	0.19

240	10	0.30
250	7	0.43
254	6	0.5
260	4.6	0.65
270	3.0	1.0
280	3.4	0.88
290	4.7	0.64
300	10	0.30
305	50	0.60
310	200	0.015
315	1000	0.003

* See Laser TLVS.

3. To determine the effective irradiance of a broadband source weighted against the peak of the spectral effectiveness curve (270 nm), the following weighting formula should be used:

$$E_{eff} = \Sigma E\lambda \, S\lambda \, \Delta \lambda$$

where:

E_{eff} = effective irradinace relative to a monochromatic source at 270 nm in W/cm^2 [$J/ (s \, cm^2)$]

$E\lambda$ = spectral irradiance in W/(cm nm)

$S\lambda$ = relative spectral effectiveness (unitless)

$\Delta \lambda$ = band width in manometers

4. Permissible exposure time in seconds for exposure to actinic ultraviolet radiation incident upon the unprotected skin or eye may be computed by dividing 0.003 J/cm^2 by E_{eff} in W/cm^2. The exposure time may also be determined using Table 3 which provides exposure times corresponding to effective irradiances in μ W/cm^2.

Table 3 Permissible Ultraviolet Exposures

Duration of Exposure Per Day	Effective Irradiance E_{eff} (m W/cm^2)
8 hrs	0.1
4 hrs	0.2
2 hrs	0.4
1 hr	0.8
30 min	1.7
15 min	3.3
10 min	5.0
5 min	10.0
1 min	50.0
30 sec	100.0
10 sec	300.0
1 sec	3,000.0
0.5 sec	6,000.0
0.1 sec	30,000.0

5. All the preceding TLVs for ultraviolet energy apply to sources which subtend an angle less than 80 degrees. Sources which subtend a greater angle need to be measured only over an angle of 80 degrees.

Conditioned (tanned) individuals can tolerate skin exposure in excess of the TLV without erythemal effects. However, such conditioning may not protect persons against cancer.

Reference

1. Sunlight and Man. Fitzpatrick et all Eds. University of Tokyo Press, Tokyo, Japan (1974).

2. Threshold Limit Values and Biological Exposures Indices for 1986 - 1987. American Conference of Governmental Industrial Hygienists, 6500 Glenway Avenue, Building D-7, Cincinnati, Ohio 45211-4438.

Physical Agent Data Sheet (PADS)

Hand-Arm Vibration

Description

Hand-arm vibration is caused by the use of vibrating hand-held tools, such as pneumatic jack hammers, drills, gas powered chain saws, and electrical tools such as grinders. The nature of these tools involves vibration (a rapid back and forth type of motion) which is transmitted from the tool to the hands and arms of the person holding the tool.

Health Hazards

Vibration Syndrome and Vibration-Induced White Finger (VWF) are the major health hazards related to the use of vibrating tools. Carpal Tunnel Syndrome is another health problem that has been linked in one study to the use of smaller hand-held vibrating tools.

Vibration Syndrome

Vibration Syndrome is a group of symptoms related to the use of vibrating tools and includes -some or all of the following: muscle weakness, muscle fatigue, pain in the arms and shoulders, and vibration-induced white finger. Many researchers believe that other symptoms--headaches, irritability, depression, forgetfulness, and sleeping problems--should also be included in descriptions of Vibration Syndrome.

Vibration-Induced White Finger

Vibration-Induced White Finger (VWF), also known as "Dead Finger" or "Dead Hand" is the result of impaired circulation (poor blood supply in the fingers, caused by the prolonged use of vibrating tools. VWF may appear after only several months on the job, or may not appear until twenty to forty years on the job.

The harmful health effects of vibrating tools are related to the length of time that a worker has been using vibrating tools and to the frequency of the vibration (how fast the tool goes back and forth). The longer a person uses a vibrating tool, and the faster the tool vibrates, the greater the risk of health effects. The length of the initial symptom-free period of vibration exposure (i.e., from first exposure to the first appearance of a white finger) is known as the latent interval. It is related to the intensity of the vibration - the shorter the latent period, the more severe the resulting VWF if vibration exposure continues.

Temporary tingling or numbness during or soon after use of a vibrating hand tool is not considered to be VWF, however tingling and numbness in the fingers lasting more than an hour after finishing work may indicate early stages of VWF. Table 1 lists the stages that Vibration White Finger may progress through if exposure continues.

Table 1
Stages of Vibration White Finger
(Taylor-Pelmear System)

Stage	Condition of Fingers	Work & Social Interference
00	No tingling, numbness or blanching of fingers	No complaints
OT	Intermittent tingling	No interference with activities
ON	Intermittent numbness	No interference with activities
TN	Intermittent tingling and numbness	No interference with activities
1	Blanching of a fingertip with or without tingling and/or numbness	No interference with activities
2	Blanching of one or more fingers beyond tips, usually during winter	Possible interference with activities outside work, no interference at work
3	Extensive blanching of fingers; frequent episodes in both summer and winter	Definite interference at work, at home, and with social activities; restriction of hobbies
4	Extensive blanching of most fingers; frequent episodes in both summer and winter	Occupation usually changed because of severity of signs and symptoms

The technical name for VWF is Raynaud's Syndrome of Occupational Origin. Raynaud's Syndrome may also occur in people who do not use vibrating hand-held tools. Several different kinds of medical illnesses can cause Raynaud's Syndrome. Raynaud's Syndrome also appears in some people who are otherwise entirely healthy.

It is important that people with Raynaud's Syndrome avoid the extensive use of vibrating tools because they can develop the most severe complications of VWF very quickly.

Many of the symptoms of Vibration Syndrome will disappear shortly after a worker stops using the types of tools which transmit vibration to the hands and arms. Fatigue and muscular pain in the arms and shoulders will generally disappear. In the early stages, if a worker stops using vibrating tools, VWF will not get any worse and may get slightly better.

Carpal Tunnel Syndrome

Carpal Tunnel Syndrome (CTS) is a group of symptoms in the hand which arise from pressure on one of the nerves which passes through the palm side of the wrist. The early symptoms are similar to the early symptoms of white finger and consist of tingling in the fingers. For the most part only the thumb, index, and middle fingers are affected in CTS. Later, symptoms can progress to numbness. Pain in the wrist and fingers may also develop. CTS may occur in people using small hand tools like pneumatic screwdrivers. Carpal Tunnel Syndrome also occurs among people having repetitive motion of the wrist or fingers, such as using a cash register, or picking fish from a net; or with forceful motion of the wrist, such as in using a

wrench. Pinching or flexing with the wrist bent upwards, downwards, or sideways increases the occurrence of CTS.

The symptoms of CTS are frequently worse at night and a person may be awakened from sleep by pain or the feeling of pins and needles in fingers, hand or wrist.

Carpal Tunnel Syndrome may improve if diagnosed in the early stages and exposure to the type of activity which caused it is stopped. In moderate cases most of the symptoms of CTS can be relieved by a surgical operation which relieves the pressure on the nerve which causes the CTS symptoms. If the surgery is performed too late, only some of the symptoms may be relieved. In very severe cases the symptoms are irreversible and may include weakness of the hand due to loss of muscle function.

Preventing Hand-Arm Vibration Diseases

Job Modification to Reduce Vibration Exposure

Wherever possible, jobs should be redesigned to minimize the use of hand-held vibrating tools. Where job redesign is not feasible, ways to reduce tool vibration should be found. Where practical, substitute a manual tool for a vibrating tool. Whenever possible, high vibration tools should be replaced by improved, low vibration tools designed to absorb vibration before it reaches the handgrip.

Determine vibration exposure times and introduce work breaks to avoid constant, continued vibration exposure. A worker who is using a vibrating tool continuously should take a 10 minute break after each hour of using the tool.

Medical Evaluation

Workers whose occupations place them at risk for developing VWF should have pre-employment physicals and thereafter should be checked at least annually by doctors who know about the diagnosis and treatment of VWF. Diagnostic tests which can be used include plethysmography, arteriography, skin thermography, and sensory tests,, such as two point discrimination depth sense, pinprick touch and temperature sensation. X-rays may also be useful.

Workers that have a past history of abnormalities in blood circulation and especially workers who have Raynaudis Syndrome should not be permitted to use vibrating hand-held tools. Workers who have moderate to severe symptoms of VWF should be reassigned to work which removes them from further direct exposure to vibrating tools.

If workers develop symptoms of tingling or numbness, or if their fingers occasionally become white or blue, or painful especially when cold, they should be examined by a doctor who knows about the diagnosis and treatment of VWF and CTS.

Work Practices

Workers using vibrating hand-held tools should wear multiple layers of warm gloves and should wear anti-vibration gloves whenever possible. Before starting the job, warm the hands. This is especially important when it is cold. workers using vibrating tools should not allow the hands to become chilled. If the hands of a worker using vibrating tools become wet or chilled, he should dry them and put on dry, warm gloves before resuming exposure to vibration. Workers exposed to cold should dress adequately to keep the whole body warm because low body temperature can make a worker more susceptible to VWF.

A worker using a vibrating hand-held tool should let the tool do the work by grasping it as lightly as possible, consistent with safe work practice. The tighter the tool is held, the more vibration is transmitted to the fingers and hand. The tool should rest on a support or on the workpiece as much as possible. The tool should be operated only when necessary and at the minimum speed (and impact force) to reduce vibration exposure.

Tools should be regularly maintained to keep vibration to a minimum. Keeping chisels and chainsaws sharp, for example, will reduce vibration. Using new grinder wheels will also reduce vibration.

Education

Employees who use or will be using vibrating hand-held tools should receive training about the hazards of vibration and they should be taught how to minimize the ill effects of vibration.

Smokers are much more susceptible to VWF that non-smokers, and the VWF in smokers is usually more severe, therefore workers who use vibrating hand-held tools should not smoke.

Recommended Exposure Limits

Table 2 contains the American Conference of Governmental Industrial Hygienists (ACGIH) recommendations on the limits for exposure of the hand to vibration.

Table 2
Threshold Limit Values for Exposure of the Hand to Vibration in Either X_h, Y_h, Z_h, Directions

Total Daily Exposure Duration[a]	Values of the Dominant,[b] Frequency-Weighted, rms, Component Acceleration Which Shall Not be Exceeded a_k, (a_{keg})	
	m/s^2	g^c
4 hours and less than 8	4	0.40
2 hours and less than 4	6	0.61
1 hour and less than 2	8	0.81
less than 1 hour	12	1.22

[a] The total time vibration enters the hand per day, whether continuously or intermittently.

[b] Usually one axis of vibration is dominant over the remaining two axes. If one or more vibration axes exceeds the Total Daily Exposure then the TLV has been exceeded.

[c] g = 9.81 m/s . d



Biodynamic and basicentric coordinate systems for the hand, showing the directions of the acceleration components (ISO 5349 and ANSI S3.34-1986).

Appendix G

Laboratory QA Manual (provided under separate cover)

Appendix H

Laboratory SOPs (provided under separate cover)

Appendix I

Response to Comments Matrix Tables

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated Sites Program

610 University Ave
Fairbanks, Alaska, 99709-3643
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June 11, 2021

File No: 107.38.006
107.38.150

Kristina Smith
Installation Restoration Program
AFCEC CZOP
2310 Central Avenue, Suite 213
Eielson AFB, AK 99702

Re: **DEC Approval for the *Final Quality Assurance Project Plan, Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base, Fairbanks North Star Borough, Alaska, June 2021***

Dear Ms. Smith:

The Alaska Department of Environmental Conservation (DEC) has completed a backcheck review of the above referenced *Final Quality Assurance Project Plan, Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base, Fairbanks North Star Borough, Alaska, June 2021* (QAPP). The purpose of the Remedial Investigation (RI) is to characterize the nature and extent of 24 PFAS compounds, specifically perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) through the application of adaptive high-resolution site characterization and the development of a flux-based conceptual site model (CSM).

Based on the United States Air Force (USAF) responses to DEC comments for the QAPP, the issue of appropriate soil screening levels remains a point of disagreement, and resolution will not likely occur in the near term. DEC considers delineation of nature and extent of contamination to include the extent of soil that is above the DEC Table B1 Method Two migration to groundwater soil cleanup levels identified at 18 AAC 75.341. DEC will not approve language in the QAPP WS# 15 that the, "ADEC Table B1 Method Two MTGW cleanup levels and Table C Groundwater Cleanup Levels (ADEC, 2019b) are included for comparison purposes and will not be used for decision making purposes."

The USAF references the *Assistant Secretary of Defense Memorandum, Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program (ASD, 2019a)* and states that, "the Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) should be used for screening to determine if further investigation in the RI phase is warranted." However, DEC asserts that the USAF is not properly implementing the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regarding consideration

of potential applicable, relevant, and appropriate requirements (ARARs) early in the Remedial Investigation process, or the appropriate evaluation of the potential for contamination in soil to migrate to groundwater. The identification and determination of potential ARARs is discussed in the *Eielson Air Force Base Federal Facilities Agreement* at Paragraph 20.10:

> For those primary or secondary documents that consist of or include ARAR determinations, prior to the issuance of a draft document the Project Managers shall meet to identify and propose, to the best of their ability, all potential ARARs pertinent to the report being addressed. Draft ARAR determinations shall be prepared in accordance with Section 121(d)(2) of CERCLA, 42 U.S.C. 9621(d)(2), the NCP, and pertinent written guidance issued by U.S. EPA and ADEC, that is not inconsistent with CERCLA and the NCP.

DEC has also noted that Section 1.4.1 of EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* states that, "[S]coping in the beginning of the RI/FS process includes, "Initiating the identification and discussion of potential ARARs with the support agency." DEC is identifying the migration to groundwater soil cleanup levels documented at 18 AAC 75.341 as potential chemical-specific ARARs. Additional information on characterization of soil contamination is found in 18 AAC 75.335(b)(2)(B), 18 AAC 75.335(b)(2)(G) and 18 AAC 75.340(j)(1).

DEC will not approve language in the QAPP WS# 11 DQOs that the, "AFCEC contract specified comparison of analytical data against the EPA soil RSLs for PFOA, PFOS, and PFBS (PSLs)," and that, "If soil analytical data collected from a validated source area soil boring indicate the PFOA, PFOS, and PFBS concentrations are less than the PSLs, then delineation is complete in that direction." As noted above, soil characterization is addressed in state regulations at 18 AAC 75.335(b)(2)(B), 18 AAC 75.335(b)(2)(G) and 18 AAC 75.340(j)(1). DEC asserts that it is appropriate to use the state's promulgated MTGW cleanup levels for PFOA and PFOS to determine the extent of contamination under the QAPP, unless/until a lower threshold is determined necessary to inform cleanup options or evaluate additional pathways such as impacts to ecoreceptors.

DEC believes that the evaluation of the soil to groundwater pathway should be part of soil delineation, and notes the EPA's risk-based resident soil to groundwater - protection of groundwater soil screening level (SSL) as described in *EPA's Regional Screening Levels (RSLs)-User's Guide* (the guide). Per Section 4.8 of the guide, "The SSLs [soil screening levels] protective of groundwater, provided in the generic tables and the calculator, are all risk-based concentrations based on three phases (vapor, soil and water)." *EPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (the supplemental guidance) explains in Section 2.1 that SSLs, including one for the migration to groundwater pathway, are risk-based values. The supplemental guidance also states in Section 2.1 that, "Areas meeting federal SSLs may still warrant further study. Some EPA Regional Offices and states have developed separate soil screening levels and/or preliminary remediation goals (PRGs) that may be more stringent that those presented in this guidance (though these alternative levels are based on the same general methodology described in this guidance). It is important that site managers confer with regional and state risk assessors when conducting soil screening evaluations to ensure that any SSLs developed will be consistent with their accepted soil levels." DEC asserts the USAF should operate in accordance with published EPA guidance and in light of DEC's promulgated

soil cleanup levels, work with the state to ensure that the SSLs adopted are consistent with DEC's levels.

Therefore, in consideration that the DoD and DEC are not in agreement on the screening level to utilize for completing the RI soil characterization, and that both parties are making progress to come up with a consensus for moving forward on this issue, and considering that this RI will be re-evaluated to determine a path forward for completing the soil delineation in areas that may require further investigation, with exception of the QAPP Worksheet #11 and QAPP Worksheet #15, the *Final Quality Assurance Project Plan, Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base, Fairbanks North Star Borough, Alaska, June 2021* is approved.

Please attach this approval letter and final comment matrix to the Final document. If you have any questions, please do not hesitate to contact the DEC project manager at (907) 451-2180, or by email at dennis.shepard@alaska.gov.

Sincerely,

Digitally signed by
Dennis Shepard
Date: 2021.06.11
10:35:53 -08'00'

Dennis Shepard
Remedial Project Manager

cc via email: Joe Price, AFCEC
Mike Boese, AFCEC
Roy Willis, AFCEC
Dustan Bott, EPA
Melinda Brunner, DEC
Axl LeVan, DEC

Enclosure: DEC Comment Matrix

DEC Comments on Draft Quality Assurance Project Plan
Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base,
Fairbanks North Star Borough, Alaska, January 2021

June 4, 2021

Reviewer: Alaska Department of Environmental Conservation

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
1.	General, WS#15			Text states in WS#15: "For the purposes of this RI scope, the PSLs are defined as the DoD screening levels (Assistant Secretary of Defense [ASD], 2019a) where available". The QAPP does not address the Table B1 Method Two migration to groundwater (MTG) cleanup levels identified at 18 AAC 75.341. The soil sample results should also be compared to the migration to groundwater cleanup levels in accordance with ADEC guidance and regulations. Unless DEC determines otherwise, any location where a contaminant is detected at concentrations greater than a state cleanup level listed in 18 AAC 75.341(c) or (d) Method Two Soil Cleanup Levels, Tables B1 and Table B2, or 18 AAC 75.345 Table C Groundwater Cleanup Levels, is subject to the site cleanup rules under 18 AAC 75.325 - 18 AAC 75.390. DEC Notes: – The laboratory's LOQ are each sufficiently sensitive to meet the ADEC MTG CUL. – The QAPP references 18 AAC 75. The work plan needs to comply with State guidance/regulations. – The proposed PSLs are being used to determine and delineate the extent of contamination, and needs to	Per Assistant Secretary of Defense Memorandum, *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (ASD, 2019a) states that the EPA RSLs should be used for screening to determine if further investigation in the RI phase is warranted. ADEC Table B1 Method Two migration to groundwater (MTGW) cleanup levels are added to Worksheet #15 for comparison purposes. The following text is added to Worksheet #15, "*ADEC Table B1 Method Two MTGW cleanup levels and Table C Groundwater Cleanup Levels (ADEC, 2019b) are included for comparison purposes*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				consider the extent of contamination above the DEC soil cleanup levels.	*only and will not be used for the RI decision making purposes.*" **DEC disagrees 5/26/2021** DEC does not agree with DEC's MTGW being presented "for comparison purposes only." The USAF should be delineating the nature and extent of contamination, which means out to the most stringent of EPA's RSLs for resident soil and tapwater, 1/10th of DEC's human health CULs for soil and groundwater, and EPA's protection of groundwater Soil SL or DEC's MTGW CUL. **BEM Team Response (06/03/2021)** The USAF acknowledges that the DoD and the State of Alaska are currently holding discussions regarding the use of Alaska screening levels in the CERCLA process in an effort to arrive at a consensus for moving forward on this issue. Based on the outcome of those discussions, the data

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					associated with this RI will be re-evaluated to determine a path forward for completing the soil delineation in areas that may require further investigation. **DEC Noted 6/11/2021**
2.		General		Soil sampling beneath the top of the groundwater table within the saturated zone for mass flux evaluation is not planned at source areas. Although the Introduction states: "The purpose of the RI investigation is to determine the vertical and lateral extent of PFAS in impacted media from U.S. Air Force (USAF) primary and secondary releases, determine their potential contribution to the Installation's PFAS groundwater plumes, and collect data needed to support a future risk assessment." And the DQO Step 2 in Worksheet 11 states: "The primary goal of this RI is to provide data regarding the extent of PFAS contamination in multiple media across and downgradient of the validated PFAS source areas at EAFB." The Step 4 of the DQO states: "A total of three (3) discrete soil samples will be collected for PFAS from each boring to characterize the vadose zone and include surface soil, midpoint of the vadose, and above the water table." The DQO does not appear designed to achieve full delineation of the vertical extent of soil contamination. The contaminant mass in source areas would remain uncertain. Per the EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA,	This comment is to be discussed further at the comment resolution meeting scheduled week ending 30 April 2021. ADEC Table B1 Method Two MTGW cleanup levels and groundwater cleanup levels were added to Worksheet #15 for comparison purposes only. Per Assistant Secretary of Defense Memorandum, *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (ASD, 2019a) states that the EPA RSLs should be used for screening to determine if further investigation in the RI phase is warranted. **DEC disagrees 5/26/2021**

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				EPA/540/G-89/004, October 1988, Section 3.2..4.2: "As with ground-water sampling, the intent of soil sampling is to characterize and estimate the limits of existing soil contamination." And "As with ground water, soil contamination should be documented in both vertical and horizontal directions. This approach will help determine both areas of contamination and background concentrations." Delineation of soil includes extent of vertical contamination in the source area. Per Section. 1.4.1 of the guidance, scoping in the beginning of the RI/FS process includes, "Initiating the identification and discussion of potential ARARs with the support agency." DEC is identifying the migration to groundwater soil cleanup levels as potential chemical-specific ARARs. Delineation of soil impacts includes extent of DEC migration to groundwater soil cleanup level exceedances. Although the project wishes to focus on the flux based model, DEC requires delineation of soils to the MTG level per 18 AAC 75.335(b)(2)(B) and 18AAC75.335(b)(2)(G) and 18 AAC 75.340(j)(1). Please delineate the nature and extent of contamination to the most stringent of DEC's cleanup levels during the RI.	DEC does not agree with DEC's MTGW being presented "for comparison purposes only." The USAF should be delineating the nature and extent of contamination, which means out to the most stringent of: EPA's RSLs for resident soil and tapwater, 1/10th of DEC's human health CULs for soil and groundwater, and EPA's protection of groundwater soil SL or DEC's MTGW CUL. DEC does not agree that EPA's RSLs for resident soil and tapwater should be the sole decision thresholds for deciding whether or not a site moves forward to RI. DEC is identifying the migration to groundwater soil cleanup levels as potential chemical-specific ARARs. **BEM Team Response (06/03/2021)** See BEM Team response to comment #1. **DEC Noted 6/11/2021**

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
3.	188	1	Intro	The text indicates an initial three-dimensional (3D) Conceptual Site Model will be developed at the planning stage to serve as a baseline for establishing the final scoping strategy for this RI. Is the CSM presented in WS#10 the 3D CSM referenced in the Introduction?	The 3D CSM will be accessible via the project-specific dashboard and is not included in WS#10. **DEC Accept 5/26/2021**
4.	197	2	Intro	The text indicates the stakeholders are defined in Worksheet #4. Please define/indicate the stakeholders are the Lead Organizations listed in WS#4.	The text is revised as follows, *"…procedures in this QAPP, the stakeholders, the Lead Organizations listed in Worksheet #4 of this QAPP, will be…"* **DEC Accept 5/26/2021**
5.	208	2	Intro	Fish tissue and pore water sampling will be conducted for the RI. Please include fish tissue and pore water sampling in the statement.	The statement is revised to include porewater and fish tissue sampling. **DEC Accept 5/26/2021**
6.	262	11	Fig. 2	Who is the AFCEC RPM? Who do the people listed under the AFCEC RPM work for? AFCEC? BEM? Please present this information on Figure 2 or provide a note referencing WS#4, #7 * #8 listing the respective organizations of each individual listed in Figure 2.	Figure 2 the organization chart is revised as requested. **DEC Accept 5/26/2021**
7.	275	13	WS#4, #7 &#8	WS#4, #7, & #8 identifies key site-specific personnel from each organization performing tasks in the RI. The BEM Team project chemist has key tasks/responsibilities for this RI. Please include the BEM Team project chemist in the Personnel Qualifications and Sign-Off Sheet. Please note that the ADEC and USEPA "project managers" are Remedial Project Managers (RPMs) delegated under the Eielson Federal Facilities Agreement.	Worksheet #4, #7, & #8 is revised to include Kevin Gallagher as the Project Manager, Chris Pisarri as the QA/QC Manager, Joseph Quinnan as the Deputy QA/QC Manager, Andy Crabb as the Project Chemist, Erika Houtz as the Deputy Project Chemist, and Nanzhu Li as the Assistant Project Chemist. In

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					addition, USEPA Dustan Bott's title is revised to RPM and ADEC Dennis Shepard's title is also revised to RPM. **DEC Accepts 5/26/2021** The Qualified environmental professionals and qualified environmental samplers should also be identified in accordance with 18 AAC 75.333.
8.	300	20	WS#6	For the Communication Drivers "QAPP changes before fieldwork" and 'QAPP changes during project execution", please specify in the "Procedure" that ADEC and EPA RPMs will be notified by the AFCEC RPM to seek approval.	The text is revised as requested. **DEC Accepts 5/26/2021** Field change forms require EPA and DEC approval prior to being implemented in the field.
9.			WS#10	The Historical PFAS Investigations section summarizes previous PFAS investigations. The text summaries compare detected concentrations to the PSLs including the 18 AAC 75.341(c) Table B1 Method Two Migration to Groundwater (MTG) cleanup levels, that were set for the specific investigations. DEC notes that the Nature and Extent of Contamination section in Work Sheet 10, and the support Figures 3 through 7 are based on the proposed PFAS RI PSLs that are excluding DEC MTG CUL exceedances. The MTG levels are considered a risk-based number since they are back calculated from the Table C groundwater cleanup levels. This means the MTG CUL is a concentration of contaminant in soil expected to give rise to a potential exceedance of the	ADEC Table B1 Method Two MTGW cleanup levels were added to Worksheet #15 for comparison purposes only. Per Assistant Secretary of Defense Memorandum, *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (ASD, 2019a) states that the EPA RSLs should be used for screening to determine if further investigation in the RI phase is warranted. **DEC disagrees 5/26/2021**

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				Table C CUL in groundwater. It is unclear why the flux based investigation is excluding a protection of groundwater PSL. However, the delineation of the nature and extent of the contamination above DEC cleanup levels is required.	See DEC responses to 1 and 2 above. **BEM Team Response (06/03/2021)** See BEM Team response to comment #1. **DEC Noted 6/11/2021**
10.			WS#10	The support Figures 9 through 13 show the proposed sample locations for the PFAS RI; however, the figures do not show the historical sampling locations. Considering the limited historical data set for most of the source areas, the historical sampling locations should be presented on Figures 9 through 13 to provide a spatial reference for the proposed sampling locations. Some proposed sampling locations fall on top of historical sampling locations. For example at Site 1 (SS310P), proposed soil borings on the northeast and southwest sides of the taxiway are positioned in almost the same location as a permanent groundwater well with PFOS/PFOA >0.07 µg/L (northeast side of taxiway) and a temporary groundwater well/boring with no PFOS/PFOA exceedances (southwest side of taxiway). What is the rationale for resampling locations?	The historic sampling locations are added to Figures 9 through 13. Additionally, all available historical data is presented in the digital CSM, which can be assessed by the user to allow data to be toggled on/off as needed. Historical soil and temporary grab groundwater data was collected in 2014. The soil collected varied in depth between locations (0-0.25, 1-2, 2-3, 5-6, etc.) and do not provide a resolution adequate for meeting the objectives of the RI. Historical temporary grab groundwater data were collected at one depth only (water table). The existing permanent wells are mostly shallow wells screened at the

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					water table (depending on the area). Based on these considerations, there are intervals where historical results and the proposed prescriptive borings are within proximity to the historical locations. In these cases, the historical data is being used as a guide for collecting higher resolution data. The groundwater samples proposed in the VAP borings for each validated source area includes the collection of 4 discrete groundwater samples from the water table to 50 feet below grade in order to refine the contaminant concentration within the vertical aquifer profile. No changes were made to the proposed locations based on the rationale provide above. **DEC Accepts 5/26/2021**
11.	542	32	WS#10	The text states, "PFOS/ PFOA concentrations exceeded the USEPA LHA and ADEC groundwater cleanup levels at all 15 sites (CH2M Hill, 2018a)." Please verify/clarify the	The sentence is revised to "*PFOS/ PFOA concentrations in groundwater samples exceeded the USEPA LHA and ADEC*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				PFOS/PFOA exceedances were in groundwater samples collected from the 15 sites.	*groundwater cleanup levels at all 15 sites (CH2M Hill, 2018a)."* **DEC Accepts 5/26/2021**
12.	554	32	WS#10	Please verify/change the USEPA LHA to 0.07 µg/L.	The value is revised to 0.07 µg/L. **DEC Accepts 5/26/2021**
13.	664	38	WS#10	The text states, "Preliminary data from Fall 2020 indicate maximum concentrations at the upgradient well (0.49 µg/L PFOS), with order of magnitude decrease in PFOS concentrations at the downgradient well (0.41 µg/L)." The reported concentrations do not decrease by an order of magnitude. Please verify/clarify.	The text is revised to "*Preliminary data from Fall 2020 indicate maximum concentrations at the upgradient well (0.49 µg/L PFOS), with an observed order of magnitude decrease in PFOS concentrations at the downgradient well (0.41 µg/L in 2020 in comparison to the 81 µg/L PFOS concentration reported form the 2016 investigation).*" **DEC Accepts 5/26/2021**
14.	934	46	WS#10	Please add pore water to the list of sampling locations.	The text is revised to "***Figures 8 through 13*** *show the proposed 2021 RI sampling locations for fish tissue, sediment, surface water, pore water, groundwater, and soil.*" **DEC Accepts 5/26/2021**
15.			WS#11	The DQOs do not have decision rules like DEC and EPA have been requesting on previous RI/RA QAPPs. BEM is relying on Adaptive Decision Logic in WS#17 to evaluate if/when additional definitive data is needed. However, per the EPA guidance *Uniform Federal Policy for Quality Assurance Project Plans* (March 2012), Step 5 of the DQO process includes: "For decision problems, these are expressed as "if--	Worksheet #11 is revised to include detailed DQO tables (DQO 001 through DQO 006) in accordance with *Uniform Federal Policy for Quality Assurance Project Plans* (March 2012) and *Guidance on Systematic*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				-then" statements, or decision rules, that link potential results with conclusions or future actions. For estimation problems, specify the estimator and the estimation procedure." Document decision logic in the DQOs in order to facilitate agreement to decisions. Please revise. DEC notes that the pre-draft review AFCEC Comment 8, requests a more robust DQO table for each of the major goals/objectives. DEC agrees that a more robust DQO table and decision logic is needed for, but not limited to: Flux based characterization, SPLP, ranking and prioritizing source zones, nature and extent delineation-Soil, Sediment, Groundwater, nature and extent of soil and sediment contamination in the Community Moose Creek.	*Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (the DQO Guidance) (February 2006). The DQOs are broken out into the following categories: DQO 001 - Assessment of PFOA, PFOS, and PFBS in Groundwater, DQO 002 – Assessment of PFOA, PFOS, and PFBS in Soil, DQO 003 – Assessment of PFOA, PFOS, and PFBS in Surface Water, Sediment, and Porewater, DQO 004 – Source Strength Evaluation, DQO 005 – Stratigraphic Flux Evaluation from Validated Source Areas, and DQO 006 – Risk Assessment. Please note Worksheet #11 is not shown in track changes due to the rework of the entire worksheet. **DEC Accepts with comment 6/01/2021** The DQO's are insufficient to delineate soil to the DEC MTG cleanup level. See DEC responses to 1 and 2 above. Future RI efforts will have to fill potential data gaps

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					BEM Team Response (06/03/2021) See BEM Team response to comment #1. **DEC Noted 6/11/2021**
16.			WS#11	As written, it is not clear in WS#11 what exactly are the Project/Data Quality Objectives. @Step 2, The text states that, "The primary goal of this RI is to provide data regarding the extent of PFAS contamination in multiple media across and downgradient of the validated PFAS source areas at EAFB." However, the goal of this RI is to determine the vertical/lateral extent of PFAS in all PFAS-impacted media from AF primary and secondary releases. Please clarify here and in the Introduction, that vertical/lateral delineation of PFAS contamination in all impacted media is the goal.	Refer to response to comment 15. The Worksheet is revised to include a detailed DQO table in accordance with *Uniform Federal Policy for Quality Assurance Project Plans* (March 2012) and *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (the DQO Guidance) (February 2006). Please note Worksheet #11 is not shown in track changes due to the rework of the entire worksheet. **DEC Accepts with comment 6/01/2021** The DQO's are insufficient to delineate soil to the DEC MTG cleanup level. See DEC responses to 1 and 2 above. **BEM Team Response (06/03/2021)** See BEM Team response to comment #1.

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					DEC Noted 6/11/2021
17.		49	WS#11	Step 4. 1st bullet item. Please clarify source characterization soil borings will be advanced to a depth of 10 feet below the groundwater table interface.	Worksheet #11 is revised as requested in ADEC Comments 15 and 16. Worksheet #11, DQO 002, Step 7 includes the following text, "*Up to 114 soil borings (installed to a depth up to 10 feet below the groundwater table interface)…*". **DEC Accepts 6/01/2021**
18.	1146	84	WS#17	Exhibit 1. Please define Options 1 – 7.	A footnote has been added beneath Exhibit 1 to define Options 1 – 7. This footnote includes: "*Options 1 through 7 include:* • *Option 1: Up to 50 soil borings to 25 feet in depth or 10 feet below the groundwater table interface with up to 3 soil samples and 1 grab groundwater sample per boring.* • *Option 2: Up to 50 HPT borings to 75 feet in depth or refusal.* • *Option 3: Up to 20soil samples collected for SPLP PFAS.* • *Option 4: Up to 25 VAP borings to 50 feet in depth with up to 4 grab*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					groundwater samples per boring. • *Option 5: Up to 50 VAP borings to 100 feet in depth with up to 8 grab groundwater samples per boring.* • *Option 6: Up to 50 VAP borings to 150 feet in depth with up to 12 grab groundwater samples per boring.* • *Option 7: Up to 50 co-located samples for surface water and sediment."* **DEC Accepts 6/01/2021**
19.	1141	84	WS#17	Prescriptive sample locations moved greater than 75 feet from the originally proposed location. Please revise to 50 feet.	The text is revised to 50 feet. **DEC Accepts 5/26/2021**
20.	1192	86	WS#17	Table 3. Fish Tissue Sampling is not sufficient to evaluate PFAS in biota from surface water bodies. Please clarify the objective of the fish tissue sampling. SPLP Key Objective: "SPLP sampling will be completed at each validated source area to evaluate leachability of PFAS across the vertical extent of the soil profile." However, source areas with multiple soil lithologies in vadose and near surface saturated/smear zone soils may require more than one SPLP sample to evaluate the leaching potential of source area soils.	The objective text is revised to "*The data will be used to evaluate potential uptake of PFAS in fish from the surface water bodies on and off site and evaluate potential risks to human and wildlife receptors that may consume fish.*" **DEC Accepts 5/26/2021** In accordance with Comment #34, up to three (3) SPLP samples will be collected from each validated source area for a

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					total of 45 SPLP samples. These samples will be split and also analyzed for PFAS, AEC, CEC, and TOC. The samples will be collected across the vertical extent of the vadose zone / smear zone to provide a more accurate evaluation of source strength. Table 9 has been revised to indicate SPLP sampling will be completed in the adaptive phase as part of the source area characterization based on the results of the prescriptive borings. At these locations, up to three (3) discrete soil samples will be collected and analyzed for PFAS, PFAS SPLP, AEC, CEC, and TOC. **DEC Accepts 5/26/2021**
21.	1198	94	WS#17	The text indicates the water used for the RI field program will be obtained from base and treated by the onsite portable water treatment system. One source blank (SB) sample will be analyzed for PFAS weekly at the mobile laboratory and the fixed laboratory with a normal 21 day turnaround time to ensure the water contains PFAS compounds at concentrations less than the method detection limit and PSLs. What corrective actions will be made if concentrations of PFAS are detected above the method detection limit in one of the weekly source blanks? The Corrective Action	The text in the 1st paragraph was revised to clarify that all water prior to use will be treated with the onsite PFAS water treatment system. The following was added to the end of the 1st paragraph under Source Characterization, "*Prior to using any water for RI purposes (decontamination water, drilling*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				"Qualify data as appropriate" as stated in WS#28 is not sufficient.	*water, and any other use), it will be treated with the PFAS water treatment system located at the Hazwaste Facility. Water will be obtained from a source on the base. The PFAS water treatment system is designed to treat PFAS impacted water using ion exchange technology.*" The following text is added to the end of the paragraph to describe a more extensive corrective action, "*One (1) source blank (SB) sample will be analyzed for PFAS compounds for each batch of treated water to confirm that source water does not contain PFAS compounds at concentrations above the method detection limit (MDL) and PSLs. The SB samples will be submitted to the fixed laboratory for 24 PFAS compounds with rush analysis TAT as needed to maintain sufficient quantity of verified clean water on site. The fixed laboratory will provide definitive data prior to the use of each batch of treated water. Treated water will be stored on site until laboratory results are returned that confirm acceptable PFAS levels. If necessary, a sample may also be*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					analyzed by the mobile laboratory while waiting for results from the fixed laboratory. *If PFAS compounds are detected in the SB at concentrations greater than the MDL using either fixed or mobile lab testing, treated water within that batch will be placed to the side to be re-treated.* *Prior to treatment the water treatment system performance will be checked using a mobile laboratory test. The water will then be treated and prior to use, the water will be analyzed by the fixed laboratory as described above."* **DEC Accepts 5/26/2021**
22.	1222	95	WS#17	Please verify/delete "water table and be completed to a depth of 25 feet bgs."	The text is deleted. **DEC Accepts 5/26/2021**
23.	1273	96	WS#17	Will pneumatic slug tests only be conducted in the event the hydraulic profiling tool cannot resolve the permeability?	For the HPT borings, which are co-located with the 50-foot and 100-foot VAP borings, the pneumatic slug testing will only be conducted at the VAP borings in the event that the HPT tool cannot be used to resolve permeability measurements. Pneumatic slug testing will be performed at select intervals within the 150-foot VAP borings.

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					DEC Accepts 5/26/2021
24.	1669	111	WS#17	The RI Report should include the results of ranking and prioritizing source zones. Figures with all sampling locations and results (historical and this RI effort) for each Source Area should be included. Also, cross sections for each source area, and vertical aquifer profile transect should be provided in the report. Other tasks for the project should also be reported on including but not limited to: results of mass flux evaluation; ranking and prioritizing source zones; 3D CSM; etc.	The text is revised to include references to ranking and prioritizing source zones, 3D CSM, mass flux evaluation, and specific figures and cross sections. **DEC Accepts 5/26/2021**
25.	1671	111	WS#17	The text indicates the RI report will detail all base and awarded optional tasks. Have the optional tasks been addressed in this RI QAPP? What are base versus optional tasks? This is the first reference to base and optional tasks. Please clarify.	The optional tasks are detailed under Exhibit 1 in WS#17. The optional tasks have been awarded and will be completed as needed as part of the RI effort. These are additional borings and samples that can be used to provide the data needed to meet the objectives of the RI. The text "*BEM will prepare and submit a pre-draft, draft, and final RI Report detailing the completion of all base and awarded optional tasks.*" has been revised to "*BEM will prepare and submit a pre-draft, draft, and final RI Report detailing the completion of all*

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
					activities conducted as part of this RI." **DEC Accepts 5/26/2021**
26.		115	WS#18	Table 9. Please address the following. <u>Soil Samples Collected from Source Area 25 foot soil borings</u> The Sonic Drill Rig will not be used to advance the shallow soil borings. Please delete Please include the rationale for the boring locations. Please indicate grain size samples will be collected. Even though the grain size samples will be collected from the groundwater sample depth interval, they are soil samples. <u>Groundwater Samples Collected from Source Area 25-foot soil borings</u> The grain size samples collected from the Source Area soil borings are soil samples. Table 9 indicates they are groundwater samples. Please move to the soil sample section. <u>Surface Water and Porewater Samples (15 surface water sample locations will be porewater)</u> Table 9 indicates two surface water samples will be collected at Site 2 – KC-135. Please add these surface water samples to the Sampling Approach presented in Table 4. For Source Area FT009, Table 4 indicates up to four (4) previously sampled locations in Garrison Slough and one (1) additional location along a drainage channel entering Garrison Slough will be sampled for collocated surface water and sediment samples. Table 9 indicates only 4 surface water	WS#17 Table 4 and WS#18 Table 9 are revised to incorporate all comments. **DEC Accepts 5/26/2021**

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				and sediment sampling locations. Please verify and add another surface water and sediment sampling location to Table 9. For Basewide, Table 4 indicates collocated surface water and sediment samples will be collected from up to 68 locations with porewater samples collected from 15 locations. For Off-base, Table 4 indicates collocated surface water and sediment samples will be collected from up to 12 locations. Table 9 indicates 47 collocated surface water and sediment sample locations and 7 porewater sample locations for Basewide and Off-site. Please reconcile. <u>Groundwater Samples collected from new shallow monitoring wells and from new nested monitoring wells</u> Please remove hydrasleeve as a sampling method/tool for collection of groundwater samples. The method is a soil sampling method. <u>Note 4.</u> Please add to Note 4 that pneumatic slug tests will be performed in the event that HPT cannot resolve permeability estimates. The notes for Table 9 state, *"*Analytical samples for SPLP analysis will be collected from each validated source area. Sample locations will be determined based on the prescriptive phase analytical results.*" This note does not convey sufficient information for these known adaptive soil boring samples. Please add information to Table 9 for the known adaptive borings that will be completed as part of the source area characterization.	

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				Specifically, the additional discrete soil sample to be collected from each source area where the highest concentrations of contaminants are identified and analyzed for PFAS SPLP. Also see Comment 34. In addition, will the soil samples only be analyzed for PFAS SPLP?	
27.	1754	121	WS19 &WS30	Please verify/change USEPA 2106-G-05 Section 2.3.5 to Section 2.3.2	Section 2.3.5 is changed to 2.3.2. **DEC Accepts 5/26/2021**
28.	1792	127	WS#20	Source blanks should also be collected from the source of water used for the HPT borings and the 150-foot VAP borings advanced with sonic drilling, if water is used to achieve the targeted drilling depth.	Water used for drilling will also be treated with the onsite water treatment system. WS #17 is revised to include, **"***Water (decontamination water, drilling water, and any other water that will be used a part of the RI) used…***"** **DEC Accepts 5/26/2021**
29.	1795	127	WS#20	QA/QC samples should be collected for the PFAS SPLP samples. Please add.	Worksheet#20 is revised to include SPLP, AEC, and CEC. **DEC Accepts 5/26/2021**
30.	1799	129	WS#21	The Field SOPs are identified by SOP # P-01 through P-20. The SOPs provided in Appendix B do not have the SOP# on them. As presented, it is difficult to locate the appropriate Field SOPs referenced in WS#21 in Appendix B. Please clarify.	The Field SOPs in Appendix B and WS #21 are updated to include SOP # on the cover page. **DEC Accepts 5/26/2021**
31.	1813	133	WS#22	The TGI – Geoprobe® Hydraulic Profiling Tool (HPT) SOP in Appendix B indicates pre-test calibration of the HPT to ensure the HPT pressure and responses are consistent with expected values. Please provide information regarding calibration of the HPT in WS#22.	Worksheet #22 has been updated to include information on the HPT calibration. **DEC Accepts 5/26/2021**

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
32.		139	WS#23	SOP "MAD10101" for the Pace Mobile Lab is identified as "Definitive" under the Definitive or Screening Data column. However, based on the text, this should be Screening. Please clarify.	SOP "MAD10101" is revised to indicate the mobile lab data is screening data. **DEC Accepts 5/26/2021**
33.	1870	152	WS#28	If a weekly Source Blank sample (analyzed by the mobile lab) exceeds the MPC, a more aggressive corrective action than "Qualify data as appropriate" should be implemented. Please provide a corrective action such as a new source of water not impacted with PFAS will be used for the remaining field sampling efforts; the onsite treatment system performance will be checked, etc. It is understood that the source blank samples will be front loaded during the field sampling efforts, thus a potential contamination issue can be avoided with the use of the mobile lab results. This also may apply to the equipment blanks and field blanks.	The corrective action is revised to, • "*Re-check the water treatment system performance.* • *Re-treat the batch of water associated with SB exceeding MDL.* • *Collect a SB from treated water and analyze for 24 PFAS compounds by the fixed lab under a rush TAT if necessary.* • *If one of 24 PFAS compounds is detected at concentrations greater than the MDL then the media in the water treatment system will be replaced and the system will be checked again."* **DEC Accepts 5/26/2021**
34.	Appendix C			The meeting text states: "CZTE indicated that SPLP is not an optimal way to measure leaching to groundwater. They recommended homogenizing and splitting the soil samples for both PFAS and SPLP analysis. They also recommend geotechnical analysis to confirm the physical and chemical properties of the underlying soil lithologies."	Up to three SPLP samples will be collected from each validated source area. These samples will be split and also analyzed for PFAS, AEC, CEC, and TOC. The samples will be collected across the vertical extent of the vadose

Comment No.	Line	Page	Section	ADEC Comment / Recommendation (3/31/2021 and 05/26/2021)	BEM Team Response (4/21/2021 and 6/4/2021)
				DEC agrees that the soil samples should be split for both PFAS and SPLP analysis. DEC also agrees with the recommendation to confirm the physical and chemical properties of the underlying soil lithologies. Source areas with multiple soil lithologies in vadose and near surface saturated/smear zone soils may require more than one SPLP sample to evaluate the leaching potential of source area soils. Guidance on SPLP includes recommendations that a minimum of three (3) SPLP samples should be collected for evaluation and development of a site specific soil partitioning coefficient. .	zone / smear zone to provide a more accurate evaluation of source strength. This is revised in WS#11, WS#17, and WS#18. **DEC Accepts 5/26/2021**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
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Seattle, WA 98101-3123

SUPERFUND &
EMERGENCY
MANAGEMENT DIVISION

June 11, 2021

Kristina Smith
Installation Restoration Program
AFCEC CZOP
2310 Central Avenue, Suite 213
Eielson AFB, AK 99702

RE: EPA Approval of the *Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites (June 2021)*

Dear Ms. Smith:

U.S. Environmental Protection Agency (EPA) has completed review of the ***Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites (June 2021)***. The purpose of this Remedial Investigation (RI) investigation is to determine the vertical and lateral extent of PFAS in impacted media from U.S. Air Force (USAF) primary and secondary releases, determine their potential contribution to the Installation's PFAS groundwater plumes, and collect data needed to support a future risk assessment. Review comments submitted by EPA have been appropriately addressed in the final report. EPA approves this document.

EPA notes that this effort is only the first phase of an RI and encourages the Air Force to develop a comprehensive plan for a full RI that includes a risk assessment and a path to a feasibility study (FS). EPA believes that an RI/FS Management Plan for PFAS and any comingled contaminants is needed and would help efficiently use limited time and resources. In reviewing the sampling results, DOD should be also be using ADECs promulgated rules and the RSL/SSLs as screening levels and selecting the lowest value for determinations.

If you have any questions, please do not hesitate to contact EPA at (206) 553-5502 or by email at Bott.Dustan@epa.gov. Please include this letter and final comment table in the final document and contact me if you have any questions.

Sincerely,

Digitally signed by
DUSTAN BOTT
Date: 2021.06.11 15:13:17
-07'00'

Dustan Bott
Remedial Project Manager

Cc: (via email)
Roy Willis, AFCEC

Mike Boese, AFCEC
Joe Price, AFCEC
Dennis Shepard, DEC
Axl Levan, DEC

EPA Review of the Draft-Final Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites
Eielson Air Force Base, Alaska, April 2021

Number	Page	Section	EPA Comment (3/31/2021 and 5/28/2021)	AF and BEM Team Response And EPA Response (04/27/21 and 06/04/21)
GENERAL COMMENT				
1.	-	-	The Draft Quality Assurance Project Plan for Remedial Investigation for PFAS at Various Sites, Eielson Air Force Base (AFB), Alaska, dated January 2021 (the QAPP) references field sampling standard operating procedures (SOPs) that are not listed in Worksheet #21 (Field SOPs) or provided in QAPP Appendix B (Field Standard Operating Procedures/Technical Guidance Instructions). For example, Worksheet #17 (Sampling Design and Rationale) references SOP P-21 for porewater sampling (see Page 98, lines 1333 through 1338); however, SOP P-21 is not listed in Worksheet #21 or provided in Appendix B. Please revise the QAPP to list all field sampling SOPs that will be used during this project in Worksheet #21, and ensure the SOPs are provided in Appendix B.	The references to the SOPs are revised and the SOP #s are added to the SOPs. Porewater sampling SOP in WS #17 is revised to P-19. ***EPA: The response partially addresses the comment. Page 110, Line 1448 still references SOP # P-21, which is incorrect and has been removed from Worksheet #21 and Appendix B. We recommend a global search of the QAPP to make sure they correct all references to SOP # P-21 (the correct reference is SOP # P-19).*** **BEM Team Response (05-28-21):** A global search was completed and reference to SOP #P-21 was located on Page 110, Line 1448. Reference to SOP #P-21 is changed to SOP #P-19. ***EPA: The response addresses the comment.***
2.	-	-	Mobile lab PFAS analytical method will be used for "screening" only. Recommend defining this use of the word "screening". *In several places, it is mentioned that mobile lab PFAS analytical method will be used for "screening" only, but this term is not defined. *Worksheet #11, Pages 50 and 51 of 182 refer to "screening level method" and "screening-level data"	WS#11, WS#17, and WS#18 Table 9 are revised to define and clarify terminology. The referenced SOPs are revised to remove reference to "field screening" as that is not applicable to this scope. Worksheet #23 are corrected to "Screening" for Pace Mobile Lab SOP. Worksheets #15 is not revised as the reference to screening is applicable and was defined previously.

			*Worksheet #15, lines 1055 and 1062 refers to the Pace Mobile Lab "Screening, Accelerated LC/MS/MS method". *Worksheet #17 lines 1121 and 1130, 1131, 1177, 1192, 1219, 1454, 1468, and Tables 4, 6, and 7 refer to "screening" samples. *The section "Screening Data Quality Assessment" beginning at line 1547 appears to use the term in several different ways. *Footnote 1 of the table in Worksheet #18 refers to "screening" samples *Worksheet #23 refers to "Definitive or Screening Data" *Worksheet #37 refers to "screening purposes only". SOP "TGI – Soil Description Rev #: 2 Rev Date: February 16, 2018", "TGI – Sediment, Surface Water, and Stormwater Sample Collection Rev #: 2 Rev Date: Rev Date: October 15, 2020." and "PFAS-SPECIFIC DRILLING AND MONITORING WELL INSTALLATION TECHNICAL GUIDANCE INSTRUCTION Rev: #4 Rev Date: 8/6/2020" refer to "field screening". Recommend defining the use of "screening" as it is used in these contexts.	Worksheet #37, "for screening purposes only" in reference to the qualifier X is applicable. All data with an X will not be used for decision making but may be used for information purposes. ***EPA: The response addresses the comment.***
3.	-	-	These are EPA recommendations to ensure greater confidence in the quality of data generated for PFAS in addition to Table B-15. a) For PFAS, methods for solids and non-drinking water are not standardized as are drinking water methods. Laboratory SOPs modify existing methods to suit their needs. Recommend each laboratory provide the most recent Demonstration of Capability (DOC) and most recent Level of Quantitation (LOQ) verification sample using the current version of	a) ELLE has provided the DOCs that are saved in Appendix H. Pace Fixed lab will provide DOC, MDL verification and LOQ verification in each data package. b) The justification from ELLE is: "*Peak asymmetry calculation is necessary when* *i. The sample extract generated by the method does not match the LC elution profile well, which can cause non-gaussian peaks and,*

			the SOP with the final data package for validation. b) Recommend providing justification for the method modification: "Peak asymmetry factors are not calculated". The short run time specified in the laboratory SOPs, (12 minutes), raises the question of whether they are actually getting 10 scans across each peak. The dwell time will possibly be quite short too, reducing sensitivity. c) DoD Table 5.3 criteria states: "If a labeled analog is not commercially available, the Extracted Internal Standard Analyte with the closest retention time or chemical similarity to the analyte must be used for quantitation. (Internal Standard Quantitation)" Recommend the Pace mobile lab SOP specify which Extracted Internal Standard (EIS) is to be used for quantitation of each analyte without a labeled analog. d) Worksheet #28 appears to equate the ISC with an LOQ verification. However - it is not clear from the analytical SOPs whether the ISC is an extracted standard, and thus equivalent to an LOQ verification. A true LOQ verification sample is taken through all preparation and analytical steps with the samples. This verification standard is recommended to evaluate analyte recoveries at low concentrations. e) Page 816 of Appendix H, Pace SOP for PFAS: "10.2.5.2. Calibration results for labeled	*ii. There are not specified criteria for sensitivity of the analysis and identification of the targets."* "*For our DoD QSM compliant method, the sample extract and elution profile are matched better for better chromatography and in addition to the RT match that is required, <u>two</u> transition masses are monitored for each compound. Additionally, there are specific requirements for the S/N required for each of those transition masses, insuring adequate sensitivity, irrespective of the peak asymmetry factor."* c) Pace Mobile lab has provided the revised SOP with the list of Extracted Internal Standards and associated analyte. The revised SOP is saved in Appendix H. d) The ISC is a standard solution at the same concentration as what is called a CAL2 standard, which has target compounds at the LOQ. The ISC or more correctly the CAL2 labeled as an ISC is injected at the beginning of each run. The LOQ verification, which is a portion of PFAS free water spiked with EIS and targets at the LOQ, is extracted and analyzed once per quarter as per DoD QSM certification criteria. e) A clarification will be added in the next SOP revision by Pace Fixed lab. ***EPA: The responses address the comments 3.a-e above.***

			Surrogate and Internal Standard compounds will be evaluated by comparing the area response of each level to the ICAL midpoint level (L5 – 1000ppt). Any ICAL points for which SUR or IS responses fall outside of 50-200% of the midpoint ICAL shall be removed. If any more than two ICAL points fail these criteria, the system should be inspected and maintenance should be performed if needed. A new ICAL will then be analyzed following any maintenance." DOD QSM 5.3 criteria Table b-15 requires "". It should be noted that calibration standards should never be removed from the middle of a curve.	
4.	-	-	Recommend including a list of data qualifiers and their meanings to be used by the data validator, or indicate a reference used; (for example, that the qualifiers and definitions in EPA National Functional Guidelines for Data Review will be followed.)	The definitions of data qualifiers are added in Worksheet #36. ***EPA: The response addresses the comment.***
SPECIFIC COMMENTS				
5.	7	QAPP Worksheet #1 & #2	The EPA signature is not necessary on this document. Please delete. We will use the comment table and approval letter approach like we do on other Eielson documents.	QAPP Worksheet is revised as requested. ***EPA: The response addresses the comment.***
6.	11	QAPP Worksheet #3 & #5, Project Organization and QAPP Distribution	This worksheet does not specify lines of authority or lines or communication or identify QAPP recipients. The name of the AFCEC RPM needs to be listed here. Please revise this worksheet to include distinct lines of authority (e.g., using solid lines) and lines of communication (e.g., using dashed lines). Also identify who should receive a copy of the QAPP (e.g., using an asterisk) and who is responsible for distribution of the final approve QAPP.	The organization chart is revised as requested. ***EPA: The response partially addresses the comment. It is not stated who is responsible for ensuring that everyone on the distribution list receives a copy of the final approved QAPP and any updates or addendums.*** **BEM Team Response (05-28-21):** The organization chart was revised to show Kevin Gallagher (BEM

				PM) responsible for distributing to AFCEC, the BEM Team, and the subcontractors. It is also revised to show AFCEC RPM responsible for distributing the QAPP to ADEC and EPA. ***EPA: The response addresses the comment.***
7.	13 to 18	QAPP Worksheet #4, #7, & #8, Personnel Qualifications and Sign-off Sheet	This worksheet includes signature checkboxes to indicate that personnel have read and agree to implement the QAPP; however, space for actual signatures is more appropriate to document that personnel have read the QAPP since checkboxes can be marked by anyone. In addition, the checkboxes do not capture the date the QAPP was read by each person. Further, this worksheet does not include all key project personnel. For example, Worksheet #3 and #5 identifies A. Crabb as the Project Chemist, but this person is not listed as someone who should read and agree to implement the QAPP in Worksheet #4, #7, and #8. Please revise this worksheet to remove the checkboxes and include space for actual signatures and dates. Also, please ensure that all key project personnel will read and agree to implement the QAPP.	Worksheet #4, #7, &#8 is revised as requested. ***EPA: The response addresses the comment.***
8.	19 to 22	QAPP Worksheet #6, Communication Pathways	This worksheet does not always include the form of communication or timeframe for notification for the communication drivers listed. For example, the procedure for stopping work because of safety issues states, "Onsite personnel will notify the BEM Team SSHO [Site Safety and Health Officer] who will then notify the BEM Team PMs [Project Managers] (verbal, electronic) and BEM's Corporate Health and Safety Manager;" however, the timeframe for this notification has not been specified. In addition, the necessary contact information for all project personnel has not been provided. While it is noted that Worksheet #9 (Project Planning Session Summary) includes email addresses for some personnel, it is	The communication timeframe is specified. For the first call out of site personnel, the email address is included. Phone numbers are listed under contact information. ***EPA: The response addresses the comment.***

			missing email addresses for several people (e.g., the SSHO, B. Siviec), and no phone numbers are listed. Please revise this worksheet to include the form of communication and timeframe for notification for all communication drivers listed. Also, please ensure the necessary contact information for all project personnel is provided.	
9.	19 to 22	QAPP Worksheet #6, Communication Pathways	This worksheet does not include EPA in any of the communication procedures. Please revise this worksheet to specify that the EPA will be notified of significant corrective actions and when changes to the QAPP occur in the field, and include the form of communication and timeframe for this notification.	USEPA and ADEC are included in appropriate communication drivers. ***EPA: The response addresses the comment.***
10.	47 to 52	QAPP Worksheet #11, Project/Data Quality Objectives	This worksheet is insufficiently detailed and should be expanded to provide additional information regarding the decision process and objectives based on the *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (the DQO Guidance), dated February 2006. Examples include, but are not limited to, the following: • Step 4 (Define the Boundaries of the Sampling) should discuss spatial and temporal boundaries that could present constraints on data collections activities (e.g., location access, environmental conditions, etc.). • Step 5 (Develop the Analytic Approach) should provide decision statements (i.e., "if…, then…" statements) for how the project data will be used. • Step 6 (Specify Performance or Acceptance Criteria) should define the screening levels that will be used for making each project decision. Please revise this worksheet to provide additional information regarding the decision process and objectives to implement the proposed Phase I	The text is revised to include a detailed DQO table in accordance with *Uniform Federal Policy for Quality Assurance Project Plans* (March 2012) and *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (the DQO Guidance) (February 2006) that addresses these comments. ***EPA: The response addresses the comment.***

			Remedial Investigation (RI) activities in accordance with the DQO Guidance.	
11.	47 and 49	QAPP Worksheet #11, Project/Data Quality Objectives	There is an inconsistency between DQO Step 2 (p. 47) and DQO Step 4 (p. 49) regarding where samples will be collected. Step 2 defines sampling across and downgradient of validated PFAS source areas, while Step 4 defines sampling taking place within, upgradient and downgradient of validated PFAS source areas. Correct the text in Step 2 and other QAPP locations if needed to confirm that samples will be collected within, upgradient and downgradient of validated PFAS source areas.	The text is revised to include a detailed DQO table in accordance with *Uniform Federal Policy for Quality Assurance Project Plans* (March 2012) and *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (the DQO Guidance) (February 2006). The spatial boundaries for each of the DQOs are included on the revised WS#11. ***EPA: The response addresses the comment.***
12.	53 & 54	QAPP Worksheet #12-1 and #12-2	Suggest adding PFAS Extracted Internal Standards recovery criteria to Worksheet #12-1 and Worksheet #12-2, in order to provide data similar to surrogate recoveries for an evaluation of extraction recovery in samples. Advise calculating EIS from the initial calibration and report for each sample and QC sample. (Note: Pace mobile lab SOP ENV-SOP-MAD1-0101, Rev 00, Appendix C, Page 1217 differs from DOD QSM criteria for extracted internal standards, using 40-160% instead of 50-150% of ICAL midpoint standard or initial CCV area.)	Extracted Internal Standard recovery criteria are added in Worksheet #12-1. ***EPA: The response addresses the comment.***
13.	59	QAPP Worksheet #12-7, Measurement Performance Criteria – Metals in Soil, Water and Waste Characterization	The measurement performance criteria for the laboratory control sample (LCS)/matrix spike samples references Department of Defense (DoD) Quality Systems Manual (QSM) version 5.1; however, the correct reference is DoD QSM version 5.3 in accordance with the laboratory accreditation certifications provided in QAPP Appendix G (Laboratory QA Manual). Please revise Worksheet #12-7 to reference the correct version of the DoD QSM.	The QSM version number are revised to 5.3. ***EPA: The response addresses the comment.***

14.	71 & 78	QAPP Worksheet #15, Table B-15, Soil/Sediment/Fish Tissue Laboratory Specific Limits	Worksheet #15 states that soil/sediment results are to be reported as dry weight, while the footnote for the Pace – Fixed Lab table for Soil/Sediment/Fish Tissue states "All results to be reported in dry weight". Recommend clarifying whether fish tissue results are to be reported as wet weight (typical for most parameters). Also recommend discussing whether or not results of percent lipids analyses will be reported for fish tissue. The fish tissue LOQs and LODs listed in Table B-15, if reported as wet weight for fish tissue should be sufficient to quantify the lowest known fish tissue residues associated with toxicity to aquatic species, based on the limited amount of residue-effects data known to EPA. Add a table footnote stating whether the Project Screening Levels in Table B-15 are for soil, sediment or both. EPA concurs with QAPP statements that there are currently no known ecological risk screening levels for PFAS congeners in fish tissue.	Results in fish tissue are to be reported in wet weight, it is corrected in Worksheet #15. PFAS have not been shown to be strongly associated with lipid content and lipid analysis is not necessary for PFAS evaluations. Additionally, the overall objective of characterizing PFAS in fish tissue is to evaluate potential human and ecological exposure via fish consumption. Lipid results are not required to make these type of risk determinations. Footnote is added to indicate the Project Screening Levels apply to both soil and sediment samples. Also, the following is added for both ELLE and Pace, "*All results for soil and sediment to be reported in dry weight and fish tissue will be reported to wet weight.*" ***EPA: The response addresses the comment.***
15.	84	QAPP Worksheet #17, Exhibit 1	Add a footnote describing options 1-7.	A footnote is added beneath Exhibit 1 to define Options 1–7. ***EPA: The response addresses the comment.***
16.	94	QAPP Worksheet #17 Source Characterization	Depth of source zone soil samples for submission to the lab is of interest. Suggest submitting zero to six-inch sample, three-foot sample and sample at the capillary fringe. Consistency will aid in leaching evaluations and RA. Consider adding moisture content measurement and collecting additional sample volume for other parameters that may be of interest.	WS#17 is revised to indicate soil sample collection depth of 0 to 0.5 feet bgs, 3 feet bgs, and above the water table at the capillary fringe. Additional samples will be collected for SPLP, AEC, CEC, and TOC analysis during the adaptive phase to evaluate leaching. This is referenced under WS#17 Adaptive Scope of Work, Source Area Characterization. ***EPA: The response addresses the comment.***

17.	95	QAPP Worksheet #17 Source Characterization	Grab groundwater samples collected by peristaltic pump or bailer? If pump, then suggest specifying pump intake position near the water table surface. Other projects on EAFB use FCF's when locations are field located and moved less than 50 feet and not 75 feet from the originally proposed locations. Revise the distance to 50 feet for FCF's in this workplan.	Grab groundwater samples will be collected via a peristaltic pump will be deployed to the approximate mid-depth of the screen point sampler interval. This is documented in TGI Vertical Aquifer Profiling for PFAS Analysis, Rev 1, Date 3/26/2019. The rationale for the placement of the pump intake (at mid-depth of the sampler), is that the screen point samplers provide a grab groundwater sample that is representative of the interval. By placing the pump intake at the mid-point of the interval, the pump intake will be in direct communication with the target interval for sampling. The distance was revised to indicate that FCFs will be submitted when sample locations are moved greater than 50 feet from the proposed location. ***EPA: The responses address the comments.***
18.	98	QAPP Worksheet #17	3rd Paragraph. PFAS are known to sorb to Lexan tubes. See Lath S, Knight ER, Navarro DA, Kookana RS, McLaughlin MJ. Sorption of PFOA onto different laboratory materials: Filter membranes and centrifuge tubes.	Previous documentation from the USEPA has recommended polycarbonate (the material of Lexan) as an acceptable material for sediment sampling in part because of its low affinity for sorbing contaminants. The following document support the use of polycarbonate as an acceptable material: - USEPA. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA-823-B-01-002. October - Tetra Tech. 2003. Literature Review and Report: Surface – Sediment Sampling Technologies. GSA Contract No. GS-10F-0076K, Prepared for USEPA. July 24. The USEPA, through its Office of Research and Development, funded and managed the research described in these references. Both documents have

				been peer reviewed by the EPA and are approved for publication. The reference to the Lath et al. 2019 document evaluated the sorption of PFOA in a laboratory setting. Under those conditions the evaluated sorption of PFOA in water to test tubes and found polycarbonate performed second best at lowest PFAS sorption with 16 to 31% PFOA sorption after water was in the test tube for 1 to 7 days. The sediment collected at Eielson would be in the polycarbonate core tube for minutes and certainly less than one hour. The potential for significant PFAS sorption from the polycarbonate sampler is minimal over this duration of contact. On this basis, we recommended the use of the sediment samplers, as detailed in the SOP. ***EPA: The response addresses the comment.***
19.	98	QAPP Worksheet #17, Porewater Sampling	Consider including an infrared thermal survey to determine gaining reaches of stream to focus sampling effort. Utility of the porewater samples is vastly improved if the relationship between groundwater and surface water is known (i.e. gaining or losing stream). Consider including a procedure for measuring water level of mini piezometer (for example, by observing whether water rises above the surface in a clear tube) to compare with surface water level and determine whether stream is gaining or losing. Augment by comparison of temperature of surface water, porewater and groundwater.	Based on temporal variability at the site, a large-scale thermal survey could be performed multiple times (i.e., wet and dry seasons). AF would consider taking this under a different effort. The surface water/groundwater interaction will be evaluated through measurement of the head difference between the porewater sampler and the surface water body. This has been added to Worksheet #17 under "Porewater Sampling". This will provide a direct measurement at each sample point as to whether the stream is gaining/losing. Duplication of the sample points for the wet and dry season sampling events will allow the changes in the surface water / groundwater interaction to be evaluated. ***EPA: The response addresses the comment.***

20.	99	QAPP Worksheet #17, Table 5	Note on Table 5 which sample locations are upgradient, within and downgradient of validated PFAS source areas.	Table 5 is revised to indicate location (upstream/downstream) proximal to validated PFAS source areas. ***EPA: The response addresses the comment.***
21.	100	QAPP Worksheet #17, Fish Species Selection,	Ideally, each composite sample should only contain tissue from the same species of fish. Multiple fish species within a composite sample provide difficult to interpret results for both human health and ecological risk assessments and should be avoided unless absolutely necessary to obtain tissue samples from a desired sampling location. For both statistical analysis reasons and to ensure that the desired 100 grams of fish/composite is obtained, EPA believes more than two individual fish per composite should be collected. EPA guidance recommends five or more individuals/composite and that the shortest individual in a composite sample containing only the same species of fish be no shorter than 75% of the length of the largest individual fish. EPA generally concurs with the discussion on p. 99-100 that the bioaccumulative tendencies of PFAS congeners do not always the trends followed by most other bioaccumulative chemicals. Given PFAS bioaccumulation and that demersal or benthic species can bioaccumulate higher PFAS concentrations than pelagic species, we recommend that several composite samples from among the 20 sampling locations consist of the demersal longnose sucker to obtain the highest possible (worst case) PFAS concentrations in fish tissue.	Page 101 of the QAPP specifies that each fish tissue sample will be a composite sample of two fish or more, depending on the availability and size of the fish, and each composite will have similar size individuals of the same species. Additionally, longnose sucker are already identified as a target species in the QAPP. No revisions are required. ***EPA: EPA's concern on the composite fish samples encompassed several issues, two of which are discussed in the BEM comment response. The clarification that each composite sample will consist only of individuals of the same species is appreciated and acceptable. EPA remains concerned that two individual fish/composite may not be a sufficiently large sample to adequately estimate central tendency contaminant concentrations at each sampling location. We require further explanation regarding why only two fish/composite sample are proposed.*** **BEM Team Response (06-04-21):** The proposed fish tissue sampling represents a base-wide screening to evaluate whether fish tissue in multiple water bodies throughout the base may be impacted by PFAS, and to evaluate potential exposure to human and ecological receptors. The QAPP proposes a large number of sample locations (20), with two composite edible fillet samples and two composite whole-body samples per location. As described below, this approach is an effective way to provide broad sampling coverage of a

				large area and is consistent with USEPA (2000a) guidance for fish tissue sampling. • The sample numbers are consistent with USEPA (2000a) requirements for contaminant screening studies, which recommends analyzing one composite sample for each of two target species (for edible-size fish). Similarly, the USEPA (2000b) National Study of Chemical Residues in Lake Fish Tissue focused on two composite samples per location (USEPA, 2000). The approach proposed in the QAPP actually includes four composite samples per location (two fillet samples and two whole-body samples). • As described in the QAPP, the proposed fish tissue sampling focuses on composite samples of multiple individuals (both for fillet and whole-body samples). According to USEPA (2000a), composite samples are recommended for analysis of target analytes in screening studies. Because the costs of performing individual chemical analyses are usually higher than the costs of sample collection and preparation, composite samples are most cost-effective for estimating average tissue concentrations of target analytes in target species populations (USEPA 2000a). Besides being cost-effective, composite samples also ensure adequate sample mass to allow analyses for all recommended target analytes. Compositing of multiple fish for each whole-body and fillet sample also accounts for potential deviation of PFAS in individual fish, as each sample more closely reflects central tendency because the sample is composed of multiple individuals.

				• The data assessment (including evaluating the DQOs for nature and extent and exposure potential) will also consider the historic PFAS fish tissue dataset (which similarly focused on two samples per sample type). For these reasons, the proposed four composite samples per location (two fillet samples and two whole-body samples) meets the objectives of the sampling program and is consistent with USEPA guidance for fish tissue sampling and analysis. <u>References</u> USEPA. 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1 Fish Sampling and Analysis Third Edition. Office of Water. Washington, DC. EPA 823-B-00-007. USEPA. 2000a. Quality Assurance Project Plan for Sample Collection Activities for a National Study of Chemical Residues in Lake Fish Tissue. Office of Water. Washington, DC. EPA-823-R-02-005. ***EPA: QAPP Worksheet #17, p. 83-84 describes the fish tissue samples as definitive samples, not screening samples. As definitive samples, five individual fish per composite sample are required according to USEPA 2000a, not the two individual fish proposed. The QAPP must be modified to state five individual fish will be contained in each composite sample. With the exception of increasing the number of individual fish per composite from two to five, and initiation of Chain of Custody forms, discussed separately in EPA Comment 22, the remainder of the fish collection and handling procedure proposed in responses to EPA Comments***

				21 and 22 are acceptable to EPA, and address our comments. **BEM Team Response (06-08-21):** Worksheet #17 line 1491 was revised to, "*Each fish tissue sample will be a composite sample of five (5) fish or more…*" ***EPA: The response addresses the comment.***
22.	100	QAPP Worksheet #17, Fish Collection	Fish sampling locations are not a single point but encompass a stream reach or an area within a wetland or pond. Describe the length of a stream reach or area within a wetland or pond from which fish will be collected with active sampling methods. If sufficient numbers of fish cannot be collected within a reach or area, this must be noted on the field sampling forms. Is there a minimum length of time active sampling will be employed at a sampling location before field crews decide that an insufficient number of fish are present at a location? This minimum amount of sampling time per location should be described in the QAPP. Given the potential for PFAS contamination of plastic bags, it may be better to wrap fish in aluminum foil after collection in the field as opposed to placing fish in plastic bags. Labels on sampled fish in the field before they are turned over to fish processors should contain sample date and time, capture location, fish species, number of individual fish/sample and the amount of sampling time needed to capture the required number of individual fish for each composite sample. The chain of custody forms should be initially filled out by a member of the fish collection team, so that a record of custody can be maintained when the fish collection teams turns over the fish to the fish processing team.	The QAPP is revised to state the following: *Fish sampling will begin at the central portion of the proposed sampling location and will be conducted outward until the target number of fish are collected, and the approximate length/area of the sampling reach will be recorded in the field notes.* *Fish will be wrapped in aluminum foil and not plastic bags.* *The labels on sampled fish will include date, time, and location. The labels will not include number of individual fish/sample, because that will be determined during sample processing. Similarly, the labels will not include amount of sampling time needed to capture the required number of fish, that information will be recorded in the field notes.* *Because the fish collection team will also process the fish tissue samples, custody of the samples will be maintained, and it will not be necessary to initiate chain of custody during sample collection.* ***EPA: Clarification that fish collection will start at the center point of each location and extend outwards until the needed number of fish are obtained, and the wrapping of fish in aluminum foil are acceptable, as they address several parts of***

				EPA's comments. Our only comment here that if the length or area of adjacent sampling locations overlap, this overlap should be documented in field notes. EPA maintains that chain of custody records should be initiated by the field crew in the field during fish collection, not after they have returned to the on-shore fish processing location. **BEM Team Response (06-01-21):** As requested, any overlap of the length or area of adjacent sampling locations will be documented in field notes. Also, chain of custody records will be initiated by the field crew during fish collection, not after they have returned to the onshore processing location. The QAPP text (Page 112) and SOPs (P17 and P18) are updated to reflect this change. ***EPA: Section 6.2.3 of EPA 2000a cited by the AF in their response to EPA Comment 21 states the following: " sample tracking forms should be used for each sampling site to document field activities from the time the sample is collected . . ." Among the sample tracking forms to be maintained from the time the fish samples are collected is the Chain of Custody form. Chain of Custody forms must be initiated by the field sampling crew at the time the fish are collected, before the fish are returned to the onshore fish processing locations to meet the requirements of EPA 2000a.*** **BEM Team Response (06-08-21):** Chain-of-Custody procedures will be initiated from the time the fish samples are collected. WS #17 line 1515, SOP P-17, and SOP P-18 were revised. ***EPA: The response addresses the comment.***

23.	100-101	QAPP Worksheet #17, Fish Processing,	Chain of custody forms must be initiated by the fish collection team at the sampling locations in the field, not by the fish processing team. The fish processing team will record the date, time and other required information on the chain of custody forms once they receive the collected fish from the fish collection team. EPA recommends that the fish processed fish samples be wrapped in aluminum foil for shipping to analytical laboratories, not in plastic bags. Aluminum foil wrapped fish should reduce the potential for PFAS contamination during the shipping to the laboratories. If possible, any morphological abnormalities, fin erosion, infections or other external abnormalities found on fish should be photographed.	Because the fish collection team will also process the fish tissue samples, custody of the samples will be maintained, and it will not be necessary to initiate chain of custody during sample collection. The QAPP is revised to state that fish will be wrapped in aluminum foil prior to placing them in plastic bags. The QAPP is also revised to state that any morphological abnormalities, fin erosion, infections or other external abnormalities will be photographed. ***EPA: See EPA response to BEM's response to comment 22 regarding chain of custody forms.*** ***EPA agrees with the QAPP modifications to wrap fish in aluminum foil, and to note any morphological abnormalities, fin erosion, etc. in field notes, and to photograph them.*** **BEM Team Response (06-01-21):** See response to Comment #22. ***EPA: See EPA response to Comment 22 regarding Chain of Custody form initiation. The remainder of the AF response to Comment 23 is acceptable to EPA and addresses the comment. Comment 22 has now been addressed (6/10/21).***
24.	101	QAPP Worksheet #17, Laboratory Methods and Analysis	If the size or mass of fish in a single composite sample requires the sample to be divided into two or more sections for homogenization, this should be noted in the laboratory bench sheets. It should also be noted if the two homogenized sections are recombined into a single sample for subsequent extraction and analysis, or whether the different sections are used for quality	The QAPP is revised to state the following: If the size or mass of fish in a single composite sample requires the sample to be divided into two or more sections for homogenization, this information will be noted in the laboratory bench sheets. The lab will also note if multiple homogenized sections are recombined

			assurance purposes such as replicate analysis or a spiked sample.	into a single sample for subsequent extraction and analysis, or whether the different sections are used for quality assurance purposes such as replicate analysis or a spiked sample. ***EPA: The response addresses the comment.***
25.	115	QAPP Worksheet #18, Table 9	Depth of source zone soil samples for submission to the lab is of interest. Suggest submitting zero to six-inch sample, three-foot sample and sample at the capillary fringe. Also, sample at facies changes. Consider adding moisture content.	In accordance with the response to Comment #16, the soil sample collection depth are revised to 0 to 0.5 feet bgs, 3 feet bgs, and above the water table at the capillary fringe. Moisture content is determined as part of the soil analysis and will be reported by both the fixed and mobile laboratories. ***EPA: The response addresses the comment.***
26.	118-119	QAPP Worksheet #18, Sampling Locations and Methods, Table 9	The descriptor of the fish tissue samples in the 'Matrix' column of Table 9 should be changed from 'bioassay' to 'tissue' (or 'fish tissue'). The term 'bioassay' generally refers to laboratory toxicity tests and should be eliminated from Table 9. No toxicity tests are being performed as part of the activities being performed under this QAPP.	The text is revised to: "*fish tissue*". ***EPA: The response addresses the comment. EPA appreciates the change in terminology.***
27.	121	QAPP Worksheet #19 & #30, Sample Containers, Preservation , and Hold Times	This worksheet indicates that the Eurofins Lancaster Laboratories Environmental (ELLE) DoD Environmental Laboratory Accreditation Program certification expired on November 30, 2020 and the Alaska Department of Environmental Conservation Laboratory Certification Program certification expired on February 28, 2021. However, according the accreditation certifications provided in QAPP Appendix G (Laboratory QA Manual), the ELLE DoD ELAP certification is valid through November 30, 2022 and the ADEC certification is valid through June 30, 2021. Please revise this worksheet to list the	The expiration data for ELLE's AK certificate and DoD ELAP are both updated per current valid accreditation and the revised certificates are provided in Appendix G. ***EPA: The response addresses the comment.***

			correct expiration dates for the ELLE accreditation certifications.	
28.	121 to 126	QAPP Worksheet #19 & #30, Sample Containers, Preservation, and Hold Times	The sample preservation, preparation holding time, and analytical holding time requirements listed in this worksheet are not always consistent with the information presented in Worksheet #12 (Measurement Performance Criteria), and the laboratory SOPs provided in QAPP Appendix G (Laboratory QA Manual). For example, this worksheet lists the holding requirements for per- and polyfluoroalkyl substances (PFAS) in groundwater and surface water samples as 7 days until preparation and 30 days until analysis, and no chemical preservation. However, Worksheet #12-1 (Measurement Performance Criteria – PFAS in Groundwater and Surface Water) indicates 7 days until extraction with no preservation, 14 days until extraction with Trizma preservation, and 28 days until analysis, which is consistent with ELLE SOP T-PFAS-WI22030. Please revise this worksheet to list sample preservation, preparation holding time, and analytical holding time requirements that are consistent with other QAPP worksheets and the laboratory SOPs.	The holding time is revised to be consistent in Worksheet #12 and Worksheet 19&30. Please note, the lab SOP suggests 14 days holding time without Trizma preservation. However, ADEC recommends 7 days holding time without any preservation. Trizma is accepted by ADEC to extend the holding time to 14 days for PFAS. ***EPA: The response addresses the comment.***
29.	124	QAPP Worksheet #19 & #30: Sample Containers, Preservation, and Hold Times, Unnumbered Table	As recommended in previous comments, fish tissue samples should be wrapped in aluminum foil, not shipped in Ziplock bags, to reduce the potential for incidental PFAS contamination of the fish samples. The table entry on fish tissue containers should be changed from Ziplock bags to aluminum foil.	This worksheet is revised from Ziploc to aluminum foil. SOP P-17 is also revised to include aluminum foil as the fish tissue sample container. ***EPA: The response addresses the comment.***

30.	128	QAPP Worksheet #20, Field Quality Control Summary	The total number of analyses is not specified for fish tissue samples. Please revise this worksheet to include this information.	This worksheet is revised to include the total number of analytes. ***EPA: The response addresses the comment.***
31.	130 to 131	QAPP Worksheet #21, Field SOPs	This worksheet notes that several SOPs will be modified for project work (i.e., SOPs P-10, P-11, P-12, P-13, P-14, and P-15), but the modifications are not listed. Please revise this worksheet to identify how the SOPs will be altered for the current investigation to help ensure consistent follow through by the project team.	The worksheet is revised to indicate only P-10 and P-15 were modified for this project. This note is added to the end of the table, "*The surface water interval was adjusted per USAF preference to sample surface water at the surface. The specific modifications are detailed on the "Version Control" pages of the SOPs, indicating date, description, and page number of the modifications.*" ***EPA: The response addresses the comment.***
32.	135 to 139	QAPP Worksheet #23, Analytical SOPs, and Appendix H, Laboratory SOPs	Inconsistencies were noted between the laboratory SOPs listed in Worksheet #23 and the SOPs provided in Appendix H. For example, Worksheet #23 lists ELLE SOP T-MET-WI1931, but this SOP is not provided in Appendix H. As another example, Appendix H includes several SOPs (e.g., ELLE SOP T-WC-WI0437, Pace SOP ME0014Q) that are not listed in Worksheet #23. Please revise Worksheet #23 to list all SOPs that will be used for this project, and ensure the SOPs are provided in Appendix H.	Inconsistent SOPs numbers are revised in both Worksheet #23 and Appendix H. ***EPA: The response addresses the comment.***
33.	156	QAPP Worksheet #28, Analytical Quality Control and Corrective Action	The quality control (QC) acceptance criteria for the LCS for total suspended solids in surface water is listed as percent recovery between 80-120%; however, Section 9.4 of Pace SOP ME0014X states that the LCS recovery range is between 90-110%. Please ensure that all QC acceptance criteria is consistent with the laboratory SOPs.	The Pace TSS recovery range 90-110% are added. ***EPA: The response addresses the comment.***

34.	157 to 161	QAPP Worksheet #28, Analytical Quality Control and Corrective Action	The QC acceptance criteria toxicity characteristic leaching procedure volatile organic compound, semi-volatile organic compound, and metals samples references DoD QSM version 5.1; however, the correct reference is DoD QSM version 5.3 in accordance with the laboratory accreditation certifications provided in QAPP Appendix G (Laboratory QA Manual). Please revise Worksheet #28 to reference the correct version of the DoD QSM.	DoD QSM version are revised to 5.3. ***EPA: The response addresses the comment.***
35.	-	QAPP Worksheet #28, Analytical Quality Control and Corrective Action	Suggest adding to Worksheet #28 to account for ELLE SOP variance request from DOD QSM (page 425 of Appendix H): "If EIS recovery is >10% [but less than 50%] and samples have no detections for associated native analytes, the native analyte response will be evaluated to confirm the validity of the reporting limit. Reporting limits will be proportionately increased as necessary and appropriate to ensure that reported values accurately reflect the sensitivity of the analysis." OR include language that will describe how this action when taken by ELLE will be addressed by the validator.	The suggested statement is added. However, the lab might not be capable of proportionally adjusting the reporting limits to Worksheet #28. ***EPA: The response addresses the comment.***
36.	171	QAPP Worksheet #36, Data Validation Procedures	This worksheet references DoD QSM version 5.3.1 for analytical specifications; however, there is no DoD QSM version 5.3.1. Please revise this worksheet to remove the reference to DoD QSM version 5.3.1.	The DoD QSM version number has been corrected to 5.3. ***EPA: The response addresses the comment.***
37.	-	QAPP Worksheet #36, Data Validation Procedures	These points need to be clarified: a. The table in Worksheet #36 indicates that a Level 4 Data Package is required for TOC, TSS, and VOC, and a Level 2a Data Package for grain size. Yet the row entitled "Percent of data packages to be validated" is indicated as 0% for these analyses in the table, while	a. The geochemical parameters will be reported as part of Level 4 report along with PFAS data but at a 2a deliverable level. ***EPA: The response partially addresses the comment. This information does not appear to be added to the table as the SVOC, metals, TOC, TSS, VOC, and grain size analyses all indicate 0% data validation. It should be clarified within the QAPP itself if and how***

			b. Footnote on line 1918 reads "100% of the data will be reviewed and verified at Stage 2B. In addition, 10% of the sample results will be validated at Stage 4." (Perhaps the footnote applies only to PFAS analyses?) c. SVOC and metals are not addressed in this Worksheet #36; however, criteria are provided for these analyses in Worksheet #12-6 and #12-7. Criteria are listed in Worksheets #12-1 through #12-7 for all analyses.	***(e.g.: Stage 2a) data from these analyses will be validated.*** **BEM Team Response (06-01-21):** Samples collected for SVOC, metals, and VOC analysis will be collected for waste characterization purposes and waste characterization data will not be validated. TOC and TSS are geotechnical samples and geotechnical samples will not be validated. There were no changes made to the work plan. ***EPA: The response addresses the comment.*** b. PFAS has been added in the footnote for clarification. ***EPA: The response addresses the comment.*** c. SVOC and metals were added in Worksheet #36. ***EPA: The response addresses the comment.***
38.	-	QAPP Worksheet #37, Data Usability Assessment	Worksheet #37 states that "If there is an instance where further limitations must be placed on qualified data, the data will be additionally qualified with "X." This would indicate that the associated data are nondefinitive data and should be used for screening purposes only." The "X" qualifier in this case appears to indicate an undetermined amount of uncertainty – perhaps this data should be rejected. At the very least how the term "screening" level data is being used here should be more specifically defined, to distinguish it from how usable data for this project are to be compared to "screening levels" criteria, described in Worksheet # 10.	The "X" qualified data might be rejected or used for screening purposes. The "Screening Level" or "Project Screening Level" is the project cleanup standard to compare. The "screening purpose" is referred to nondefinitive sample result with uncertain values. ***EPA: The response addresses the comment.***
39.	Pdf page 345	Appendix B – GW Sampling Section 6	Discuss need to review well rehabilitation records to verify well has been stressed recently and water levels respond accordingly. Discuss need to purge wells that have not been stressed or redeveloped recently. Consider placing pump intake near the water table	Groundwater sampling activities will be performed at newly installed wells only which will be installed following completion of the prescriptive and adaptive phases. During sampling, a peristaltic pump will be deployed to the approximate center of the saturated

			surface and within the screened section (i.e., near the top of the screen if the screen is submerged and one foot below the water table if the screen is partially submerged).	screen section of each well. By placing the pump intake at the mid-point of the screened interval, the pump intake will be in direct communication with the screened interval for sampling. Wells are proposed to be installed with screens across the water table, and at target depths of 50-, 100-, and 150-ft below grade. ***EPA: The response addresses the comment.***
40.	Pdf page 483	TGI Fish Sampling Procedures Appendix	The equipment, staff requirements and procedures, and the fish collection and handling procedures are all standard fisheries biology procedures. They even include filling out of chain-of-custody forms and sample labels in the field, which is not discussed adequately in QAPP Worksheet #17, as discussed in earlier comments.	See response to previous comments #21 to #24. ***EPA: With the exception of our concerns regarding when chain of custody forms are to be initiated, and clarification why only two fish/composite sample are an acceptable number of individuals/composite, the BEM response to this comment is acceptable and appreciated.*** **BEM Team Response (06-01-21):** See response to Comments #21 and #22. ***EPA: No changes to our response to comment 40 needed. See comments #21 and #22.***
41.	Pdf page 525	Kickoff Meeting Minutes	We agree that clear DQOs on fish sampling and analysis are required. Collection of small forage fish species such as minnows, while not appropriate for human health risk assessment, may be appropriate for and useful in ecological risk assessment.	Fish tissue sampling will include both filet samples (for human health risk assessment) and whole-body samples (for ecological risk assessment). Sampling will target four composite fish samples per location, including two edible-size fish fillet samples and two forage size fish whole-body samples. Edible-size will be defined as 6-inches or larger total length for trout and grayling and 20-inches or larger total length for northern pike. Additionally, whole-body fish may include smaller individuals or different species, such as longnose sucker, with a target size of less than 6-inches total length. This is detailed in Worksheet #17 under “Species Selection”.

				EPA: As is often the case during fish sampling for contaminant analyses, the numbers and species desired for collection may not be present at a desired sampling location within a reasonable level of sampling effort. EPA recognizes that some flexibility may be needed in the species, number of individuals, size and location from which fish are collected, and which may vary from that proposed in the QAPP. EPA requires that any such variations from the QAPP be documented in field notes. If necessary and possible, it may be useful for field crews to contact an EPA or ADEC risk assessor, if one is not present during sampling, to discuss possible changes to QAPP procedures and approve such changes on the spot. **BEM Team Response (06-03-21):** As requested, any variations from the QAPP will be documented in field notes. Also, if changes to QAPP procedures are required the field crews will contact the BEM PM and/ or Technical Leads and move to the next sample location. The BEM PM and/or the Technical Leads will then complete a Field Change Form describing the change to the QAPP procedures for that location and submit to AFCEC RPM immediately, who will review and upon approval send to the Regulators for approval. Once the Field Change Form is approved the field team will then relocate to the sample location and implement the procedure identified in the approved Field Change Form. These types of variations will also be discussed during Thursday's weekly status meeting. Approval from AFCEC and Regulators will be obtained prior to conducting any alternate sampling methods beyond the approved QAPP.
42.	-	Appendix H	The ELLE SOPs in Appendix are dated August 2020 and references DoD QSM 5.1 rather than 5.3. The	Updated version of SOPs for QSM 5.3 are obtained from ELLE and replaced the old SOPs.

			SOP should be updated to reflect the project accreditation method QC requirements. (Note: The file "03 Eielson PFAS RI_AFCEC RTC Pre-Draft QAPP 01-25-21backcheck.pdf" under item "pre34" states "The SOP for QSM 5.3 is under review and will be included in the Draft-Final QAPP." The updated SOP is apparently not included in the Appendix for H this QAPP.)	***EPA: The response addresses the comment.***